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International Symposium on Integrating Research, Education, and Problem Solving: IREPS 2011
In the Context of
International Conference on Design and Modeling in Science, Education, and Technology: DeMset 2011

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TOTAL	112	100%
United States	34	30,36%
Japan	9	8,04%
Finland	6	5,36%
Mexico	5	4,46%
Brazil	4	3,57%
Germany	4	3,57%
South Korea	4	3,57%
Taiwan	4	3,57%
New Zealand	3	2,68%
Spain	3	2,68%
Canada	2	1,79%
France	2	1,79%
Hungary	2	1,79%
India	2	1,79%
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Italy	2	1,79%
Malaysia	2	1,79%
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Switzerland	2	1,79%
United Kingdom	2	1,79%
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Foreword

Information and Communication Technologies (ICT) are having an increasing impact in almost every scientific discipline and are facilitating the creation of integrative systems and processes, which are in turn supporting the creation of effective relationships among different academic activities and potentiating effective collaboration in research, design, and education. On the other hand the conceptual infrastructures of Systemics, Informatics, and Cybernetics (Communication and control) are increasingly being related to each other and are providing an effective intellectual platform for inter-disciplinary communication. Accordingly, the main purpose of the organizing committees of the collocated events organized by the International Institute of Informatics and Systemics (IIIS) on 11/29-12/2, 2011, in Orlando Florida is to bring together researchers, developers, practitioners, consultants and users of Information and Communication Technologies, for **intra- and inter-disciplinary communication**,

Consequently, three kinds of activities have been planned:

1. Regular traditional presentations in breakout sessions to support *intra-disciplinary* communication,

2. Plenary sessions where Keynote Speakers will address the *multi-disciplinary* audience, mostly with inter- or trans-disciplinary topics, and

3. Conversational sessions on inter- or trans-disciplinary topics in order to support *inter-disciplinary communications* and to foster the **analogical thinking** that might emerge in a multi-disciplinary forum based on trans-disciplinary concepts and/or multi-disciplinary tools, technologies, and methodologies. Ideas generated by analogical thinking might be a) applied to a diversity of areas and practical domains, and b) support a synergic combination of **analytical** and **synthetic** thinking.

The disciplinary *variety*, required for inter-disciplinary communications, analogical learning, and synergic analytical/synthetic thinking, is one of the motivation for organizing the following related events:

- International Conference on Information and Communication Technologies and Applications ICTA 2011
- Design and Modeling in Science, Education, and Technology: DeMset 2011
- International Symposium on Integrating Research, Education, and Problem Solving: IREPS 2011
- International Conference on Education, Informatics, and Cybernetics: icEIC 2011

The articles accepted for presentation that also have an author registered in the conference for the respective presentation, have been grouped in two volumes for their publications in the hard copy proceedings of the collocated events. Their grouping is based on the similarities of the respective topics. Consequently, papers of ICTA 2011 and DeMset 2011 have been grouped in one volume, and papers of IREPS 2011 and ICEIC 2011 have been grouped in another volume.

All papers to be presented at the collocated events were included in the electronic version of the proceedings as well.

Since different kinds of reviewing methodologies are applied in different disciplines we integrated the most used reviewing methods into a *systemic reviewing methodology* for the reviewing process of the papers submitted to the collocated events.

This methodology is based on three-tier reviews: open (or non-blind), double-blind, and participative reviews. Final acceptance depends on the three kinds of reviews. However, a paper should be recommended by non-blind reviewers AND blind reviewers in order to be accepted for presentation at any event and to be included in the respective proceedings. A recommendation to accept made by non-blind reviewers is a **necessary** condition, but it is not a **sufficient** one. A submission, to be accepted, should also have a majority of its double-blind reviewers recommending its acceptance. This double necessary conditions generate a **more reliable and rigorous** reviewing than those reviewing methods based on just one of the indicated methods, or just on the traditional double-blind reviewing.

Double-blind reviewing has been done by a random selection of 3-5 reviewers from about 20,000 IIIS reviewers who classified their research or expertise field in the same theme, area, or subarea where the author classified his/her submission. The random selection (made by a computer program) has been conceived in order to avoid any conscious, or un-conscious, bias that might be done by a human-being selection of the respective reviewers.

IIIS' non-blind reviewing is based on the essence of what Kaplan (2005, "How to Fix Peer Review", *The Scientist*, Volume 19, Issue 1, Page 10, Jun. 6) proposed in order to fix peer reviewing problems. Kaplan affirms that "Peer review subsumes two functions. First, peer reviewers attempt to improve manuscripts by offering constructive criticisms about concrete elements … The second function of peer review is to render a decision about the … significance of the findings so that the manuscript can be prioritized for publication. I propose reforming peer review so that the two functions are independent." With regards to the first function of peer reviewing, Kaplan proposes that "**Review of a manuscript would be solicited from colleagues by the authors.** The first task of these reviewers would be to identify revisions that could be made to improve the manuscript. Second, the reviewers would be responsible for writing an evaluation of the revised work. This assessment would be mostly concerned with the significance of the findings, and the reviewers would sign it" (emphasis added).

We try to achieve the first function via Kaplan's non-blind peer reviewing and the second function by the traditional means of double-blind review. This is why acceptance of submissions by the non-blind reviewers is a necessary condition but not a sufficient one. The submission should also have favorable recommendations by the majority of the double-blind reviewers in order to be accepted by IIIS for its presentation and inclusion in the respective conference proceedings.

A third reviewing tier is the participative peer reviewing, which complements the two tiers described above but is not a necessary condition for accepting a submission. An article submitted to a conference being organized by IIIS is immediately displayed for review to those authors who submitted articles in the same theme, area, or sub-area. Accordingly, each submitting author has access to all submissions sent to the same area where he/she submitted his/her article and can comment and evaluate them. This is what we call at IIIS "Participative Peer-to-Peer Reviewing" or PPPR. This kind of reviewing provides additional input to the selection process and assists all participants in placing their presentations in context. It is not a necessary condition but it has a complementary function, especially in those cases where the non-blind reviewers have a strong disagreement or there is no majority of recommendations accepting, or not accepting, the article.

On behalf of the Organizing Committees, I extend our heartfelt thanks to the members of the four Program Committees (from 74 countries), and to the additional 847 reviewers, from 85 countries, each one of whom reviewed at least one of the submitted articles. 327 reviewers, from 65 countries, were suggested by the respective authors for the non-blind peer reviews. *Each registered author could get information about: 1) the average of the reviewers' evaluations according to 8 criteria, and the average of a global evaluation of his/her submission; and 2) the comments and constructive feedback made by the reviewers, who recommended the acceptance of his/her submission, so the author would be able to improve the final version of the paper.*

A total of 1792 reviews were made to the 303 submissions that were received, which means that an average of 5.91 reviews were made to each received submission, and an average of 2.12 reviews were made by each reviewer. The 112 papers included in these proceedings, from 33 countries, are 36.96% of the 303 submissions that were initially received. Details for each of the four events are summarized in the following table.

Conference	# of submissions received	# of reviewers that made at least one review	# of reviews made	Average of reviews per reviewer	Average of reviews per submission	# of papers included in the proceedings	% of submissions included in the proceedings
icEIC 2011	58	210	400	1.90	6.90	22	37.93%
ICTA 2011	115	323	758	2.35	6.59	41	35.65%
DeMSET 2011	56	142	326	2.30	5.82	22	39.29%
IREPS 2011	74	172	308	1.79	4.16	27	36.49%
TOTAL	**303**	**847**	**1792**	**2.12**	**5.91**	**112**	**36.96%**

We are also grateful to the co-editors of these proceedings for the hard work, energy, and eagerness they displayed in preparing them. We express our intense gratitude to Professor William Lesso for his wise and opportune tutoring, for his eternal energy, integrity, and continuous support and advice as Honorary President of IIIS' conferences, as well as for being a very caring old friend and intellectual father to many of us. We also extend our gratitude to Professor Belkis Sanchez, who brilliantly managed the organizing process. Special thanks to doctors C. Dale Zinn and Jeremy Horne, and to professors Hsing-Wei Chu, Friedrich Welsch, Michael Savoie, Andrés Tremante, Jorge Baralt, Mohammad Siddique, and José Ferrer for chairing, or co-chairing the respective program committees.

We also extend our gratitude to doctors Robert Baker, Joseph Finkelstein, Jeremy Horne, Daniel Katz, Lisbeth Amhag, Merja Bauters and to professors Juha Kettunen, T. Grandon Gill, Bodil Ask, Harald Haugen, Mohamed El-Sayed, and Donald Poochigian, for accepting to address the audience of the General Joint Plenary Sessions with keynote addresses.

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Professor Nagib C. Callaos,
General Chair

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Learning about Atrial Fibrillation using Social Media: A Qualitative Inquiry

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Abstract
Health information is one of the major topics searched on-line. Social media is increasingly used by patients for health education, empowerment and support. There is a lack of systematic data on what kind of information is being sought by patients via social medial channels. By analyzing information exchange in an on-line support group we can better understand what information is not provided reliably to patients in a clinical setting. The aim of this study was to analyze a content of messages exchanged between participants in an online support group for people with atrial fibrillation. Using Grounded Theory, we conducted a content analysis of 626 messages, which were grouped into seven categories. We described each category and provided examples of users¶ citations belonging to each category. In addition, proportion of initial posts and responses to them was analyzed depending on message category. Social media facilitated health education on major topics related to atrial fibrillation. Practical implications of qualitative analysis of messages posted on an online support group are discussed.

Keywords:

Atrial fibrillation, online support group, qualitative analysis, knowledge gaps, social support

Introduction

Atrial fibrillation (AF) is the most common cardiac dysrhythmia which affects over 6 million patients in Europe and approximately 2.3 million in the United States. The number of patients with AF continues to grow rapidly due to an expanding elderly population. AF increases the risk of embolic stroke by about 4-5 times [1]. Furthermore, AF is responsible for one-third of all hospitalizations for cardiac dysrhythmia, and the number of hospital admissions for AF increased two- to three times from 1985 to 1999 [1].

Despite high hospital admission rates and high prevalence of the disease, even after emergency room and hospital admission, patients with recently detected AF have limited knowledge about AF symptoms, purpose of medication, stroke prevention, and side effects of warfarin [2]. Gaps in knowledge about the disease and its treatment, detection of symptoms and how and when to seek treatment were found in another study in patients visiting emergency room for AF symptoms and 3 months after discharge [3].

AF significantly affects patients¶ everyday quality of life [4]. It may sometimes limit their everyday and extracurricular activities, such as physical exercise, travel and others. Treatment for AF symptoms has been shown to improve the quality of life [4]. Among treatment options available are prescription of medication, electrical cardioversion, radiofrequency ablation, implantation of atrial pacemakers, surgery and others.

With wide Internet expansion, individuals affected by AF turn to Internet in search of informational and emotional support from other people who are also affected by the disease by joining disease-specific online support groups. Online support groups help individuals to cope with their disease-related issues by overcoming distance, access, or communication-related challenges [5]. Members can share their experiences anonymously and ask questions that they may be uncomfortable to ask in person when interacting with their peers or a medical professional. Moreover, patients get access to more diverse points of view and information as compared to what they can get through established close relationships [6,7]. Therefore, online group members may obtain diverse information about their condition, treatment and related issues from other members. Such information is based on members¶ own experience and information from other sources like Internet web sites, books, patients¶ doctors and others. Thus, active participation in an online support group may help educate patients about their condition by addressing their knowledge gaps.

In addition to sharing information, patients share their emotions and feelings related to their disease. Participation in online groups promotes trust, empathy and emotional integration into a ‡virtual community· [8]. Higher levels of social support are related to lower psychological distress and better mental health in the sense of coping resources [9]. Social support buffers effect of stressors, like chronic health conditions, negative life events and other long-term conditions. In this case, social support may help a patient to cope better with the disease. Perceived availability of social support serves as a protective factor against psychological distress, depression, and anxiety [10,11].

Qualitative research methods are widely used to gain in-depth understanding of human behavior and the reasons that govern such behavior. The content of messages posted in online support group web sites may be a valuable resource for understanding experiences of group members and the utility of online interactions for the group participants [12]. Content analysis of the messages posted online has been previously successfully applied to investigate moderated and non-moderated online disease-specific support groups [13-14]**.** However**,** analysis based on Grounded Theory (GT) has not been applied systematically to the content of online support groups, particularly in individuals with AF [15].

The goal of the present study was to analyze information content of messages exchanged between participants in an online AF support group using qualitative methodology in order to identify and classify major topics which are being discussed by the group participants. Understanding the everyday concerns and worries in the lives of patients with AF can help health care professionals to better meet their patients¶expectations, and address patient-centered values, preferences and needs.

Methods

A grounded theory approach was followed in the analysis of online posts [16]. Research based on GT employs inductive thinking, aiming to understand a situation from 'inside' rather than stating a hypothesis first. Therefore, no categories were specified in advance of data collection. We analyzed archived messages posted on one of the AF support group web site. The content of 626 messages posted during the period of 1/1 to 1/31 2008 by 144 anonymous users was analyzed using the NVivo 8 software. Messages were analyzed in terms of similarities or differences, which was followed by finding common themes and developing categories. These categories then were used as a basis for the creation of a hypothesis.

Results

All messages have been grouped into seven major categories (see Table 1 for details). The most discussed category of messages was related to *medications.* Within this category, group members discussed medications prescribed to alleviate AF symptoms, which medications helped and which did not, and medication side effects. The most frequently mentioned medications were amiodarone and coumodin, e.g. ‡It (amiodarone) got me very very sick and I did not know it until I had to be hospitalized. ‡

The *procedures* category included postings about effectiveness of such procedures as ablation, cardioversion, and half/full maze procedure, e.g. ‡My ablation healing seems to be progressing very well. My EKG is fine. I have been AF free except for three post ablation episodes (of decreasing duration) the first week. I understand that is part of the healing process. ·

The *experiences with AF* category contained messages describing personal experience with AF symptoms, asking how common the symptoms are and how other members cope with them, e.g. ‡Sometimes I will feel dizzy beforehand, but very often it will come out of the blue («) My heart does palpitate very strongly several times a day, but this seems to happen independently of other symptoms. ·

The category named *quality of life* included messages about the impact of AF on quality of life. The members discussed limitations in physical exercise and travel: ‡AF was basically ruining my life. I could no longer travel, I could no longer feel free to do simple things like paint a wall, or work in the garden on a hot day. · Also, members shared how the disease affects their everyday life activities such as shopping, work, leisure time.

The *diet* category reflected the properties of various foods and drinks, such as green vs. black tea, fruits and vegetables, and how they affect the disease and blood coagulation: ‡A month ago after reading that green tea can cause palpitations I stopped taking the tea - and my AF has been behaving itself! ·

In *helpful links and articles* helpful web sites, links and other sources of information were posted, e.g. ‡See Medscape, guidelines for the management of AF. Dr. Calkins has some very useful comments on Amiodarone in his interview with editor. ‡

In the last category, *devices*, two devices helping to monitor and regulate the heart rhythm were actively discussed - atrial pacemakers and holter monitors, e.g. ‡I had a holter a few years ago, but unfortunately wasn¶t able to catch any of the episodes on it. ·

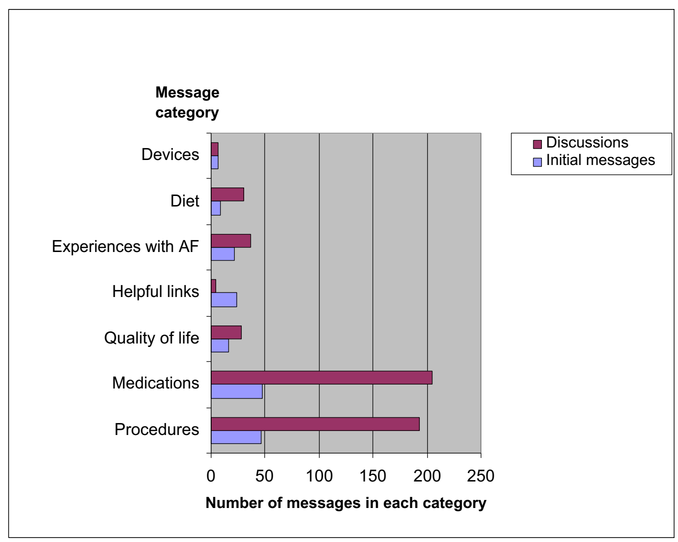

Figure 1- Number of initial messages and their discussions in each message category

As seen in Figure 1, messages posted in some categories initiated active discussion of a topic, whereas in other categories number of responses was relatively low. For instance, the two most discussed categories were medications and procedures. At the same time, posts related to helpful links and articles were not discussed as actively as other messages.

Table 1- Number of messages in each category and subcategory and their percentage values

Message category	**Total number of messages in each category and subcategory and their percentage**	
	Total number	%
Medications	252	
Antiarrhythmic drugs	79	31.35
Anticoagulants	59	23.41
Beta-blokers	27	10.71
Calcium channel blockers	9	3.57
Calcium and potassium	40	15.87
Side effects	33	13.01
Others	5	1.98
Procedures	239	
Ablation	151	63.18
Cardioversion	26	10.88
Maze	19	7.95
Location	19	7.95
Other	24	10.04
Life with AF	59	
Symptoms	17	28.80
Sleep	7	11.85
Dealing with AF	4	6.77
AF during pregnancy	3	5.05
Other	28	47.44
Quality of life	44	
Exercise	33	75.00
Travel	6	13.64
Influence of AF	2	4.55
Other	3	6.82
Diet	39	
Green tea	15	38.46
Red tea	3	7.69
Other	21	53.84
Helpful links	28	
Devices	18	
Holter	7	38.88
Pacemaker	4	22.22
AfibAlert	2	11.11
Other	5	27.77

Discussion

We identified seven major categories of messages posted in the AF online support group: medications, procedures, life with AF, quality of life, diet, helpful links, and devices. With exception of helpful links and devices categories, in all other categories the proportion of messages offering support was much bigger than initial messages. This finding supports previous research describing major discussion topics in a disease-specific online support group [18].

We analyzed messages posted on the AF online support group during one month. Messages were content analyzed and grouped into seven major categories. We found that in five out of seven categories AF patients were more inclined to offer support than ask for it. This pattern was especially evident in topics related to AF medications and treatment procedures. At the same time, much less interest was expressed toward objective information related to atrial fibrillation available online, such as articles, web sites and useful links.

Messages posted in AF online support group provided insight into the disease- related topics that are the most important for AF patients and which were not addressed otherwise. The most common topics in group members ¶messages were related to AF medications and treatment procedures. This finding supports previous research demonstrating gaps in AF patients ¶knowledge about the disease and its treatment [2,3]. It also emphasizes patients ¶need in opinion from others who have similar condition, not just a medical professional. The number of responses to posts related to medications and treatment procedures was four times greater than the number of initial posts. Therefore, group members sought other members ¶opinion and advice in addition to their doctor¶s suggestions, e.g., ³I have been advised to increase that (medication dosage) to 400 mg of paceron once a day, 200 in the AM and 200 at night. Anyone else take that large a dose with no side effect? ·, ³I think I am ready to say goodbye to the meds, talk to my Doctor and go for rate control. Anyone have any thoughts or advice? ·

Furthermore, AF patients paid much less attention to the discussion of validated sources of factual information related to atrial fibrillation available via online educational resources, such as articles, web sites and useful links, as compared to exchange of personal experiences and opinions. This demonstrates that the primary impetus for joining the online group for the AF patients was the desire to learn more about the disease from other people with the same disease, to understand how other people deal with this condition, and to validate their personal opinions by the group experience. Similar findings were reported in a case study of another online support group [8]. Our findings also correspond to results of a recent survey which demonstrated that patients preferred to discuss medical information online before talking with medical professionals [17].

Analysis of the content topics supported the notion that participation in the AF online group helped patients to cope with life challenges posed by their condition. Sharing emotions related to life with AF and getting understanding from others reduced psychological distress in patients, e.g. ‡Thanks for the additional information re: other rhythms. It has given me some stress relief from the concerns I had.· Moreover, in response to sharing personal experiences, the patients received information about a wide range of disease coping strategies that may be potentially effective in patient¶ situation. The fact that the group participants were more inclined to provide support rather than request it from others underscored previously described phenomena according to which providing social support to others may result in health benefits comparable to † or even greater † than receiving support [19].

Previous studies demonstrated the efficacy of computer-assisted education in delivering knowledge and empowerment for disease prevention and management [20-21]. Social media can be used in conjunction with other tools available on the internet to improve continuous personalized patient education and support [22].

Conclusion

Our study provides evidence that an online support group for AF patients can help them to address knowledge gaps about their condition based on others¶personal experience. In addition, by joining such groups, patients can find emotional and informational support and resources that can help them to deal with disease-related stress. Understanding information needs of people with AF can help medical professionals to provide better medical care and improve patient-provider communication.

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Online Lifelong Learners and the Work Life Learning Balance

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ABSTRACT

We analyze the Work Life Learning Balance (WLLB) of life long learners' time use, considering the time management strategies these adults consider to maintain equilibrium between their professional engagements, their family life and their academic times.

Keywords: Work Life Balance (WLB); Work Life Learning Balance (WLLB); Time flexibility; Time quantity; Time quality; E-learning; Academic performance.

1. INTRODUCTION

Over the last few years, the issue of work - life balance (WLB) has been receiving increasing attention in the society. Much is being considered about the strategies to adapt the professional timetable and temporal requirements to help encourage work/life balance within the employees. Companies are beginning to recognize signs of stress, or even worst, burnout among the employees that who invest themselves mainly in their professional activity, without considering their private and social life.

In Europe Work-Life Balance (WLB) paints a mixed picture. It shows growing awareness of work-life issues, quite widespread flexible working practices, but also a dominant long-hours culture. The current financial crisis has stifled many of the Work Life Balance (WLB) initiatives promoted in the last years, despite of the social interest of making professional life and family life more compatible.

In addition to the balance of work and private and social time, there is a need to invest time in the personal learning and the development of competences (Beckett & Hager, 2002).

2. ENHANCING EUROPE COMPETITIVENESS THROUGH LIFE LONG LEARNING

The need for continuous life long learning actions has increased, especially in knowledge based sectors. The (life long) learning times (i.e., quantity, quality and pattern of usable time) must be combined with the professional and family times to ensure a balance of the adults' academic, professional, and family responsibilities and the overall well-being and their personal development. However, finding an appropriate balance between different life domains is neither easy nor instantaneous (Metzger & Cléach, 2004).

3. ONLINE EDUCATION FOR TIME POOR ADULT LIFELONG LEARNERS

One of the main reasons to enrol in an online campus, is a lack of time availability to attend the traditional face to face university. The reasons for this lack of time availability is often related to the adult lifelong learners professional and family responsibilities. Online education offers them the temporal flexibility required to adjust their academic time-on-task to their professional and family temporal requirements.

Temporal flexibility is one of the main expectations of online learners' enrolling in the virtual campus.

Nevertheless, adult lifelong learners could fall in the error to confound time flexibility and academic time-on-task reduction. Learning times in the virtual campus are similar from the point of view of the student; despite the temporal flexibility the students' have for allocating the academic time-on-task in the flexible institutional time of the virtual campus.

4. ONLINE LEARNERS' QUALITY TIME

Time quality in online learning depends on a combination of time availability and willingness to devote quality cognitive time to learning activities (Romero & Barberà, 2011). However, the quantity and quality of the time spent by adult e-learners on learning activities can be reduced by professional, family and social commitments. Considering that the main time pattern of most adult e-learners is their professional time-pattern, online education could offer a certain degree of flexibility in instructional time to allow life long learners to adjust learning times to professional constraints. However, using the time left over once professional and family requirements have been fulfilled could lead to a reduction in quality time for learning.

Romero and Barberà suggest analysing the distance life long learners' performance according to their temporal attributes (working hours, time-on-task engagement, time flexibility, time of day, day of week) and also observe and capture attributes that influence the quality of the time invest in learning related with the level of performance (i.e., motivation, attention).

4. RESEARCH OBJECTIVES

In this study, we propose the term Work Life Learning Balance (WLLB) to refer to the adjustments of the life long learners' temporal patterns that are done to maintain equilibrium between their professional engagements, their family life and their academic times. Despite a possible WLLB in a quantitative perspective, we should consider the quality of the time devoted to each of the time uses (professional time use, family time, academic time) to analyse the impact that the quality of the time could have in their performance. In this study we focus on characterising the life long learners' academic times and their impact in their individual and collaborative learning activities' performance in their distance learning course.

5. METHODOLOGY

For this reason, we analyse the time-related attributes of the life long learners (working hours, time-on-task engagement, time flexibility, time of day, day of week) according to their individual and collaborative grades during an online master course.

The context of the study is the Universitat Oberta de Catalunya virtual campus. The students are postgraduate students of the master of e-learning.

6. RESULTS

Students' time flexibility (r=.98) and especially their availability for time in the morning are related to better grades in individual (r=.93) and collaborative activities (r=.46).

7. DISCUSSION

The results of our study allow us to consider better results in the morning time use for the academic activities in the virtual campus. In this study, better results are observed both in individual and collaborative activities. Previous research studies had considered the increase of the peak of performance during the early morning hours, especially for the morningness-types (McElroy & Mosteller, 2006).

We should consider in further studies within the Time Factor research project, the analysis of the quality of the academic lifelong learners' time to advance in the understanding between the students' temporal flexibility, the moment of day and the learning activities typologies.

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Integration of Traditional and Emerging Technologies in the Education Sector

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ABSTRACT

The constant evolution that the Internet and Communication Technologies (ICTs) have suffered in recent years, has allowed the creation and improvement of more productive sectors. Education sector has been one of the sectors which most increase has had due to ICTs. Unfortunately, ICTs have been designed and deployed to change drastically the learning methodologies. One of the reasons for this reality is the several technology plans promoted by the governments. The main objectives of this kind of plans are to provide ICT resources to students and schools, ensuring Internet connectivity within the classroom and to promote the access to digital educational materials. Moreover, the technological gap is the main problem to solve in this area. Lecturers, teachers and students have to learn a lot of tools to have better experience inside the educational environments. We show by this work a platform based on digital pens integrated with one Learning Management System to minimize the technological gap by using devices that are everyday used.

Keywords: learning management system; digital pen; technological gap, user experience

1. INTRODUCTION

The constant evolution that the Internet and Communication Technologies (ICTs) have suffered in recent years has allowed the creation and improvement of more productive sectors. Education sector has been one of the sectors which has had most increase due to ICTs.

One of the reasons for this reality is the technology plans promoted by public institutions and governments of the different countries. The most important plan in Spain, which promotes the use of ICTs in education, is called Escuela 2.0[1]. The main objectives of this plan are to provide ICT resources to students and schools, ensuring Internet connectivity and interconnectivity within the classroom for all teams; to promote the training of teachers in the technological aspects, generating and facilitating access to digital educational materials; and to involve students and families in the acquisition, custody and use of these resources. One of the aims of these plans, which governments are trying to achieve, is the decrease of the technological gap.

Nowadays, we can find several number of education centres (from schools to universities) where a Learning Management System (LMS) is implanted. By those platforms resources like courses, subjects, teachers, students, or grades related to teaching are managed.

By this we show a platform based on digital pens integrated with one Learning Management System that can minimize the technological gap by using devices that are everyday used; in this case the subsequently exposed digital pen.

Firstly, existing LMSs are shown in Chapter II. In Chapter III we explain what a digital pen is. Chapter IV presents the Virtual Learning Environment (VLE) we have designed. In Chapter V we explain in great detail the system architecture of the VLE. Chapter VI presents the preliminary evaluation of the implemented system. Finally, the research is concluded and further work discussed in Chapter VII.

2. EXISTING LEARNING MANAGEMENT SYSTEMS

Moodle [2] is one of the LMS companies that has the highest market share. Moodle was one of the firsts LMS platforms. This fact, combined with the open source philosophy, is the principal reason why it has a great commercial success. The groups, courses, documents and questionnaires (inside a specific course) management are the most important functionalities that this LMS platform offers.

Due to the open source politic aforementioned, functionalities of Moodle grow steadily because of the facilities to create new components that developers have.

The other most used LMS in education centres is the BlackBoard Learning [3]. The biggest difference between this platform and Moodle is that BlackBoard Learning has a commercial use and so that, a license for its use has to be paid. Apart from this characteristic, the functionalities of both platforms are basically the same.

Sakai CLE [4] is a relatively new LMS that has deeply entered into the market. The main difference between this platform and the other two is that Sakai, apart from offering functionalities to manage different courses, adds more complete resources to manage different tests in order to evaluate the knowledge of the students.

These three platforms are the most commonly used in education but they are not the only ones. There are other fairly used platforms like In-houseDevelopment [5] and TotalLMS [6].

Moreover, there are many education centres where instead of using a system designed specifically for teaching, make use of generics ones. The most used platform in those centres is GoogleDocs [7]. Usually, schools that use this system have agreements with Google. This company offers the ability to access to various Google applications through an email from a domain which is different to the one Google offers (Gmail.com). GoogleDocs is typically used by companies for the sharing and collaborative editing of documents. The problem with this is that GoogleDocs, basically, focuses on records management across the board. At no time can be created courses, groups and so on, clearly representing concepts related to education.

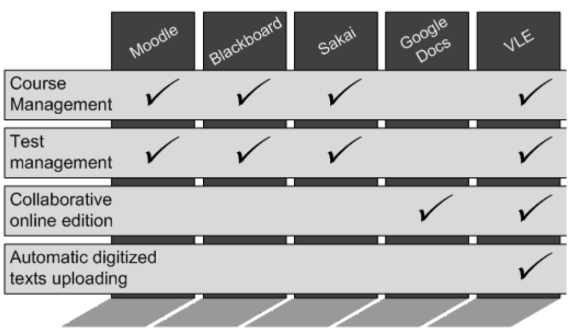


Figure 1. LMS comparison

Although the productivity of those 3 platforms is high, all of them have the same problem. When a student wants to share the notes that he takes in class with his classmates, he has to transform them to a digital document or take them directly by digital way.

In the first case, the action of sharing notes has a low rate, because many people would not be willing to pass notes to digital format to share them later. The problem of the second case is that a low number of people would be able to take notes using a word processor as efficient as if they take them in a traditional way.

Another action that few LMS contemplate is the better and complete tests management. Even the tests are one of the most common forms of assessment; none of the above described platforms enables the creation and automatically correction of tests.

3. THE DIGITAL PEN

A digital pen [8] looks and feels like a normal ballpoint pen. The person who uses this element does not realize that he is using a digital pen while he is writing; he does not sense the different between a digital and a traditional pen. Although the digital pen user does not realize of the difference, the digital pen contains an integrated digital camera, an advanced image microprocessor and a mobile communication device for wireless connection.

Thanks to the digital pen you can capture the handwriting, store it and finally send it in a safe way. By this manner you easily can convert the inked handwriting to digital data.

When a digital pen is used with a surface that has the Anoto dot pattern [9] printed on it, in the moment when the pen is put on the surface it starts to digitize handwritten text. Thanks to the Anoto dot pattern is easy to know in which place of the surface the digital pen is writing. The pen reads and records pen strokes in relation to the barely visible pattern. This digitizing content is sent to a server that saves all this data.

4. THE VIRTUAL LEARNING ENVIROMENT

Once we have analyzed the advantages and disadvantages of the existing LMS platforms, we have designed a new platform that takes into account the features that are already covered by existing platforms and adds very powerful new ones.

The new platform that has been designed and implemented along with the use of digital pen makes up what is called Virtual Learning Environment (VLE).

The main goal of this environment is to reduce the digital gap in the academic scope. To achieve it, the designed platform offers different functionality necessary to meet the 3 basic scenarios that have been established. The scenarios are attending classes, reviewing documents and conducting exercises.

Regarding the *attendance to class*, we have detected that the functionalities that has to satisfy the platform are the digitalization of the notes and the creation or edition of documents with the digitalized content. The system in order to meet these two features, allows students to take notes by traditional way (using a pen) and have them automatically available in digital format on the platform, with the advantages that entails.

Furthermore, the scenario in which students *review the scanned documents* has been contemplated. Once the student notes have been scanned and digitalized, the student not only can use this content to create new documents but also can merge the content with other documents stored in the platform. In order to make the documents more accessible to the VLE users, the platform is integrated with GoogleDocs, where all the documents are stored. Users can share all the documents they have created with several platform users. Through this sharing any student with access to the document may take action on them such as correcting any information that is wrong or adding comments.

The functionalities that the platform develops to cover the scenario of *creation of exercises* are the creation of new tests and automatic correction of the digitized responses to them. The platform offers the possibility to create different tests, based on the questions, possible answers and the correct choice. When students complete the test in an answer sheet that has the Anoto pattern printed, automatically the items marked by the students are digitalized and the platform correct the test using the correct answers given by the teacher when the test was created.

Apart of the functionalities we can take out from the scenarios we have previously described (document digitalization, digitalized content management, test management, document sharing, etc.); there are another GoogleDocs functionalities that are offered by the VLE. The most interesting extra functionality is the collaborative online edition. Thanks to this functionality, more than one student can add information to a document or correct it at the same time.

5. SYSTEM ARCHITECTURE

The Virtual Learning Environment (VLE) is divided into the following 3 layers: Presentation, Logic and Integration. Each of these layers has its own distinct features. The *Presentation* layer is the responsible for exposing to the user all the functionality of the platform. The logic layer manages the system behaviour. Finally, the *Integration* layer is responsible for the communication with external services in order to obtain digital notes (Astutia) and management of documents (GoogleDocs).

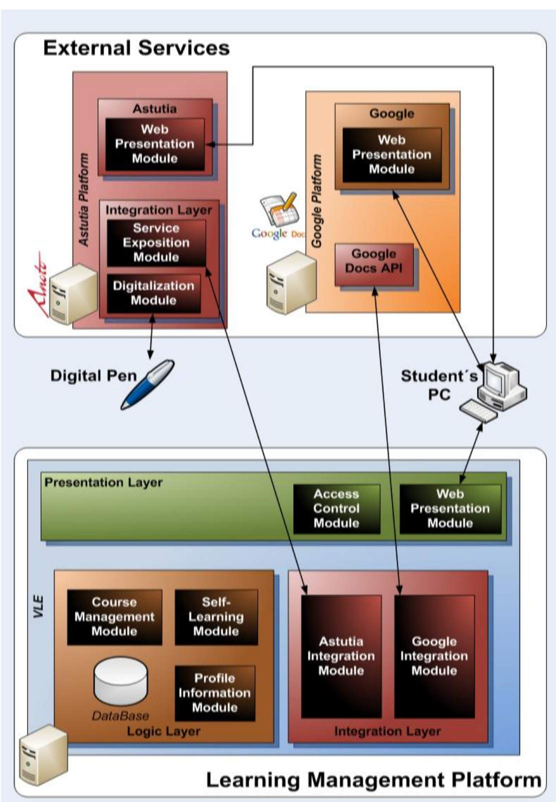


Figure 2. VLE Architecture

Within the *Presentation layer* of VLE two modules can be distinguished: Web Presentation and Access Control modules.

Web Presentation module enables users to access to all the services the VLE offers, such as to authenticate into the platform, manage their documents, manage the tests performed and so on. The access to this module by the user can only be made by using a web browser.

VLE platform provides the Access Control module in order to obtain a safe access to the contents of the platform through the Web Presentation module. This module controls that only authenticated users can enter to the private areas of the platform and they can only perform actions for which they have been authorized. For an efficient control an input filter has been implemented. This filter is consulted whenever a user makes a HTTP request on any resource located in the private area of the VLE platform

The *Logic layer* in turn, is divided into the following modules: Profile Information, Course Management and Self-Learning.

Effective management of information associated with a student profile is critical in any system and the mismanagement of it can cause a lot of security problems. For this reason the VLE platform provides the Profile Information module. This module provides functionality for user authentication, authorization and the registration of new user.

With authentication, the system always knows that the connected user to the platform is the user who claims be. As the VLE platform is all time in communication with Google and this company provides its own authentication systems [10], the Profile Information module will use the AuthSub authentication protocol that Google offers to authenticate to the platform. With this feature the user should not learn a new user name and password to access to VLE.

The authorization functionality that the platform offers effectively controls the access to all resources it manages. Like all documents that use VLE platform are hosted in GoogleDocs and it has its own policy on roles and permissions, VLE uses these access rules defined by Google. [11]

The last of the features provided by this module is the possibility of registration on the VLE platform. As discussed in the section of authentication, the credentials that are used in the platform are obtained from Google. Therefore, the first time a user accesses to the platform, this module checks that the credentials are correct and the only thing that all the users have to do is to provide the identifier of his digital pen in order to finish his registration.

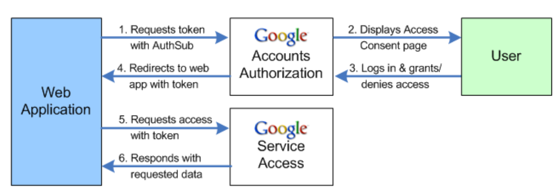


Figure 3. AuthSub protocol

One of the most important requirements of a virtual learning environment is the document management. To do this management VLE platform provides the Course Management module. For the proper management of these documents, the module makes use of the integration layer described later. The most important features that this module offers are the following ones: Obtaining the courses in which the student is enrolled, obtaining documents to which a student can access within a course, uploading a new document to a course, deleting a document from a course, downloading a document of a course and creating a new document from a scanned document.

The last module in the logic layer is the Self-Learning module. This module is intended to facilitate the process of implementation and test evaluation. In this context the system offers two functions: Firstly, the creation of a new test and secondly, the completion and immediate correction of tests. In the first case, creation of a new test, this functionality is oriented to teachers who wish to assess their students through this system. The second feature in turn is directed to the student. The student, once performed the tests will know the results, because this module is responsible for obtaining the answers the student has written in the sheet and comparing them with the correct answers that the teacher has introduced when he/she created the test.

As for the system *Integration layer*, thanks to it, the VLE platform communicates with services offered by Google for document management and scanning services created within the project scope. This layer is of great importance because it is responsible for the platform to have all the information necessary to satisfy user needs.

The Google integration module communicates with the services offered by this company using REST (Representational State Transfer) calls [12]. The first call made from this module by each user is the authentication on the Google system. This call returns a token which is used by the following queries. These consultations will be made against the Google Documents List API [13]. Without the token the calls to this API will fail.

On the other hand, the management of the communication with the services of digitization is performed by SOAP calls (Simple Object Access Protocol) [14]. These services have been implemented within the project scope.

We have used the Java Enterprise Edition (JEE) for the implementation of the VLE platform. To implement the layers of Logic and Integration, Enterprise JavaBeans (EJB) API has been used. On the other hand, in the case of the presentation layer, we used the JavaServer Faces (JSF) and RichFaces frameworks. Finally, the Web Services for the digitalization have been implemented using the Windows Comunication Foundation (WCF) tool of Microsoft .NET framework.

As for the servers where applications are deployed, we decided to use JBOSS as application server for the VLE platform deployment and Internet Information Services (IIS) for the deployment of the digitalization management Web Services.

6. PRELIMINARY EVALUATION

Finally, we decide to carry out the evaluation in a learning environment where the sharing of notes is a typical action on the students lifes. For this reason, we have considered the university as the most suitable place for conducting the tests. The selected users are students of the Network Design and Evaluation subject that is taught in the fifth year of the degree of Computer Engineering at the Faculty of Engineering at University of Deusto. Students who have done the tests have had at their disposal all the necessary equipment: a digital pen, a notebook with the Anoto pattern printed on its pages, an answer sheet and a computer to access to the platform.

In order to validate the implemented platform we have studied the ISO/IEC 9126 [15] standard. ISO 9126 defines a quality framework by three aspects: Internal Quality, External Quality and Quality in Use. Internal Quality is the totality of characteristics of the software product from an internal view (i.e. cyclomatic complexity, code maintainability). This kind of quality can be improved during code implementation, reviewing and testing. External Quality is the quality when software is executed, which is measured and evaluated focusing on the software application behavior (i.e. number of wrong expected reactions of software). Finally, Quality in Use is defined within ISO/IEC 9126-4. It is the quality of the software system that the user can perceive when it is used in an explicit context of use.

It measures the extent to which users can complete their tasks in a particular environment. It is measured by four main capabilities of the software product in a specified context of use:

1) Effectiveness: The capability to enable users to achieve specified goals with accuracy and completeness.

2) Productivity: The capability to enable users to expend appropriate amounts of resources in relation to the effectiveness achieved.

3) Safety: The capability to achieve acceptable levels of risk of harm to people, business, software, property or the surrounding environment.

4) Satisfaction: The capability to satisfy users.

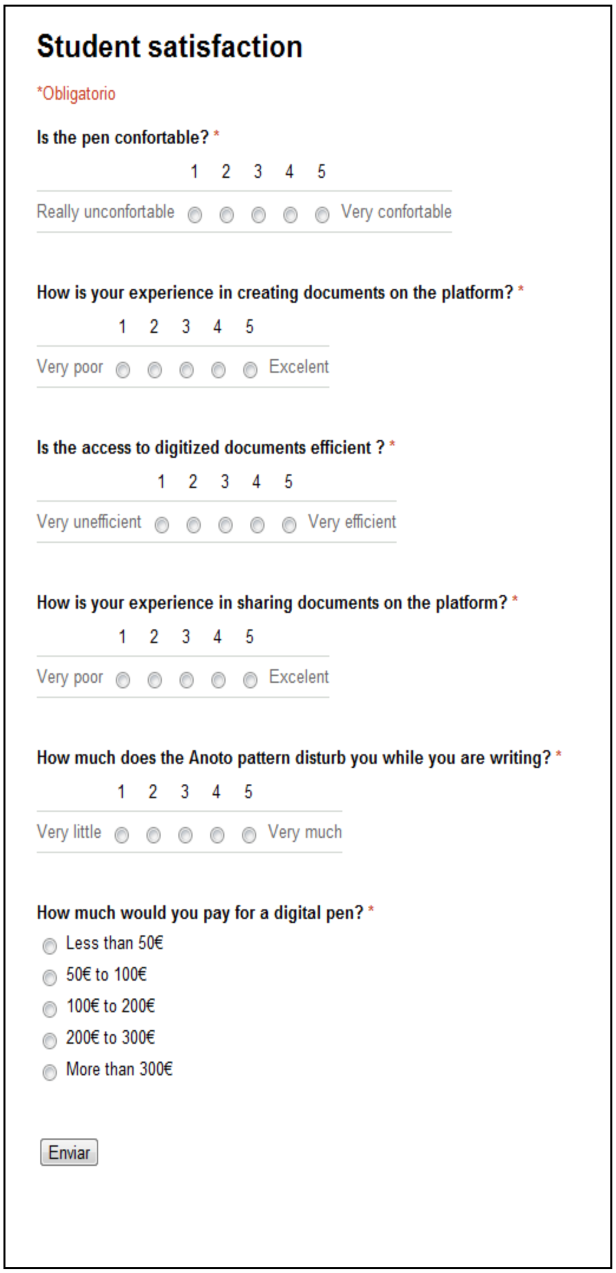
These capabilities have to be measured in order to calculate how the quality in use of evaluated software is. Focusing on this kind of platforms, we have measured the satisfaction and the effectiveness of the platform.

The formulas used to calculate the shown characteristics are based on the adaptation of the formulas set of ISO 9126-4 standard for the system evaluated.

To make the experiment we lent five pens to a group of university students, these students could share notes by the exposed platform. Moreover, other five students collaborated in the experiment sharing between them the notes, but using traditional techniques. In these tests, several concepts have been explained and the students have had to aim by their respective methods of capturing notes. They have assisted three classes of 50 minutes in which students generated notes. These notes have been studied and several metrics have been captured for the subsequent calculation of results. At the end of the course, a test of satisfaction has also carried out to measure the satisfaction level.

In order to capture the metrics that make up the features to be measured, all the generated drafts have been read and several data have been completed. These data were the concepts explained at class, the concepts captured by the students, the number of sheets used and the number of discarded sheets. As we have already mentioned, the effectiveness measures the proportion of the goals achieved with completeness. In this case, the goals have been to capture the largest number of concepts presented and to minimize the number of sheets needed for the preparation of the final notes. Thanks to this, we had noticed the differences between taking notes by an ordinary way (Pen and paper) and taking notes by the described platform (VLE).

Another feature to be measured is the level of student satisfaction using the Digital Pen in class. A satisfaction form created by Google Docs has been sent and answered by mail using the accounts created by the studied students.



Student satisfaction

*Obligatorio

Is the pen confortable? *

1 2 3 4 5

Really unconfortable ○ ○ ○ ○ ○ Very confortable

How is your experience in creating documents on the platform? *

1 2 3 4 5

Very poor ○ ○ ○ ○ ○ Excelent

Is the access to digitized documents efficient ? *

1 2 3 4 5

Very unefficient ○ ○ ○ ○ ○ Very efficient

How is your experience in sharing documents on the platform? *

1 2 3 4 5

Very poor ○ ○ ○ ○ ○ Excelent

How much does the Anoto pattern disturb you while you are writing? *

1 2 3 4 5

Very little ○ ○ ○ ○ ○ Very much

How much would you pay for a digital pen? *

- Less than 50€
- 50€ to 100€
- 100€ to 200€
- 200€ to 300€
- More than 300€

Enviar

Figure 4. User satisfaction form

This form could capture the metrics used to the calculation of the satisfaction feature. In other words, by this form the students could give us their feedback about their satisfaction and the discretionary use of the platform. In the following image we can see the asked questions and the answers given by students.

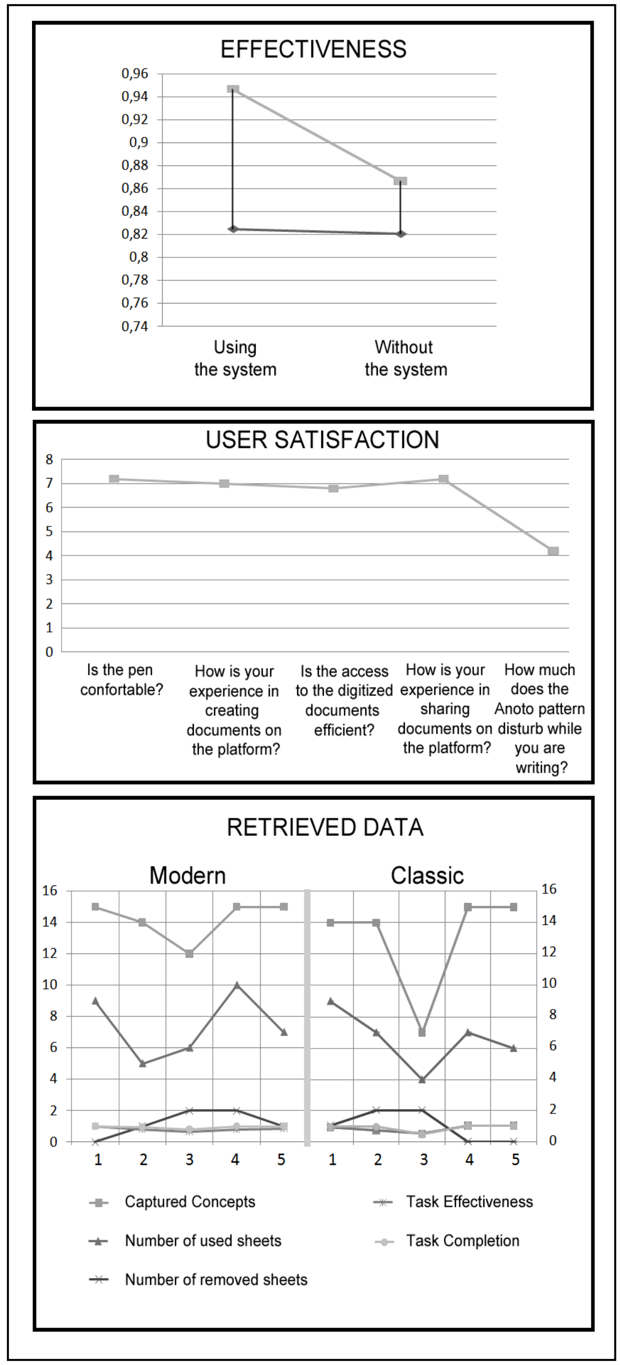


Figure 5. Graphs of retrieved results

7. CONCLUSIONS

As we can see in the previous graph that shows the averages of effectiveness of the platform, there is no improvement in the effectiveness of note taking because it shows a little reduce of the use of real paper sheets. However, an improvement is seen in the completeness of the note-taking because it increases by 8%. It surprisingly means users will not be affected by the new device use.

Focusing on the results corresponding to the satisfaction of students using the system we can see not only the digital pen does not affect the use, but also the printed pattern has a good acceptance. In an overall view we can say students were satisfied sharing and using the system, in fact, the discretional use calculated is very good (more than 60% would pay more than 50€ for the digital pen).

Summing up, we have implemented a system to share notes by a digital platform with digital pens. By this way, we can improve competencies and we can provide a better method to digitize the notes without new devices. As we have shown, this system can help to write more complete notes with the same efficiency and completeness and also satisfying the students.

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Transformation of E-Learning to Mobile Learning for the Academic Work Force in Turkey with Encountered Barriers and Tradeoffs

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ABSTRACT

Most of the universities are executing distance learning or e-learning programs in Turkey as the reason of benefits such as low costs, reduced learning times, quick reference variables on the system, reduced grade evaluation time for academic staff, time and location advantages. With the advance of technological development, students have started to reach information everywhere and every time. These features attract students in order to use e-learning education instead of teacher centered education and we can examine the increase in numbers of e-learning based lectures in the universities. Throughout the integration period of e-learning, universities frequently suffer with various problems such as framework, lack of qualified academic staff for content creation step, low levels for interactive education systems and etc. At the same time, advanced mobile communication tools are spreading rapidly with the high technology in today's world and Turkey has the youngest generations with highly capable of technological improvements and high ratio mobile phone usages. This research covers the transformation period for the academic institutions throughout the mobile learning integration with examining the barriers and tradeoffs in Turkey. Our aim is to look at the factors which affect the integration period of e-learning programs and measure the drivers. After framing the situation, research will provide suggestions to increase the level of mobile learning integration success.

Keywords: Mobile learning, E-learning, Distance Learning, Mobile Applications.

1. INTRODUCTION

At this point in time; companies, governments and individuals are trying to adapt the technological developments for harvesting the digital world benefits. Contemporaneously, education side is trying to adapt this transformation with distance or electronic learning and mobile learning concepts. Nowadays, universities are perceived as leaders of these change and companies are the followers.

Most of the universities throughout worldwide are executing e-learning programs as the reasons of new systems' benefits will be examined in the following section and also new distance learning systems in Turkey will be discussed. For instance, low costs, reduced learning times, quick reference variables on the system, reduced grade evaluation time for academic staff, time, location advantage, the rich learning contents, new featured tools that increase the learning performance and socialization tools such as forums, chat rooms are the basic benefits of distance learning. These features attract students in order to use e-learning education instead of teacher centered education and we can examine the increase in numbers of e-learning based lectures in the universities.

Besides the benefits, throughout the integration period of e-learning, universities frequently suffer with various problems. Most encountered problems are framework, lack of qualified academic staff for content creation step and perceptions against the distance learning system. The second part of the content will cover the main barriers of the distance learning systems.

While examining the transformation period we should underline the distinction part of e-learning and mobile learning concepts. Because, main differences between e-learning and mobile learning can affect the transformation period of mobile learning. The third sections will underline the differences between e-learning and mobile learning with covering the main factors that affects the system.

With the advance of technological development and developed frameworks especially with the 3G frameworks in Turkey creates learning environments for students to reach information everywhere and every time. These features attract students in order to use distance learning education instead of teacher centered education and we can examine the increase in numbers of distance based lectures in the universities. Besides, mobile learning systems with supported applications and devices are rapidly spreading towards the universities and companies in Turkey. The fourth sections will cover the integration process with academic work force side and also will cover the main factors such as framework, students' perceptions and service providers in Turkey.

2. BENEFITS

While examining distance or e-learning and mobile learning systems we can examine that there are four role players which are; distance learning provider institutions (companies, universities and etc.), students, teachers and distance learning system integration companies. We are going to focus the students, teachers and distance learning provider institutions' benefits through this section.

There are different types of distance education systems in Turkey. Generally, most of the institutions in Turkey prefer blended learning throughout the e-learning and mobile learning. Blended learning is a solution that covers different delivery methods such as web based courses, software and knowledge management practices [1]. The main reason of using blended learning is compensating interactivity and infrastructure problems. Providers can support e-learning and mobile learning courses, but students and teachers need more interactivity. Chat rooms, face to face video conferences can be supported by the providers. Throughout the integration period of e-learning and mobile learning systems, teachers and students should be oriented by deploying the blended learning systems. Most of the institutions in Turkey prefer blended learning as providing web and mobile application based courses with supporting the course with classic system based courses with bringing students and teachers at the defined hours in the classes or conference rooms.

In the basis, distance learning provider institutions can use their sources such as teachers, physical locations, students' affairs more effectively that can reduce their costs. There is no need to use physical rooms and instructors can consume less time relative to classic education systems. For instance, if a company wants to train their employees a word spreading software, company should send their employees to a education institution in their working hours and pay more related to mobile or e-learning learning system. Time and place dependency will be solved with the new education system.

Students can provide courses with low charges and use their time more effectively without place constraints. Also, new education system acts the courses as a one to one teaching, more customized. Rich visual contents help to learn more effectively and enjoying related to classical method. Furthermore, students can reach course announcements such as; course notes, documents and syllabus. This is important in terms of users, because they can know what instructor expects from them [2]. In addition, we should admit that there are no limits in mobile education systems and applications. For instance, while you are traveling you can learn the historical information of the building close to you with new generation mobile devices with GPS support.

Teachers or alias "content creators" are the key players of new education system. They can have more spare time, share course materials that are more richer visualized content more easily, track and evaluate their students more effectively. Besides, they can reach more students in a specified time and course without place constraints. Besides, slow learners and quick learners' conflict can be solved with e-learning and mobile education systems.

3. BARRIERS

While examining the barriers of e-learning and mobile learning systems we can face different approaches, but generally the barriers usually covers the four role players that mentioned in the benefits section or classifies the barriers related to these players such as Yamamato that the barriers related to e-learning are macro barriers, personal barriers, organizational barriers and technological barriers [3].

But, in today's world, the technological or infrastructural barriers are just related to distance learning provider institutions and distance learning system integration companies' strategic based decisions which covers cost concerns. Because, with cloud computing facilities, enhanced mobile application developer software, 3G and 4G based mobile networks, and sophisticated mobile devices such as pads, net books, Android operating system based devices we can announce that there are not technological based barriers; there are just cost concerns of institutions and integrator companies.

Besides the cost concerns, teacher and student based barriers are mainly perceptive [4]. Teachers are mainly scared of adapting themselves to new education system as a content creator as the reason of their low technological capabilities, we can face this result in many cases in Turkey such as primary school research in Turkey [5]. Another perceptive barrier for the teachers is the interactivity concerns, but most of the teachers are still hesitating to open online courses with more developed systems that support virtual face to face classes or a blended learning choice that meets students and teachers in physical classroom in a specified time periods.

Students based barriers are also based on perceptions. E-learning systems force the learners to be self managed and learners demand to be interactive with their teachers. Besides, enhanced visual contents and accessibility advantages the course dropout rates are high and the demand for classical system is still high [6]**.** At the same time, they want more interactive education system and rich lecture content and most of them are happy to be organized and planned with the help of the e-learning system [7].

Moreover, learners do not want to change their learning habits and also they have concerns on being social, because some students believe that virtual courses will prevent them to be socialized with other students. Mobile application based learning tools are more popular in these days, but the main problem is that students can really sustain the education and organized to finish their mobile application based learning. Besides, these barriers online book sales are accelerating, so we have to think about the e-learning and mobile learning system based education models as a next education model.

4. DIFFERENCES BETWEEN E-LEARNING AND MOBILE LEARNING

E-learning can be summarized as web based learning and have blended learning or hybrid forms while mobile learning is perceived as the supplementary method of e-learning. After all, mobile learning is the second generation of e-learning with covering lots of technological advantages and can be act as a new learning method with mobile applications. This section covers the examination of the technological and connection based differences.

With the improved mobile devices m-learning supports more custom, flexible, rapid feed backs, mobilized learning systems and applications. Students and teachers can be more flexible throughout their lectures. For instance, they will carry lightweight devices with longer battery durations and with the support of 3G or 4G network they can access internet without any boundaries. Additionally, students can access and respond their assignments and tests more effectively, individualized, flexible and secured. In e-learning system, students should be connected in dedicated time and there is a chance to get response with delayed feed backs and they are evaluated in the dedicated times and locations frequently [8].

Formerly, e-learning lecture contents are richer than the mobile learning lectures because of the mobile devices. But, now improved mobile devices (pads and light net books with mobile network support such as 3G) students can access rich visual lecture contents. While mobile applications cope with resolution and different monitor sizes, pads and big monitor sized mobile devices are spreading throughout the worldwide by certain companies such as Apple, Samsung which are becoming as a monopoly. This situation helps developers to produce faster throughout the mobile application software production which increases the number of mobile applications.

5. MOBILE LEARNING INTEGRATION PERIOD IN TURKEY

In Turkey, e-learning based education programs are increasing in last decade and now there are approximately one million e-learning system users in Turkey. Especially, finance, insurance, telecommunication, medicine and retail sectors are mainly using the e-learning applications in Turkey and listed in Table 1 [9].

Table 1: E-learning Users Numbers in Turkey

Year	Number of Company	Number of University	Number of Institutions	Total Number
1997	5	3	0	10000
2002	20	5	2	120000
2008	150	20	10	800000
2010	200	30	15	1000000

Because of the high service costs, there are not sufficient number of mobile application based learning education programs in Turkey. Mobile learning applications in the academic environment in Turkey are in the test mood while there are few commercial applications such as “Turkcell Mobil Egitim”, “Mobil Ogren” and “Avea Mobil Akademi” for educating companies’ employees in the business environment in Turkey [10].

As we mentioned, distance learning system integration companies are playing an important role through the transformation period. Enocta and Skillsoft named companies are important distance learning system providers in Turkey. According to report by general manager of Enocta, Turkish companies’ executives demand book summaries, papers, researches, online books or e-books, online contents for applicable in mobile devices, voice and video contents for their mobile devices [11].

Generally, the researches related to mobile learning applications in Turkey are based on students’ perceptions and the mobile learning environments’ success and most of them fasten on positive perception on mobile learning. For instance, according to a research by Cakir, students want to use mobile learning and students believe that mobile learning is effective [12]. There is a similar research by Demirbilek on mobile application and learning which supports that people have positive thoughts on mobile learning and they prefer synchronized and interactive applications in Turkey [13]. Also, there are pre-test and post test based researches related to topic and underlines that mobile devices and applications support learning and more effective than classical learning tools especially in language learning [14].

The researches that reflect the teachers’ perceptions on mobile learning applications are inadequate in Turkey. In spite of high ratio of mobile devices users in Turkey the mobile learning based application numbers are still few. For evaluating the academic staffs’ attitudes toward the mobile learning application, we can use the data related to electronic learning based researches in Turkey. There is an effective research on e-learning in Turkey which covers 18 researches on academic staff and students aspects with comprising related researches in 2010 and 2009 by Yildirim underlines that technological capabilities of academic staff are correlated with attitudes towards distance learning [15]. The most important integrating barrier of distance learning is the content creation step for teacher. In addition, unsafe environments with low motivation decrease the success of teachers.

While focusing the teachers’ role in distance learning systems, we can conclude that teachers should focus on creating the content rather than delivering the old ways (lectures or books, test etc.). Also, they should create and support social networking and establish first hand learning environments [16].

Consequently, benefits, barriers, distance learning systems are forcing teachers to be more technologically skilled, creative, supporter of social network environments. So, education institutions should create environment by providing technological educations to their teachers with supporting online interactive distance learning systems and should motivate their academic staff for shortening the integration period in Turkey.

6. CONCLUSION

Mobile learning applications are becoming the new form of education. We examined that main factors are teachers, students and e-learning provider institutions. And, teachers are playing a crucial role in this trilogy. Institutions’ administrators and students indirectly are demanding teachers or academic staff to be more creative and technologically capable. But, at the same time institutions' cost fears can prevent to create that environment for their academic staff and can prevent from fast transformation.

We can assume that the future of learning is distance learning covering mobile learning, so administrators should focus on academic staff and create needed environment and motivate them for change.

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e-Meeting Solution for Higher Education on the WebELS Platform

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ABSTRACT

With the advancements of information technology and the informatization of society, there is a paradigm shift of teaching methodologies in higher education, where a virtual collaborative learning system is being sought for not just as an extension of traditional classroom-based methodology, but also to meet the social demands for a flexible and internationalized educational system. To achieve an effective virtual collaborative learning system, features like online presentation, online annotation, chat messaging and video conference system are required, and the system must support the concept of "anytime and anywhere" system. This paper introduces the e-Meeting system built on the Web-based e-Learning System (WebELS) platform designed for higher education in science and engineering. The system supports easy content authoring, online slide presentation, online annotation, chat messaging and video conferencing. These features effectively demonstrate the usefulness with higher performance of the system in supporting collaborative learning for higher education in domestic and international organizations and universities.

Keywords: e-Learning, e-Meeting, online presentation, video conference, virtual collaborative learning

1. INTRODUCTION

Advancements of technology and the informatization of society are factors that paved the way for shifting the teaching methodologies in higher educational system from the traditional classroom-based method to the use of information and communications technology. In recent years, Internet-based teaching and learning technologies have been widely available enabling e-learning to become a major form of educational methodology addressing time-limitation and location-limitation between teacher and students [1]. e-Learning infrastructure can be easily carried out because of the advancement in internetworking technologies, multimedia information processing technologies, and software technologies at lower cost and higher quality in a global scale [2].

Unlike e-Learning in the middle school and undergraduate programs where course management and automated student assessment are typical features, the activities in the higher education, particularly in the graduate school are characterized as self-learning, group meetings, and research presentations. In most cases, there is a need to collaborate with the experts of the particular research field in the academe and industry. These characteristics of higher education based on the information technology perspective have been analyzed in previous studies [3-6].

In carring out the demands of higher education in view of information technology, an e-Meeting system is strongly requested rather than a typical learning management system (LMS) [7,8]. An effective e-Meeting system requires primary features like online slide presentation, online annotation, chat messaging and video conferencing. Although there are a lot of similar systems, but it is very rare to find an all-in-one system that really answer the need to support e-Meeting for higher education.

In this paper, we discuss the design and implementation of the e-Meeting system built on the Web-based e-Learning System (WebELS) platform [9]. The system features online slide presentation, online annotation, video conferencing, and chat messaging system, which are required features for a virtual collaborative learning system. Online presentation is based on slide synchronization between the presenter and the listeners. It is implemented by utilizing a shared virtual presentation board (VPB) stored on the server, which is updated by the presenter for every slide events, and polled by the listeners periodically for synchronization [10]. Synchronization in our context refers to real-time mirroring of slide presentation events that include controls for changing the slides back and forth, vertical and horizontal scrolling, panning, zooming, cursor positioning, annotation, and even controlling the playback of video embedded on the slide between the presenter and listeners. e-Meeting is made possible then by combining the online slide presentation and video conferencing system to create a virtual classroom, where meeting participants convene via the Internet. Video conferencing system is based on server-client architecture, which is in contrast with the peer-to-peer architecture utilized by a number of similar systems. Finally, we present the practical application and evaluation of e-Meeting in its successful performance in domestic and international collaboration between academic institutes and organizations.

2. REVIEW OF RELATED TECHNOLOGIES

With the fast-paced development of Internet application technologies, various web-based conferencing tools become widely available. We describe some popular related technology on online presentation, video conference, and web-based conference systems. We also discuss the advantages and drawbacks for each in view of e-Meeting application for higher education.

Online presentations systems widely available nowadays come from a variety of underlying technologies, such as screen sharing and document sharing. Screen sharing allows one to transmit the contents of his computer desktop to one or more remotely connected network users. Some screen sharing systems allow remote control which shares the ability to control the keyboard and mouse to other users. Some systems that use screen sharing are GoToMeeting [11], Real VNC [12], Skype [13], WebEx [14], to name a few. The advantage of screen-sharing technique is that presenter can show various applications on his desktop and be seen by other participants. In view of e-Meeting however, presenter have to be careful that sensitive information is not displayed as it can be visible to other meeting participants. Another drawback of screen-sharing technology is the reduced graphic quality that small text or objects cannot be clearly seen. Screen sharing technique works well in broadband, but may not operate well in narrowband as it utilizes greater bandwidth for streaming of encoded pixel data of screen image. Bandwidth demand gets very high if there is a lot of pixel change at the same time, such as when scrolling a window or viewing full-screen video. Another major drawback of screen sharing is that it requires advanced network address translation (NAT), firewall and router configuration such as port forwarding in order for the connection to go through [15].

Document sharing tools are sometimes referred to as online presentation tool because it is possible to share presentation files online. Some document sharing tools allow one to create a PowerPoint presentation online or upload an existing PowerPoint file onto the server. Other users can then view and edit the shared presentation [16,17], while others allow anyone to view only but does not allow editing [18]. Some systems support various file formats such as the Google Docs [16], but others only support PowerPoint [17-19].

To realize an e-Meeting, some screen sharing and document sharing systems have an integrated support for video conference or Voice over Internet Protocol (VoIP) system. But others do not have and users have to use another platform for video conferencing or teleconferencing.

3. WebELS MEETING SYSTEM

The overview of the WebELS Meeting system is shown in Fig. 1. There are three servers in the server side, i.e., database server, content server and streaming server. Database and content server are used for content and user data management, while streaming server is used for real-time audio-video communication.

There are two major operations available for the user of the system, i.e., content authoring and joining a meeting. Content authoring is usually done by meeting presenter or lecturer. Content authoring tool downloaded from the server is an easy-to-use Java-based content authoring tool. Content authoring using this tool can achieve three operations – (1) creating new content, (2) editing content, and (3) importing content from other servers. Files in the form of slide presentations, word processor documents, portable document format (PDF) and images can be used as raw material for the WebELS-based content. Files are automatically converted to a series of slides locally and compressed prior to uploading to the server. However, if file conversion is not available locally, files are converted at the server. Video files can also be embedded onto a slide which is possible to playback in synchronous manner when viewing the content.

Joining a meeting is another major user operation but it follows only after creating content [5]. Assuming that content has already been made and stored in the server, joining a meeting requires the user to download the presentation panel and the compressed content. The client user stores the downloaded content onto the temporary folder, unzip the content package, and then load the slide images onto the presentation panel. The system prompts the user for username input, and when done, displays the first slide image on the presentation panel. Online presentation has two user modes, i.e., the presenter mode and the listener mode. In presenter mode, the user has over-all control of the slide, such as slide changing, cursor positioning, panning, zooming and annotation functions. Users in listener mode can only monitor who have joined the presentation, but does not have the right to control the slides. The listener's presentation panel serves as a passive listener where it displays what is on the presenter's presentation panel. This slide presentation synchronization is implemented using a virtual presentation board (VPB) concept. VPB data that is stored on the server is updated by the presenter every slide events, and polled by the listener periodically to achieve synchronization. Synchronization in our context refers to real-time mirroring of slide presentation. Switching of presenter's right among meeting participants is permitted in order to attain a collaborative approach.

The video conference system is based on client-server architecture, in contrast with the peer-to-peer architecture utilized by a number of similar systems. With client-server architecture, more than two users can join the video meeting at the same time. The video meeting panel is designed to be independent from the presentation panel, thereby participants logged-in on the video meeting can still open a different presentation content, while keeping the video meeting connection. There can be only one meeting administrator at one time. Administrator can assign presenter, mute all listeners, kick out a user, and manage the viewing focus to the presenter.

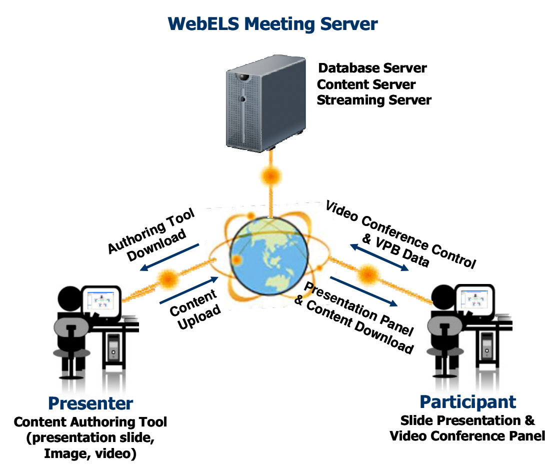

Figure 1: WebELS Meeting System Diagram

Figure 2 depicts WebELS Meeting as a virtual collaborative learning system. The fundamental requirements for e-Meeting include online presentation, online annotation, video conference and chat messaging, which are all available in the system. With these features, users in remote location, i.e., presenter and meeting participants, share the same virtual room over the Internet anytime and anywhere. Moreover, WebELS Meeting system is a web-based application, thus there is no need to download software for installation. The user computer however must have Java Runtime Environment (JRE) and Flash Player installed as an Internet browser plug-in. A web-camera is also required as well as the headset.

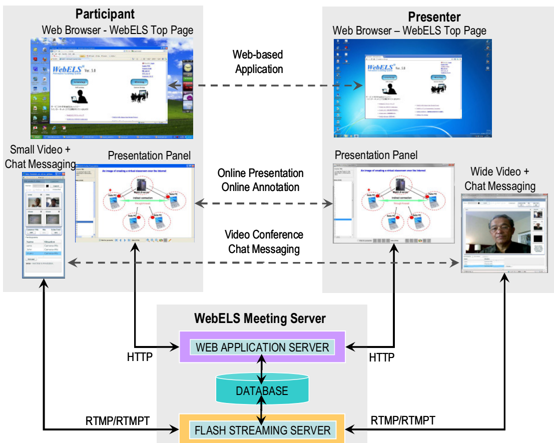

Figure 2: WebELS Meeting as a Virtual Collaborative Learning System

4. SYSTEM FEATURES

The following sub-sections describe the major features of WebELS Meeting as a virtual collaborative learning system for higher education.

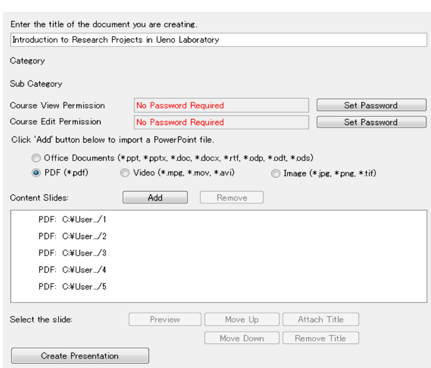

Figure 3: Content Authoring Tool Interface

Content Authoring

WebELS content authoring tool is an easy-to-use Java-based content editor shown in Fig. 3. Novice and non-IT users can create their own presentation content very easily as a series of slide images converted from various documents, such as Microsoft Office (*.doc, *.docx. *.ppt, *.pptx, *.rtf), OpenOffice (*.odt, *.odp, *.ods), PDF, and images (*.jpg, *.png, *.tif). Video (*.mpg, *.mov, *.avi) can also be embedded on the content with various template designs. Content presentation title, content view and edit passwords, and title of each slide can be inputted in the editor.

To create a WebELS-based content, all necessary documents will be compressed first as a package, and then the package will be uploaded to the server system through the Internet. In the server, the package will be decompressed, and the server-side program will choose the proper conversion tools (e.g., Ghostscript, OpenOffice) for file document to PDF to image conversion. All different types of documents are converted into images, except for the embedded video. All newly created images will be compressed again to a package and sent back to client. After receiving the package, the client uncompress the package and display the first image on the presentation panel. A copy of the content is stored in the server.

Online Presentation

The online presentation panel shown in Fig. 4 is divided into four sub-panels, namely (1) Content Information and Slide List, (2) Presentation Display, (3) Viewing Controls, and (4) Collapsible Annotation Toolbar. Content information and slide list shows the content title and the slide navigator for quick slide browsing. Presentation display panel serves as the graphical screen of the online slide presentation. Viewing controls contain control buttons for slide changing, scrolling, panning, zooming, and presentation mode selection buttons. Annotation Toolbar is hidden by default, but is displayed when annotation function is activated.

Online presentation features synchronized slide control, i.e., every event on presenter's display panel is replicated on the listeners' display panel in almost real-time. These events include the following:

- shifting slides back and forth using buttons for next, back, move to first slide, and move to last slide,
- cursor display function as a pointer for helping an easy presentation (Fig. 5a),
- zooming function, such as zoom-in, zoom-out and fit window (Fig. 5c),
- scrolling function, such as vertical and horizontal scrolling,
- slide panning function which is done by mouse clicking any point on the slide, hold, and dragging the mouse.

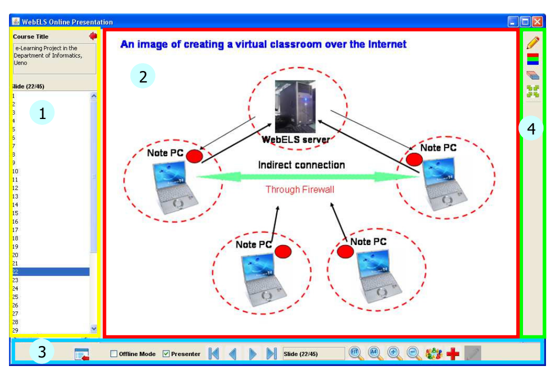

Figure 4: Online Presentation Panel

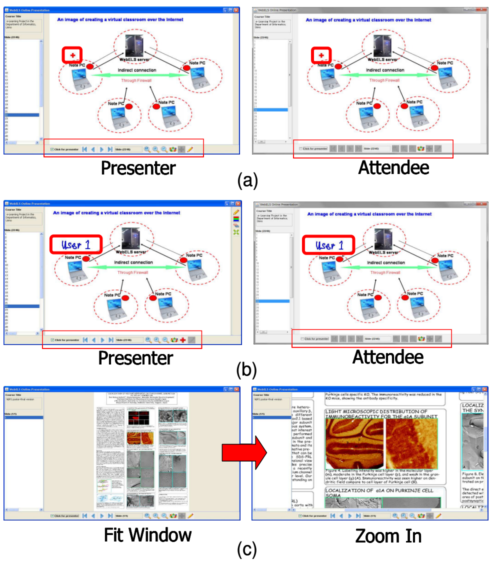

Figure 5: (a) Cursor synchronization function, (b) Online annotation function, (c) Zooming function (Content courtesy of NIPS, Japan)

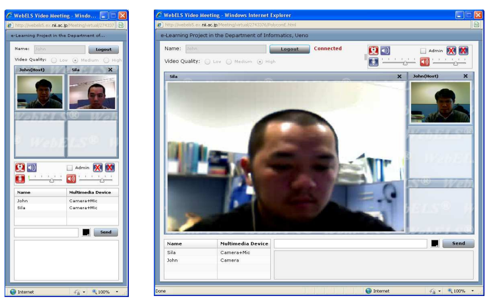

Figure 6: (a) Small Video Meeting Panel, (b) Wide Video Meeting panel

Online Annotation

During presentation, online cursor helps the listeners to follow what the presenter is discussing. However, there would be a necessity at times to overwrite figures, draw objects or write mathematical equations to further elaborate what is being presented. Writing annotation on the presentation display panel is simply done like a freehand drawing. It is done by pressing the left-hand mouse, and holding it steadily while dragging the thin crosshair cursor to form the desired object. An example of online annotation is shown in Fig. 5b.

Video Conferencing

Video conference system provides audio-video communication among the users in a shared virtual room. With this system, online collaborative work can take place because users can discuss in a face-to-face like environment. In the system, small video meeting panel and wide video meeting panel are available as shown in Fig. 6a and 6b, respectively. Small video meeting panel is useful for individual user, while wide video meeting panel is useful for group audiences using one computer connected to a wide-screen projector or wide-screen monitor, e.g., inside a classroom or in a meeting room. There can be only one meeting administrator among the participants who has the right to manage the online meeting by assigning a presenter, muting all participants except the presenter, kick-out participant, and assigning viewing focus to the presenter. Wide video meeting panel can also be switched to full-screen mode. The video conference system also features auto-reconnection function, which is very useful whenever the network have intermittent connection. Auto-reconnection function is very important during meeting especially when the on-going presentation cannot be interrupted. Moreover, video meeting and online presentation panels in the system are designed to be independent with each other, so that multiple presentation contents can be used while keeping the video meeting connection.

Chat Messaging

Another useful tool for a collaborative system is chat messaging. Any user in the virtual room can send a message to the server, and this message is shared among the users. There are many instances that chat messaging is very important in an online meeting. For example, before the online meeting begins, some users may have trouble setting up their own system successfully. In this case, they can send a message to the virtual room users or the presenter. During online meeting, users can also send message to the presenter which may be in a form of a question. Chat messaging system is integrated to both the small and wide video meeting panels.

Content and Group Management

Currently, a new version of WebELS Meeting for Business application was designed to support business meeting situations in industries and organizations. An administrative tool is added to provide privacy and security for users and contents. It has user and group management functions, content access limitation control, and other administrative features [21].

5. SYSTEM IMPLEMENTATION AND EVALUATION

Figure 7 shows the system diagram of WebELS Meeting System. HTTP protocol is used for the synchronization of slide presentation and RTMP/RTMPT protocol (Real Time Messaging Protocol / Real Time Messaging Protocol Tunneled) for audio-video communication.

Online Presentation Synchronization

Online slide presentation synchronization is implemented using the concept of virtual presentation board (VPB). The concept is to make copy of what is displayed on the presenter's presentation viewer, send this copy to the server, where every user can retrieve and use to reproduce on their presentation viewer. As shown in Fig. 7, the presenter is the source of VPB data, wherein every slide event in its display panel, a new update of VPB data is sent to the server. Slide event objects include slide number, cursor position, slide zoom information, scrollbar position, video playback information, and annotation information. For the listeners to mirror the presenter's display panel in a synchronized fashion, the client system checks the VPB data by polling the server and retrieves the VPB data file every one second. It should be noted that the server stores the presentation panel applet, the presentation content, and the VPB data. When a client joins a meeting, it starts by automatically downloading the presentation panel and the content in compressed format. At the client computer, it is uncompressed at the temporary folder, and the viewer retrieves the VPB data from the server, and loads the slide image accordingly. VPB data structure consists of static and dynamic data structures. Static data structure is for slide and cursor representation object, while dynamic data structure is for annotation data.

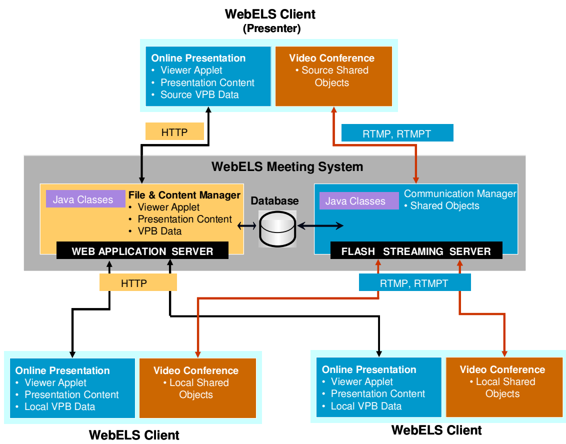

Figure 7: WebELS Meeting System Diagram

Video conference system

Also shown in Fig. 7, the video conference system uses RTMP/RTMPT protocol for audio-video communication. In the system, it uses RTMP as the default protocol. RTMP is a protocol used for streaming audio, video and data over the Internet, between a Flash player and a streaming server. However, the system will switch automatically to RTMP Tunneled (RTMPT) or HTTP tunneling when the video communication cannot transverse through firewall due to security issues of certain network location. RTMPT helps facilitate the use of RTMP in scenarios where RTMP is not possible to use, such as when the user is behind a firewall that blocks non-HTTP outbound traffic. The reason that we don't use RTMPT from the beginning of the network connection is because the speed of communication via RTMPT is slower than RTMP. Hence, we want to keep the quality of real-time communication as high as possible.

The communication control between the server and the client is also managed by the communication manager that implements the shared object. Shared object in video conference helps facilitate the basic operations, such as turning on and off of the camera, microphone, and admin functions, like assigning a presenter and muting all listeners. Chat messages are also distributed to meeting participants by means of shared object.

System Evaluation

It should be noted that in cursor-based presentation mode, only the slide presentation data field of the VPB data structure contain values, while the annotation data field is empty. When the presenter uses the pen-based presentation mode, and writes on the presentation display panel, the annotation data field increases in size. Nevertheless, this size does not consume much of the network bandwidth. Table 1 shows the online presentation data type sizes and image quality. The data shows that using VPB, the amount of data transmitted between the server and the client is much smaller than the encoded computer screen image used in screen sharing. With the slide presentation data, the VPB data contains a minimum of 34 bytes to a maximum or 54 bytes. With few annotation data, it may ranges from 100 bytes to 1000 bytes. With annotations all over the slide, it may amount to less than 10 Kbytes. In a narrowband Internet environment, slide synchronization based on VPB can work well in almost real-time.

With screen sharing technique, suppose an 800×600 true color screen image has a size of 1.44 Mbytes and 85 fps will produce more than 100 Mbytes data. Data compression is required in order to transmit this image in real-time. Sophisticated data compression algorithms may be able to produce encoded file size less than 100 Kbytes [22]. With this data size, it is still required to use broadband Internet for better quality.

Furthermore, the image quality for slide-based synchronization technology is better than the screen sharing technology for reasons that the images are located in client's local computer.

Table 1. Online Presentation Data Sizes and Image Quality

Data Type	Size (bytes)	Image Quality
VPB Slide Presentation Data	34 ~ 54	Clear
VPB Slide Presentation Data with Few Annotation	100 ~ 1000	Clear
VPB Slide Presentation Data with Many Annotation	1,000 ~ 10,000	Clear
Encoded Computer Screen Image for Screen Sharing	< 100,000	Blurry

6. PRACTICAL USAGE AND PERFORMANCE

WebELS Meeting has been used by a number of domestic and international organizations and universities for distance exchange lectures and meetings for e-Meeting purposes. Recent distance lecture was conducted between the National Institute and Informatics (Japan) and the Tsinghua University (China). The exchange lecture was successful using the online slide presentation and the video meeting functions.

Moreover, WebELS Meeting has been used to distribute the presentation and live video for the 1st Asia-Arab Sustainable Energy Forum held in Nagoya, Japan [23]. Fig. 8 shows the system interconnection setup where there were individual and group remote viewers of the on-going conference.

Because of the multi-location access and no firewall and proxy setting requirements, WebELS is considered to be an effective collaboration tool for higher education in international cooperation between academic institutions and industries.

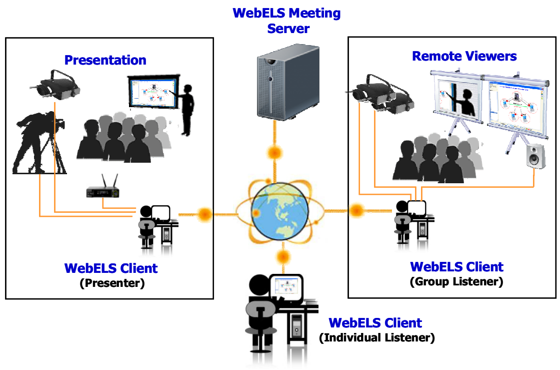

Figure 8. e-Meeting System Interconnection Diagram

7. CONCLUSION

This paper presented the overview of WebELS Meeting System as an e-Meeting solution for higher education in science and engineering. The system combines the online slide presentation and the video conferencing function that creates a so-called virtual room, where meeting participants convene via the Internet. The online slide presentation implements the VPB concept wherein synchronization of slide presentation is achieved. Synchronization in our context refers to real-time mirroring of slide presentation between the presenter and listeners. With VPB concept, online presentation can work well with clear image display in narrowband Internet environment as compared to screen sharing technique because VPB data is considerably minimal. Moreover, the video conferencing system provides face-to-face environment between the presenter and listeners. Since the video meeting system is available in small and wide panel, various e-Meeting setup can be made, e.g., individual or group meeting. Finally, the usefulness and performance of the system have been proven by practical usage in various domestic and international organizations and universities.

8. ACKNOWLEDGMENT

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Digital Storytelling: The Arts and Preservice Teachers

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ABSTRACT

In this presentation, the authors describe a journey of teachers in a graduate Fine Arts Methods course. The journey began with conversations about what art is and the nature of collections in exploring this question. Elements of visual literacy, storytelling and music were investigated. The final product was a Digital Story incorporating all of these elements into a teaching artifact that integrated the Arts into other content areas for K-8 students.

Keywords: visual literacy; digital storytelling; fine arts.

INTRODUCTION

Digital storytelling is not new [1] but how does a preservice teacher educator introduce this 21st century skill along with some kind of content to graduate students in an MAT program? We will describe the journey of students taking a Fine Arts Methods Course.

LITERATURE REVIEW

Joe Lambert [2], the executive director of the Center for Digital Storytelling, counters arguments that visual media have been a factor in the decline of written literacy and comprehension. One of the goals of the Center is to bring people back into the language of the written word. Digital storytelling has been criticized because traditional stories of indigenous peoples may become lost in translation by the use of graphic effects and outside perspectives [3]. Kunuk, an Inuit filmmaker, declares that, rather than threatening storytelling traditions, digital storytelling enriches the oral tradition of indigenous people since they are doing what they have always done: making things their own.

Experience design focuses on creating memorable experiences as a foundation of any educational endeavor. McLellan [4] uses the experience design model to integrate technology into the classroom. Inherent in her model is the need for educators to shift their thinking from notions of delivering instruction to one of staging an educational experience. Dramatic storytelling itself is designed to induce naturally specific actions essential to the experience design process. Storytelling is interactive, including and entertaining a specific audience, and providing closure both emotionally and cognitively. In conjunction with technology, storytelling is not an end unto itself; it is an all-encompassing approach to deliberate design through experience.

Chung [5] explores the impact on teachers of designing digital stories for teaching art. Chung's students use a traditional approach to design electronic stories. Students examine and critique intact stories, develop a story that focused on art, research information, write a script, storyboard the digital story, and produce it. In this model, students perform multiple tasks as researchers, playwrights, designers, media producers, and educators; this enables them to implement the methodology in their own classrooms. However, this is a linear product-based approach. In contrast, the work described herein takes a nonlinear, aesthetically more abstract approach that engages the imagination. The final digital story, although important, is not the goal of the project. Nor is the essential objective doing digital storytelling with K-8 students.

Maxine Greene [6] declares that if we can enable more young persons to make sense of what they see and hear and to attend to works [of art] in their particularity, they may begin to experience art as a way of understanding a way of knowing. She observes that the experience and knowledge gained by this way of knowing opens new modalities for us in the lived world; it brings us in touch with our primordial landscape, our original act of perceiving. Greene challenges us to enable young people to realize that they have the right to find works of art meaningful against their own lived lives. To do this teachers must experience this first themselves. Digital Storytelling: The Arts and Preservice Teachers is a beginning.

INTER-DISCIPLINARY ANALOGY

This required course attempts, in five sessions, to provide both content and pedagogy for preservice teachers to learn how to integrate the arts into other content areas. This would be a daunting task over a semester or even a year; however, we believe we have established a good foundation from which these future teachers can grow. The presentation will include examples of students' digital stories along with excerpts from their reflections upon this experience.

The question becomes: how to begin?

> I have always found monochromatic art interesting and I wanted to focus my project on telling a story-one color at a time. I think that students typically see art that is full of color. I thought focusing in on each color would help students see a new perspective and art that they may have never seen before. I would start with a picture that has multiple colors (maybe even a rainbow) and then go through red, yellow, blue, etc. I wanted to use a combination of professional photography and well-known paintings. Is this a good beginning? Jennifer

EXPRESSIONAL METAPHOR

A Collection

The first element in good digital storytelling is developing the concept of a collection. All artists are collectors. Keri Smith [7] gives us a practical way to become artistic collectors and the methods to do it. The students began their collections that then became the themes for their digital stories.

> I had been intrigued by his artwork. Besides his characteristic large-scale heavy pieces of sculptures that grace the open public spaces in many cities around the world, Alexander Calder also is renowned for the magical moving sculptures hanging in delicate balance in many art museums and buildings. *Carol*

Vito Dipinto is an artist: actually a performance artist. His longest running performance piece is something he calls teaching. He is also a collector. The students explored how they could use his collections to help their future students to answer the questions:

What is art? What should students know about the arts? And why should they care?

> This is the type of assignment that taught me a lot about art and how it is used in every aspect of life. From the perspective of a teacher, it would help me to learn what is important to my students and where their creative minds lead them. *Franny*

ANALOGICAL INFERENCE

Visual Literacy

Knowledge of visual literacy is the second element in good digital storytelling. Just as we need to teach our students how to read and understand what they are reading, we need to teach them to how to read, understand, and use visual images. The Black Square Problem [8] introduced students to concepts in visual literacy and design. The Magic Square Activity [9] provided a practical template for designing a story in discrete pieces.

> I used a lot of Dali and Munch, some Matisse and Cezanne. The two hardest stanzas were "Shape without form, shade without colour/Paralysed force, gesture without motion." Shape without form and shade without color? No picture is going to capture that. That is almost the antithesis of a visual image. I knew I needed abstract art for that one. The final stanza was tricky, because that's the big punch of the poem. While I used very powerful images throughout, I knew that to stay with the meaning of the poem, I needed something simple, almost elegant. *Rose*

COMMUNICATIONAL ANALOGIES

The Story

Of course, the story itself is critical in digital storytelling. Vito Dipinto is a professional storyteller among other things. Storytellers collect stories. He has a collection of objects that are story starters. These form a cognitive template for storytelling.

> For the digital story, I thought about what I think what makes a good story and I came up with a beginning, middle and an end. But then I thought, well, what about the seasons and nature? They have beginnings, middles, and ends, but then they repeat! And I liked the repetition because Mother Nature never truly repeats, each season our weather is different. *Martina*

Music

Students also need to understand the importance of a musical background for good storytelling. Vito and Kaki Dipinto have used music in variety ways in teaching students. Each student selected one piece of music that their students might not have on their iPods. They presented the history of this musical piece, some interesting information about the artist, and some personal account of the impact of this music on their lives.

> I let the music tell a story to me, the music sounded to me like the ocean. That got me thinking about all the various paintings of ocean scenes and I wondered if I could find a painting of all five oceans, it became a little challenge I gave myself. *Justin*

DESIGN PROPOSAL

Each student was required to visit the Center for Digital Storytelling [10]. Then they designed and produced a digital story in class. What they produce is not a virtual field trip. Students are telling stories with a collection of still images.

> As a learner this assignment taught me to think outside of the box--to explore my creative side and interests in art. I wanted to find and use artwork that meant something to me, that was more than just a painting on the wall. *Krista*

The students could choose to introduce some of world's famous art museums, or choose an artist and provide a collection of his/her work displayed around the world, or look at indigenous peoples' art, or some other creative theme. However, they needed to select at least 15 images and note the URL for each image. In addition, they needed a piece of music 2.5-3.5 minutes long. Using iMovie, each student produced a final product in less than two hours [11].

> This assignment has impacted me as a learner because it helped to awaken my creative side and allowed me to view and use things in a way that I would have not normally been able to. While doing the assignment, I started thinking of other ways that I can use such an idea in the classroom to help students like myself begin to think more creatively. The thinking process of new ideas has allowed me to grow as a teacher. I now will feel more comfortable trying new things in the classroom. *Narissa*

CONCLUSION

Most of the students had no previous experience in visual literacy or in using any kind of software to produce a digital story. The students incorporated the ideas of visual literacy and storytelling from the course to design a learning tool for K-8 students.

> While doing this assignment I thought a lot about all the different forms of art there are, and how art is constantly changing and evolving to match the times. But while it evolves and changes, the things that came before are still done. The assignment helped cement the idea that there isn't a wrong way to do something, only a different way. I have tried to live by that motto for a long time but it's refreshing to have it enforced like this. But it also reminded me that even though I consider myself an artist I only use a few mediums and there are many more out there for me to explore. *J.J.*

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Digital Technologies, New Literacies and 21st Century Skills

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ABSTRACT

The research described in this paper was conducted in action research collaboration between a university and local school district. The questions explored by teachers and university researcher (the author) include: What is the impact of the information and communication technologies on teaching and learning in classrooms? Do the educational trends and pedagogical mandates of new literacies and 21st century skills complement one another or do they increase teacher stress by pulling pedagogy in different directions? Data demonstrate the productive relationship among information and communication technologies (ICTs), new literacies, and 21st century skills.

Keywords: 21st century learning, ICT, technology infusion, new literacies, K-12 education, teacher research, classroom inquiry

INTRODUCTION

In K-to-12 schools, teachers are being challenged to change their pedagogical practice to accommodate three trends: the increasing availability and popularity of information and communication technologies (ICTs), expanded and changing notions of literacy, and the advocacy of 21st century skills and learning. These changing pedagogical practices raise research questions: What is the impact of the information and communication technologies on teaching and learning in their classrooms? Do these various education trends and pedagogical mandates complement one another or do they increase teacher stress by pulling pedagogy in different directions? I intend to draw on my recent research with teachers to explore these questions.

THE PEDAGOGICAL CONTEXT: NEW LITERACIES

New literacies are conceptualized within a sociocultural perspective which accentuates literacies as contextualized practices [1]. Official curriculum has increasingly emphasized authentic literacy practices within real world contexts and experiences [See, for example, 2]. Current literacy curriculum in Newfoundland and Labrador has expanded to include viewing, representing, speaking and listening with traditionally emphasized literacies of reading and writing. These strands of literacy are intertwined, so that students interact with and produce texts that are often multimodal. As well, a critical lens is highlighted in current curriculum.

Lankshear and Knobel [3] describe literacies as "socially recognized ways of generating, communicating and negotiating meaningful content through the medium of encoded texts within contexts of participation in discourse" (p. 64). They add that *new* literacies are characterized by new technologies and new *ethos* – participatory, collaborative, and distributed. This latter concept – new ethos – is particularly important in Web 2.0, where communities of users contribute to and create texts and sites, and where mash-ups, remix, re-creation and collaborative writing are facilitated by available onsite technologies. Lankshear and Knobel [4] also emphasize that new literacies involve "using language (reading, writing, speaking, listening), gestures and other semiotics (images, sounds, graphics, signs, codes) to communicate" (p. 3). Thus multimodality is another aspect of new literacies. Composing with sound, image, text and gesture is facilitated in Web 2.0 though application programming interfaces (APIs) and multimedia production tools.

Teachers who often worked within an autonomous model of literacy, whereby literacy was viewed as individual, de-contextualized skills [1], have found that digital technologies and Web 2.0 resources have facilitated a change to a sociocultural model in which social, cultural and historical contexts of literacy are acknowledged.

Leu et. al. [5] offer the following description of new literacies:

> "The new literacies of the Internet and other ICTs include the skills, strategies, and dispositions necessary to successfully use and adapt to the rapidly changing information and communication technologies and contexts that continuously emerge in our world and influence all areas of our personal and professional lives. These new literacies allow us to use the Internet and other ICTs to identify important questions, locate information, critically evaluate the usefulness of that information, synthesize information to answer those questions, and then communicate the answers to others." (¶8)

In the view of Leu et al., new literacies are digital literacies, dependent on Internet and other ICTs, but their use is contextualized within social practices and personal, professional and political contexts. Teachers go beyond information literacy (locating and evaluating information) to participation in communities, both local and global, and working toward, according to Evans [6] "[u]nderstanding ... technology as something that embodies a complex set of actions, behaviors, discourses, assumptions and ideologies...." (p. 5)

Web 2.0 provides a wealth of digital tools and resources that can either be downloaded or used online. Many of the available resources are ideal for student and school use, and are, in fact, set up with classrooms in mind. Three such Web 2.0 resources used by teachers in this are Kidblog, Ning, and Glogster. Kidblog offers K-12 teachers class sets of blogs so that students may blog and respond to one another within a collaborative space that may or may not be open to a wider audience. Ning, once free but now available for a small yearly fee, allows teachers to set up a social network for class interaction. Each student has a member page, a blog, and potential for threaded asynchronous discussion and synchronous chat, as well as possibilities for sharing images and other texts. Glogster, also once free, offers classroom accounts to teachers so that students may create and display electronic posters. The posters, which are displayed on the Glogster site, may include images, linguistic text, audio and video files, and decorative art. Teachers can determine the level of privacy for the site. These are three of a myriad of sites where users can create and display comics, animations, podcasts, presentations (e.g., Prezi), stories, and photo essays. In addition, teachers may download digital tools to record and edit audio, create digital movies (digital storytelling), screen capture, and create and edit images and photos. Teachers in the study are exploring the potential of these tools, as well as some of the collaborative sites that encourage communication with schools globally.

21st CENTURY SKILLS

Beginning with Metiri Group and Partnership for 21st Century Skills and spreading to and through many other educational organizations, 21st century skills emphasize the knowledge, attitudes and abilities students need for current and future success in globalized landscapes and economies. These skills include digital-age literacies, effective communication, inventive thinking, and high productivity [7]. Similarly, Partnership for 21st Century Skills [8] envision a comprehensive program of [traditional] core subjects; 21st century content, like global awareness, entrepreneurial literacy, civic knowledge, and health and wellness awareness; and learning and thinking skills that include critical-thinking and problem-solving skills, communication skills, creativity and innovation skills, collaboration skills, contextual learning skills, and information and media literacy skills; ICT literacy; life skills such as personal productivity and social responsibility, and 21st century assessments. These concepts of 21st century learning have been included in all recent professional development sessions in local schools and districts in Newfoundland and Labrador.

Much of the current published literature on 21st century skills falls into the advocacy realm [9]; descriptions of programs [10]; discussion of assessment challenges [11]; implications for teacher education [12]; links with gaming [13]; critiques of the concept and programs [14]; and exploration of applications to a variety of fields, like nursing [15] and higher education [16]. There is a dearth of concrete evidence of successful learning related to 21st century skills and new literacies (as opposed to advocacy literature). This research attempts to provide research-based evidence of enhanced learning.

RESEARCH CONTEXT

This action research partnership is being carried out within a school-university collaboration in which teachers receive technological (limited) and research support as they investigate their practice and explore ways to enhance their pedagogy with digital technologies and implement new literacies.[1] As a professor of education and a researcher, the author offers professional development to teachers in the form of workshops and one-on-one support to facilitate integration of new technologies. Teachers, as pedagogical and curriculum experts, plan activities and learning opportunities to engage all students in inclusive classrooms. As reflective practitioners, they employ classroom inquiry to construct their "knowledge *of* practice" [17] as they integrate ICTs to accomplish their classroom learning outcomes along with their own professional development goals. They pose their own research questions and collect data to explore them in on-going iterative cycles.

Such classroom inquiry or teacher-as-researcher practice is well supported in research literature [See, for example, 18, 19, and 20]. Stenhouse [21] claimed: "the refinement of professional skills is generally achieved by the gradual elimination of failings through systematic study of one's own teaching" (p. 39). At the core of practitioner research is an action-knowledge interaction – a reflective, cyclical process that enhances understanding of the teaching-learning process and other educational activities, by acting, observing, and constructing knowledge in situ. Classroom inquiry is systematic research, with data gathering, analysis and interpretation as part of the process [20].

In the study described here, both teachers and university researcher are collecting data, with teachers in ten K-12 classrooms writing reports of their research and sharing knowledge with one another and colleagues in general. The author's data collection is primarily in the form interviews with teachers, the teacher-as-researcher reports, and archived student texts, such as blogs, social networking site postings and digital movies. These data, compiled with and from teachers, were analyzed for common themes and insights [20]. At this point, analysis has been preliminary and exploratory. Additional data analysis by multiple researchers is contemplated to establish inter-rater reliability. Often this is accomplished through research meetings with groups of teachers who share their own data for peer input as well as develop common themes between data sets.

FINDINGS

The research question explored in the research related to the impact of digital technologies on teaching and learning. As data analysis progresses, it became apparent to teachers and researchers that data categories related to new literacies and 21st century skills. This paper contends that these work together in productive synergy, as do collaborations between universities and schools and between teacher-researchers and university-based researchers in supportive roles. Using the frame of 21st century skills this paper will describe and quote illustrative details of these themes from students' multimodal texts, posted on blogs, nings, and other Web 2.0 sites, and from teachers' reflective reports and interviews. The model of 21st century skills released by NCREL/Metiri Group [22] will serve as the organizing structure; its major categories are Digital-Age Literacy, Inventive Thinking, Effective Communication, and High Productivity. This model, like others, ties these skill categories to content area learning.

Digital-Age Literacy

For teachers and their students, technological or digital literacy is an important outcome. Teacher researchers in this project began with some trepidation about their technological abilities. Vera described it this way: "One of the challenges I faced with the blogging was the time I had to invest in learning how to actually set up the blog as well as figuring out how to make postings and embed pictures and videos."

Edna also commented that she was unsure about her technological skills, but she was ready to learn from and with her students: "I didn't know what I had in store, [but] I was ready to jump into the deep end thinking they'll help me along with whatever." However, she learned that the students were not experts in all aspects of computer use, so her classes became sites of reciprocal learning:

> "And I did learn a lot from them, but what I also learned in my surprise was that when it came to using Word, the very simplest of things, they didn't understand what the squiggly lines were about, they didn't know how to check for a spelling mistake or fix a grammatical error, they didn't know how to find the thesaurus online to look up words, right in the Word document. They didn't know how to do referencing or footnoting, so this was all stuff that came out

[1] This study is supported by the Social Sciences and Humanities Research Council of Canada, in the form of an Image, Text, Sound and Technology Program Grant (849-2009-0031). The author gratefully acknowledges this support.

as I was doing projects with them through the year, and they showed me some other things like how to work the WordArt and inserting different things that I wasn't clear on."

Students (9th graders, in this case) also commented on their technological experiences. Students, who were required to make a digital movie, selected the software that best fit their purposes. In most cases, they were unfamiliar with the programs and learned how to use them as they created their projects. Often, persistence and troubleshooting were required, but these led to learning and sense of accomplishment. Sample comments are:

> "We found photostory easy to use after we learned how to work it."

> "We have experimented with all the programs and we have made a decision that windows movie maker is the easier, faster and more efficient format."

Digital-age literacies also include visual and media literacies. In commenting about her grade one students experience making a video about patterning, Vera explains:

> "Being able to construct new media teaches literacy and job skills that are highly valued in a digital society. Constructing media also plays an important role in the development of media literacy. If students are able to construct their own media, then they will be able to recognize and evaluate more effectively the techniques that the media uses to persuade them into buying things and know how they can take control of this in their own lives."

Laura, in her interview, catalogued many of the skills her students had acquired: "how to copy and paste, how to save in different programs, how to upload and download, change font, how to add dialogue to pictures – how movies are actually made." She added, "It was a brand new experience – really exciting to them."

The author acknowledges that there are additional competencies under the rubric of Digital-Age Literacy. Although there is no data to support their inclusion here, teachers in the local school district are turning their attention to such learnings as multicultural literacy, global awareness, and scientific literacy. A science teacher has just joined the team of teacher-researchers.

Inventive Thinking

The enGauge model of 21st century thinking skills includes such skills as: Adaptability, Managing Complexity, and Self-Direction; Curiosity, Creativity and Risk taking; and Higher-Order Thinking and Sound Reasoning. A priority in our school district is critical thinking, both in the sense of higher order thinking and sound reasoning and critical literacy, whereby issues of power, equity and social justice are recognized and critiqued in texts. All of these skills were considered by teachers and researcher to be evident in the research data analyzed in this project.

Connections among creativity, collaboration, and learning have been argued within a variety of contexts. Both Web 2.0 and 21st century classrooms provide spaces for social discourse, collaboration, interactivity and intertextuality – and for creativity in the context of new literacies. The 9th graders the author observed made these connections themselves; they recognized that their collaborative digital compositions - mashups and remixes of others' creative works from a wide variety of contexts – are creative in that they generated new knowledge about the play in the social milieux of Web 2.0 resources and the classroom. For example, the group Jangly Janitors created a Photo Story comprised of black and white photos found on various Internet sites, a song soundtrack, and screens displaying quotations form *Romeo and Juliet*. Their classmates commented:

> "This is great, the black and white show more emotion i think, like between good and dark, my personal take but great project, …very emotional and music's just epic."

> "Wow, this is a great project. The black and white makes it so intense and epic. I love how deep all your pictures are, you definitely read into Romeo and Juliet in ways I never would've thought of!"

> "I'm really impressed by the black and white photography project, it's really intelligent the way they thought about the tones of the play and other expressions of the play (i.e. movies, old and new). I really like this project because i get to see how other people think and learn more about my thinking. Representing Romeo and Juliet in other forms is hard, but creative and fun. Even though reading the play was fun in itself, being able to play and manipulate it using technology that we know best really helped me understand the play more."

The comments of the fellow students indicate their recognition that the digital movie conveyed the emotion of the play in unexpected and innovative ways and that Jangly Janitors "read into" the play through different perspectives and with divergent thinking.

Grade 7 students using Kidblog to post their original poems received peer feedback on their poems. For example, one student wrote to her classmate: "This poem is very heart felt it talks about life and death and it's very truthful it makes me think about how we should cherish the people in our lives and enjoy every second together. I really liked this poem!" Such feedback shows not only interpersonal skills, but also demonstrates peer assessment. Teachers are keen to encourage peer and self assessment, to help students develop their own criteria for evaluating multimodal texts and acquire a language of critique that is supportive and effective.

Edna commented on the process of developing these skills with grade 9 students constructing digital movies in groups of two or three about a novel they had studied as a class:

> "Also for the most part we learned, and I learned at that point, that if they watched the videos as a class while they were in the process of finishing them, before they did the end product, then they could get some really useful critiques of each others' work: 'that was too dark;' 'I don't think that music matches;' 'I don't think it shows what you're trying to portray; why don't you put this in a paint program and put the words there for that and make that a slide so that the picture is separate.'"

In her digital movie account of her research, Lenora described how her 5th-grade students composed digital multimodal responses to the novels they studied in literature circles. They used pictures and narratives to create a movie about the novel – a task that Lenora describes as risk-taking for both herself and her students. She concludes, "Sometimes taking a risk can be very rewarding for both me and my students."

Teachers are becoming more mindful of thinking skills and the various forms that may take in the classroom as they observe students and read students blogs and other posts about their composing processes and responses to classmates' compositions. Students, too, can be encouraged to be metacognitive - to think about their own thinking processes.

Effective Communication

Teachers in the study, mostly English Language Arts teachers, noted that ICTs increased the quantity and quality of their students' writing, and the enthusiasm with which they approached it.

Vera studied blogging in two studies: in her grade one classroom and while home-schooling her son during a temporary family resettlement to Singapore. In observing her son's progress, she noted:

> "My son was always a reluctant writer, but because he had the freedom to write what he wanted on his blog coupled with the fact that his work was more made public and accessible through the blog, he became much more motivated to write. Through blogging the quality of his writing also improved. He knew from the comments that he received that others were reading it and because of this the pressure to produce high quality work increased. Contrary to what many people think, students need to be able to write more effectively than ever in today's digital age. They need to think and write clearly and precisely if they are to be effective contributors of the web. Blog writing helps with prioritization, conciseness and clarity."

Vera also notes,

> "Last fall in my grade one class, we decided to create our own blog page. Having explored several grade one blogs on the internet, the students were very excited about starting their own. The students began blogging by making a comment on their own photograph, as well as a classmate's photo. Because I set up the blog to allow for 'real-time' participation and feedback, students were motivated to make additional responses as their ideas were still fresh in their heads."

One of the sub-skills noted in Effective Communication is interactive communication and another is interpersonal skills. Most teachers in the study noted that 'conversations' among classmates increased greatly, with collaboration turning to other school tasks as well. Jane explained about the rules for the Ning she created:

> "I told them what is was about and described it in relation to Facebook, except I told them that it would be academically related only. They did socialize about their academics, which was very refreshing and they took it upon themselves not just during computer lab time here at school but at home on their own time as well. Many times at night I would go in and see that if there were things that I needed to give approval for, and I could see that they are [writing] back and forth even for other courses, or they had a test or something about notes. It was strictly academically related, socially and academically."

Vera also says,

> "It is interesting to note, that the students were conversing with each other outside of school time. Blogging is a wonderful way to help bridge the gap between home and school experiences. Blogging can also be very beneficial for those students whom are very shy or intimidated to speak in a classroom setting. This is a space where students can freely express themselves and get feedback from their peers."

Vera adds,

> "Blogging is also an excellent tool to help parents become involved in their children's schooling. Parents can participate in the blogs by making comments to postings or simply being the viewer of a blog. In either case, the information on the blog brings with it an awareness of the learning that is occurring in the classroom and through students' responses, parents can see the various levels of progress."

Laura noted that her grade 5 students continued writing blogs after the year ended and told their next grade teacher about their blogs, encouraging her to continue blogging in her class.

As MOO, a 9th grader, concluded,

> "Blogging lets you get your ideas out there, and lets you share what you know. Blogging also helps you make new connections with other bloggers, and through comments and new posts, you can create a virtual world of innovative thinking."

High Productivity

Working individually and in groups on digital projects demands a commitment on the part of student composers to prioritize, plan and manage for results, to make effective use of real-world tools, and to produce relevant high-quality products [20]. Teachers all commented on the engagement of their students in the task. Edna noted:

> "I had a group of grade eight and most of the class has difficulty in English, and even engaging them is difficult. So I asked them to do a PhotoStory for me on a novel that we had done together and they were to work in pairs or groups of three, and what I enjoyed watching was the engagement. They were automatically into the task, now admittedly the first thing they wanted to do was pick out the music. But at least it got them talking, and they were searching together, and they were sort of constructing ideas through their conversations so it was really good social process. Then as they watched each other, the people next to them working and they'd hear me going on and then it sort of made them want to do better than the other group."

Grade 9 students using a Ning to plan, comment on, and display multimodal projects on *Romeo and Juliet* commented:

> "After our experience with the project, we are finally accustomed with the ning and have truly realized how useful it really was. It was a great idea to use a specific website for this project. The ning was a fantastic way to organize your ideas and learn from fellow students, either from their comments, opinions, questions or ideas."

Emma shared these observations about her use of a Ning for novel study (Lois Lowry's *The Giver*):

> "On average grades improved 14-16% over other novel assignments submitted throughout the year; students demonstrated a greater understanding of the novel that they had demonstrated with any other work this year.

> Assignment motivation among Ning participants was awesome, and class and hallway discussion of Ning experiences was prolific."

As the teachers observed, using digital technologies engages students and motivates them to complete projects, produce their best work, and strive to interest and provide pleasure for their classmates.

Content Area Learning

Models of 21st century skills like Partnership for 21st Century Skills [8] and Metiri Group [20] emphasize that the skills are employed in learning the authorized curriculum and promoting academic achievement. Infusion of ICTs and digital technologies has that same goal. In their research, teachers observed not just the acquisition of technological literacies and demonstration of skills, but also learning of content.

Vera's grade one class also the students created a video about patterning, which they posted on the blog. The students were very excited to show their video to other classes as well as friends and relatives at home. Vera argues, "Through the making of the video and the repeated viewings of the final production, the students gained a much stronger understanding of the concept of patterning and it became more meaningful to them."

Edna explained than her students, through their ning activities of blogging and threaded discussions were preparing for the criterion reference tests (CRTs) administered by the Province at the end of grade 9:

> "So they were constantly practicing for this demand aspect of the CRT, so when they wrote the other day their writing had been elevated to such a point where I was amazed at what they did. And I totally give credit to the use of the Ning because they had so much practice writing, and developing a voice, and knowing they had an audience meant that they were going to make that voice much more interesting and appealing."

Laura, teaching her grade 5 students about setting in novels, decided to have them construct models of the novel's settings in art class. Working in small groups, they created the settings important in 2 or 3 assigned chapters. Laura then used a digital camera to photograph the models and asked the groups to write summaries of the events in their chapters. Combining the pictures with audio-recordings of the summaries, they created digital movie clips that could then be combined into a digital movie of the entire movie. Laura described this as an excellent learning experience for students about setting and characters. She concluded that they learned much more about setting than ever before, and became more critical of their efforts making the models. If they could do it over, she said, they would be more careful of the details.

These, and the examples in other 21st century skill categories, are just a few of the illustrations selected from the collective data to demonstrate the importance of technology infusion in literacy teaching and learning. As the research continues, the team hopes to build resources for other teachers in the district, sharing their "knowledge of practice" [17] widely.

CONCLUSION

While not finely analyzed and interpreted at this stage, the data produced in these studies indicate that there is a productive relationship among information and communication technologies (ICTs), new literacies, and 21st century skills. Teachers taking up technologies and infusing them in their literacy teaching and learning are excited about the engagement of their students, the possibilities for connecting with all learners and implementing differentiated instruction, and their own learning of multimodality. As we continue our collaboration, we will continue to gather data on these themes and 21st century skills, as well as sharing ideas about assessing multimodal projects. Interviews with teachers also illustrate that well-functioning computers, computer room availability, IT support and trouble shooting, and their own technological professional development are issues that still exist and problems that need solution. However, this research also indicates that the efforts to solve them are well worthwhile.

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Technology Evolves but Basic Ideas Survive. Enabling Institutional Collaboration through ICT

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ABSTRACT

In 1994 four colleagues from different HE institutions in Norway started a collaborative R & D project for net based, open and flexible higher education. The project was named Norway-net with IT for Open Learning (NITOL), with focus on professional and institutional collaboration. Exchange and distribution of learning material through electronic networks were hard to implement in the pre-WWW days, and much attention was given to technical solutions at the early stages.

Students' interest in the project was overwhelming. From 30 students registered in spring 1994, enrolments exceeded 2500 students in fall 1998. NITOL had outgrown the project stage, and the group asked their institutions to take over administration of course activities. Other institutions joined in and the management of a new, national, networked university, NVU, was given to administrative representatives from 9 partner institutions. After a couple of years, however, they decided to close down the joint course activities, and NVU became a forum for exchange of ideas and organisation of annual conferences.

The basic principles from NITOL, however, were carried on through international projects on virtual universities, and now - nearly 20 years later - still seem to be relevant for fruitful collaboration across institutional borders.

Keywords: Higher Education, Net Based Learning, Institutional Collaboration, International Projects, Virtual Universities

ESTABLISHING THE NITOL MODEL OF COLLABORATION

It is not always obvious to administrators and professional staff at HE institutions that collaboration is superior to competition when it comes to attracting students. Four Norwegian higher educational institutions, the three University Colleges of Agder, Stord/Haugesund and Sør-Trøndelag, and the University of Trondheim (NTNU), have all been active in a European collaborative project on open learning, i.e. JITOL - Just In Time Open Learning, 1992-94 [1] (Lewis et al, 1992) under the European Delta programme [2]. Building on experiences from this and other related projects, representatives from the four institutions decided to propose a national experiment along the same principles. Support was granted from a governmental agency, and NITOL - Norway-net with IT for Open Learning [3] was established in April 1994.

NITOL was initially a joint open learning project for students, teachers, IT professionals and others. Research questions particularly focused on collaborative development and distribution of course material. A group of around 30 students participated as "guinea pigs" in the experiment. Interest in the courses showed that there was possibly a large potential for business, expanding the experimental group and perhaps demanding student fees for participation and examination.

At the pre-www time learning material had to be distributed through different electronic network systems, e.g. the nationally developed WINIX [4], a system that included many of the present World Wide Web features. The institutions collaborated on technical solutions and in the development of goals and objectives, strategies, courses, course material and evaluation tools for the project as well as in the on-line contact with students. Hypertext and hypermedia were at the time under development, parallel to the project.

Experiences from the initial part of the project, i.e. *pre-www* existence, covered areas related to the learning process, such as

- the establishment of an open network making higher education available to students, groups and individual participants from business, schools, administration, SMEs, etc.
- production of joint learning/training materials
- distribution of educational materials through electronic networks
- development of an extensive, dynamic and creative electronic learning environment based on local and wide area electronic networks
- development and application of assessment tools
- evaluation of open and distance learning/training

In to-days world of e-learning, with Internet, World Wide Web (WWW), broad band connections, social media and lots of research and experiences from ICT-based open and distance learning, it is hard to imagine how much trouble the items listed above could cause. On the other hand, it made the project group appreciate the facilities eventually becoming available and simplifying practice of the basic thoughts that were once the foundation of NITOL [5].

Student Attraction

The initial R & D group of students obviously told their friends about the net based possibilities for higher education where they could cross borders and distances between institutions virtually, having access to a wider selection of courses. Similarly the initial teachers and developers convinced some of their colleagues to join an interesting field of development. This changed the scope of the project. In addition to being an R & D project on collaboration and distribution for facilitation of learning, focusing on pedagogy and learning principles, the project group also had to look into the area of administration and organisation for larger groups of ODL-students.
The resulting development of student enrolment is shown in Figure 1:

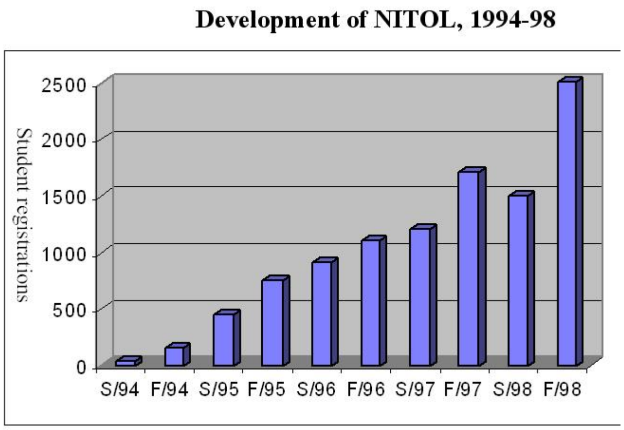

Figure 1. Development of NITOL, 1994-98 [6]

Parallel to the increase in student interest there was a growing political interest in ODL and the applications of Internet. The European year of lifelong learning in 1996 stressed the work for making education at all levels available to the public, and lots of attention was drawn towards the use of new technology. Funding of international projects helped the development both at national and international levels.

Technical and Software Development

During the first couple of years technical hurdles had to be overcome almost daily. As Internet and PCs stabilised and became more user-friendly, pedagogy and subject content came more to the foreground of the work. The sudden introduction and rapid development of WWW indicated a major breakthrough for ICT-based ODL. NITOL happened to be there "just-in-time" to meet the requirements. The project group had a feeling of body-surfing at the front of a huge wave, only hoping that the ride would end on a soft beach, not in rough waters and rocks.

Organising the Project

The increase in student numbers required serious thinking about daily routines of the project running. In 1996 some systematic work was done to develop "The Administrative Concept of NITOL" [7], covering the central issues of the project organization.

An important part of the concept was the *free flow of material* between the four NITOL partners. Of course, copy rights and the academic property rules applied equally well to electronic products as to printed material. At the start of the project, however, an agreement was signed, stating that partners were free to "borrow" material from their colleagues, use it in their own courses, develop it further and offer it back to the original author as well as to the other partners. The condition was that the name/institution of the author was visible to everyone who was exposed to the material. During the project period this free exchange of competence and material was one of the major assets of the project. All partners had great advantages from it.

The NITOL project was based on inter-institutional collaboration on the organisational level, and also encouraged collaboration between professionals on content and pedagogical issues.

Examples of Professional Collaboration

Sharing and exchange of learning material could be as simple as just putting courses together in an open course pool, making a joint catalogue of courses etc. In NITOL this was called the Open Access Model (Fig 2). Teaching staff having access to other colleagues' materials could study their way of dealing with pedagogical problems, as a well of experience and inspiration. But it might be tough for the author to be scrutinized by several colleagues and their students. Once they got used to it, however, it was a win-win situation [8].

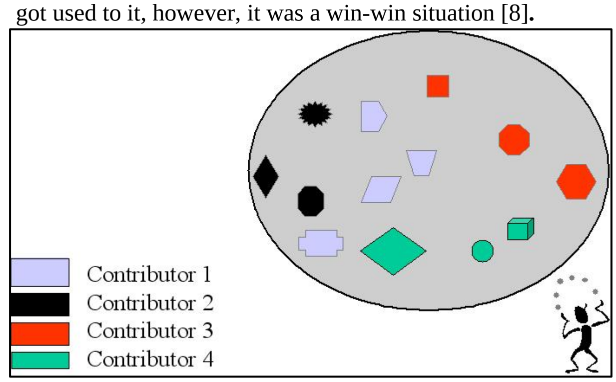

Figure 2. The Open Access Model

Another way of dealing with learning material was to join forces in development of course material, the **Joint Venture Model** (Fig 3). An example here can be when professionals from two or more institutions - even across national borders - join forces in developing a course. Networked institutions can really profit from this way of sharing workloads [9].

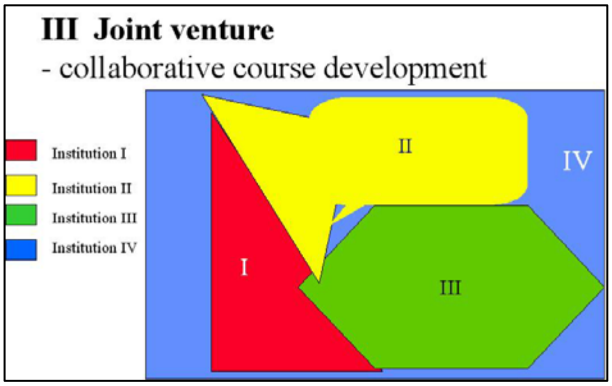

Figure 3. Joint Venture Model

A third option, the **Composite Model** (Fig. 4), was to develop independent modules - or learning units - that could be components in different courses or studies within the collaboration. This kind of arrangements requires particularly strong co-operation for recognition of credits and academic level. The model may have its special strength when colleges/institutions are small or medium sized, where resources and the staffs' expertise and capacity are limited.

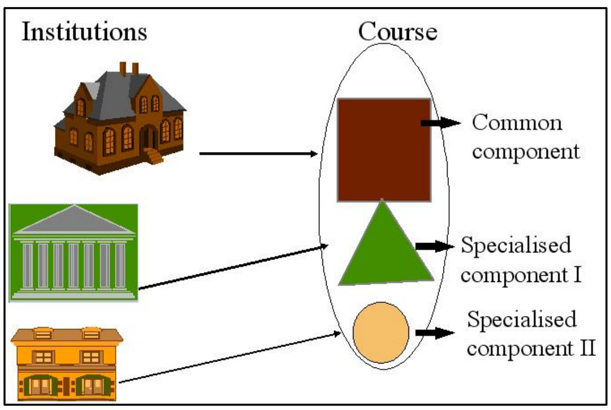

Fig 4. *The Composite Model*

Organising Networked Learning Environments

For inter-institutional collaboration it seemed to be an advantage to agree on a common technical platform or learning environment. During the first years of NITOL this kind of environment had to be developed through special software techniques, e.g. the aforementioned WINIX system [4], and later on the basis of web pages. Today several Learning Management Systems (LMS) offer this kind of platforms. The weaknesses of many LMS'es are that they often focus more on management than on pedagogical approaches and facilities for developers. This is particularly supporting *electronification* of the traditional correspondence school where learning material and exercises are distributed to students, answers are returned and grades are awarded on the basis of work during the course and/or traditional exams. The initial courses in NITOL were often organised this way.

As new tools became available more advanced pedagogical approaches were introduced, e.g. the popular socioconstructivist models, where students and tutors jointly exchanged ideas and developed new knowledge through discussion forums and social media on the net.

NITOL exchanged ideas and evolved in close relations with projects funded by the European Commission under different framework programmes and specific initiatives. Joint experiences through these projects have supported and inspired new developments, both on the R&D side and more practically for courses and study programmes that were offered. But establishments of *collaborative virtual universities* constituted great challenges for existing higher education institutions [5].

FURTHER APPLICATIONS OF THE NITOL MODEL

A rather modest national project showed a way that many other collaborative projects and net based education providers could follow for establishing and further develop towards virtual universities [10]. The model could be applied both nationally and across national borders.

Establishing a national networked university

The NITOL project group realised that course activities soon grew too large for ad hoc administration. Leaders of the four partner institutions were invited for an institutionalisation and a more official status of the project. In early 1998 the agreement for establishment of a national networked university, NettVerksUniversitetet (NVU), was worked out. In December 1998 the partnership agreement was officially signed by the four NITOL institutions - plus five other Norwegian partners. A board and a steering committee for NVU were appointed at the institutional administrative level.

The Networked University (NVU) was meant to be open to all HE institutions in Norway, not a new, independent Norwegian university, but a partnership between existing institutions, taking over the course activities from NITOL and develop it further. After a few years, however, the NVU board decided to skip most of their joint course activities, like course catalogue, enrolment of students, marketing etc.

Development of NVU did not meet the expectations of the NITOL group. The actual NVU joint activities ended up being the establishment of special interest groups (SIG) and the arrangement of a conference of e-learning once a year. Joint activities for marketing of courses etc. were abolished, the total course enrolments went down and there were only minor exchanges between the partner institutions. The major mistake is suspected to be that the new NVU administration distanced themselves from the professionals, the founders and enthusiast that created and developed the NITOL principles.

The initial NITOL group remained active through 2008, since 1999 mainly with R & D work, engagement in national and international projects, and less with daily services to students and practical administration. There were lots of challenges that had been waiting for the group to find time for. Collaboration, openness and joint developments remained the major "glue" in the group. A final project report was printed, handed over to the four institutions and made available for interested parties [3].

International offsprings

As already mentioned in the introduction, NITOL got its first inspiration from participation in the European JITOL project (1992-94) [1], where 11 HE institutions from 9 countries worked together for Development of European Learning through Technological Advance, DELTA [2]. The NITOL group further developed the principles of open collaboration, and “paid back” to the European Community through active engagement in several other EU projects, where the NITOL model was a central core of activities.

Internationally the NITOL group kept up the activity within joint networks and e-learning projects also after the NVU was established. During the total of 15 years (1994 - 2008) the gospel of collaboration was promoted through several projects. A short-list of such projects with references follows below:

European projects. During 1995 – 2009 one of the NITOL institutions were leading and coordination 5 different European projects:

- MECPOL - Models for European Collaboration and Pedagogy in Open Learning (1995-98) [11]
- Do ODL Dissemination of Open and Distributed Learning (1996-97) [12]
- EuroCompetence (1998-2000) [13]
- MENU – Models for a European Networked University for e-learning (2001-03), with a clear intention to create a European NITOL, or a European Virtual University EVU [14]
- QUIS – Quality, Interoperability and Standards in e-learning (2005-06) [15]

In several other projects NITOL was invited as a partner, either as a joint group, as four separate partners or through one of the institutions as partner representing the whole group. This was the case for e.g.

- EONT - (1995-96), coordinated from Greece [16]
- SHARP SHAreable Representation of Practice (1998-99), coordinated from UK [17]
- E-LEN (2003 - 05), coordinated from Cyprus [18]
- B-learn – Blended Learning (2005-07), coordinated from Estonia [19]
- e-JUMP 2.0 – (2008 – 09), coordinated from Estonia [20]

In particular the idea of developing a Model for a European Networked University (2004) was closely related to an initiative taken by the European Commission in 2001 [21], aiming at mobilising existing resources for designing tomorrow’s education. The partners of MENU defined strategy and models for collaboration - partnership agreement, for joint study plans, organization and economic strategy, which were tested and evaluated through user trials. Based on these building blocks, the model for establishing a sustainable ENU - a European Networked University for e-learning was presented in the reports from the project. Internationally MENU contributed to the direction of development for an offspring from the United Nations University, the Global Virtual University.

Global Virtual University, UNU-GVU [22] was established as an online network of universities for sustainable development, and had a particular objective to meet the educational needs of the third world. GVU was officially launched in September 2002 at the World Summit on Sustainable Development in Johannesburg, SA, where the Norwegian Government, the United Nations University, UNU, [23] and the United Nations Environment Programme, UNEP, [24] pledged their support and partnership.

The United Nations University - Global Virtual University, UNU-GVU, [25] offered courses from different universities, e.g. a course on global environment issues based on the UNEP report “Global Environment Outlook”, GEO [26], as part of a master degree programme, Global Environment and Development Studies, GEDS [27]. This was part of the MENU demonstrator, involving students and tutors from around the World, actually following the NITOL principles of joint development and collaboration for net based learning.

One of the most popular courses offered through the GVU network, was e-Teaching, actually a sequence of two courses, E-teaching I [28] and e-Teaching II [29], both based on structure and content ideas from the NITOL course on Pedagogy in Open Learning, PiOL [30]. The main idea behind these courses was to qualify professors and teachers to develop and tutor e-learning - or net based - courses within their own subject areas. This was particularly important for the partners of GVU that should provide higher education for students in developing countries, in remote areas and at universities lacking capacity and competence in certain disciplines.

The concept and principles of open collaboration, mutual trust and joint efforts are fragile, but still a key issues for success at local, national and international levels. They turn out to be hard to carry over from the initial NITOL partnership to other HE institutions. Even at the founding institutions, most of the basic principles in NITOL have suffered shifting support.

PRESENT STATUS

NITOL is history with its final report in 2009 [3]. The four member institutions continued on separate basis with different net based activities that could be linked to the NITOL experiences. The courses that survived were mainly within ICT related topics at bachelor and masters level. The focus on inter-institutional collaboration, however, seemed to be dormant - at least for a while.

At national level the NVU still exists. It has now 5 member institutions [31] with a revised partnership agreement signed in 2009. The intention is to create a meeting place and a network for professional collaboration on matters related to net based learning, with the main event being the annual NVU conference. There are no joint courses, marketing or catalogues.

At the European level, there is still no real joint virtual university according the MENU prescriptions. In discussions between e-learning professionals, the idea is generally supported. But the implementation of such an organisation, with devoted commitment from the participating institutions, still seems to be out of reach. This agrees well with experiences from the MENU trials, where institutional regulations, traditions and national laws were in conflict with the principles of open collaboration required by the suggested model. These hurdles are still hard to overcome. Paper presentations and discussions at international conferences on e-learning, reveal that in 2010 - 11 new projects and R&D groups are still working on similar challenges for net based collaboration.

On the global level, UNU-GVU lost its governmental funding from 2008, and therefore had to wind up its portfolio. The e-teaching courses continued for 2-3 years under the umbrella of University of Agder, UiA [32]. The same university also coordinates a revised version of GEDS now named a master programme in development management [33], offered as blended learning in cooperation with African and Asian universities. The net based parts are designed and run in accordance with parts of the MENU model and the principles taught through the e-teaching courses.

Returning to the roots

Stord/Haugesund University College, SHUC [34], was the coordinating institution for NITOL as well as for MECPOL and MENU, for longer periods also for NVU. Net based learning has been offered by the Department for Educational Information Science ever since the days of JITOL and the birth of NITOL. Attempts to involve other departments at the college have been met with scepticism, particularly when it comes to exchange and close collaboration over institutional borders. When the master's programme for *ICT in learning* [35] was established in 2003, new approaches were made to other faculties again. And with the revision of study plans in 2006 several other subject specialists were involved as tutors and advisers for master students - but only for students registered at SHUC.

When new national regulations for teacher education in Norway were introduced in 2009, the division into separate lines of study, more specialisation and requirements for larger variety of electives at each site, made the resource situation particularly difficult for smaller institutions. At a meeting in *UH-nett Vest* [36], i.e. a network of 5 higher educational institutions in Western Norway, different ways of exchanging competence and expertise were discussed. After the meeting the old proposal for the NITOL project - written in 1993 - was brought forward by SHUC. It seemed to fit right into the concept at hand, and a "new" pilot project was composed, revitalizing the original NITOL idea of joint development and expert collaboration between colleagues from different institutions.

The new project was named *Campus based e-learning at topic level* [37]. It started in May 2011 and the partners will have its report and first products ready by June 2012. Technology has developed much sine NITOL started in 1994. Broadband connections, fast and high capacity PCs, video cameras, social media etc. were only *dream-ware* in the mid 1990ies. Now they are natural parts of the tools being applied. Educational methods for net based learning have also evolved over the past 17 years.

The principles of work, however, are not so very different. A major goal is to promote campus based e-learning at the partner institutions. A central part along that road is to develop a particular 10 credit (ECTS) course on *E-learning at HE level*, and make it compulsory for all new teaching staff members at the institutions. The course will be net based, developed jointly by experts in the field from all partners, and at a next stage also made available for teachers outside of UH-nett Vest.

Now in 2011 subject specialist groups are composed within a few limited topics early in the pilot period. In according with plans these are in the areas of Mathematics, Norwegian, English and Arts & Crafts. Each group has at least two subject specialists, coming from different institutions, who are now jointly developing their course, sharing responsibility and tutoring of 10-15 "students" within the network. Each topic has a content value of 5 - 30 ECTS credits.

The groups are already established, the development work is on its way, and the first trials will be performed during spring 2012. Partner and group meetings are performed through multi point Internet based video conferences, on low or no-cost platforms like *Adobe Connect* [38] or *LiveRoom/Fronter* [39], saving time and money previously needed for physical meetings. Otherwise, much of the methods and principles here are very close to the initial NITOL ideas, but at this stage only planning for services to campus students, i.e. net based support as part of *blended learning*, so far not inviting individuals outside the participating institutions. May be next year there will be an expanding round of the same ideas, from a small pilot through greater visions?

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Localized Image Segmentation and Enhancement for Meteorite Images

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ABSTRACT

This paper proposed an image enhancement and segmentation algorithm to localize the segment of interest in a series of images obtained from the Electron Microprobe. There are totally four different images that are corresponding to the spatial density distributions of four major chemical elements inside a meteorite rock surface. The density distribution of each chemical element is shown in a gray valued image with a resolution in the micrometer range. Our algorithm applied a statistical image enhancement technique to improve the visualization of features about the same segment of interest in three images using one image as a reference. The three chemical elements distributions of a localized cluster were enhanced, and eventually integrated together into a synthetic color image to reflect various chemical compound distributions insider this cluster.

Keywords

Image enhancement, segmentation, meteorite images.

1. INTRODUCTION

The methods for analyzing images often varied according to the different features in images acquired from various imaging instruments. In the case of studying the chemical compound in the ureilites, the typical small size (about 1x1 in^2) of ureilites used for analysis has made measurement extremely difficult for scientists. The measurement is powered by using a new generation imaging system called Electron Microprobe. The Electron Microprobe allows scientists to acquire a set of high spatial resolution gray images. Each shows the concentration of one chemical element. In this paper, four images of chemical distributions of a ureilite rock are acquired from the Electron Microprobe. The images represent the spatial density distributions of four chemical elements, Magnesium (Mg), Iron (Fe), Aluminum (Al), and Calcium (Ca). The Field of view (FOV) of each image covers the polished surface of ureilite with a resolution in a micrometer (mm) range [1]. The high intensity pixel value in an image shows high chemical concentration, while a low intensity value shows a low chemical concentration in a pixel. The four chemical element images of the ureilite have the following features. The intensity values of the Mg image are grouped by clusters; hence, the overall image is of bright and high contrast as shown (Fig. 1). This is consistent with the existing knowledge of the rich Mg concentrations inside a ureilite in general. The Iron (Fe), Aluminum (Al), and Calcium (Ca) images usually were very dark inside each cluster due to their lower concentrations in general, and the low intensity values shadowed the boundaries between adjacent clusters as shown in Fig. 2.

It is not practical to study directly the whole spatial content of the images while, often, only a small cluster was of interest. The images acquired from an Electron Microprobe usually are of large size with around 1,000 x 1,500 pixels in total for a ureilite roack of size 1x1 in^2. Not only is the computational burden a concern, but also the rich intensity scales inside a large size image will degrade the view of the cluster of interest if the whole image is directly studied. Due to its simultaneous acquisition feature, a pixel in the same location in each image usually accounts for the same position in the rock surface. It is useful to use one chemical element image, such as the Mg image, as a reference, to identify the segments of interest in the rest images to reveal the material composition in the rock surface. This is useful for analyzing all chemical element distribution images simultaneously in order to study the highly correlated features inside the images. Another reason for narrowing into a small segment of the images for study is that the rich intensities coexisted in the image makes it difficult to enhance the features using the existing algorithms. It is rational to search for a small cluster of interest for enhancement to avoid the complexity with enhancement of the entire dark image (see fig. 2)

In this paper, we first described an interactive method to select a cluster of interest in the rock surface by using the bright and high contrast Mg image as a reference image. The location of the selected cluster was then mapped into the distribution images of the other chemical elements. The low intensity contrast inside the cluster will be selected for further processing. Secondly, we describe a method to correct the gray values of the low intensity images by constraining to this small cluster. The interior pixels inside this cluster only count for a fraction of the original image size. An improved contrast within this cluster will be locally maximized. Finally, we proposed to synthesize all the enhanced segments of three major chemical elements into a color image to characterize the chemical compounds to show the microscopic view of a cluster inside the rock surface.

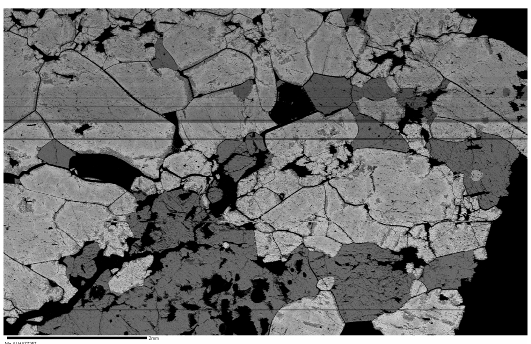


Figure 1: The Mg image to be used as a reference.

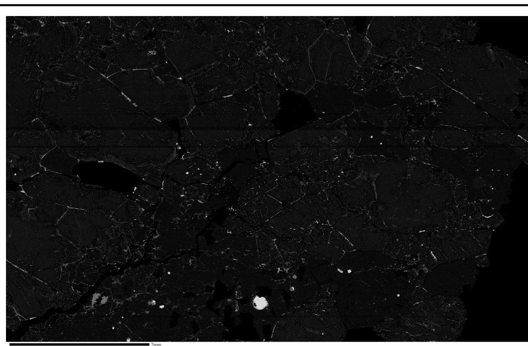


Figure 2: The Fe image to be enhanced.

2. CLUSTER SEGMENTATION

Image segmentation is often associated with edge detection. Often, a closed edge formed with connected curves is of interest, which typically defines the boundary of a segmented object. However, most of edge detection methods are simply based on either the gradient or the zero crossing information and therefore are not geometrically oriented. The gradient information is used for edge detection by defining edges as the local directional maxima of the absolute gradient magnitude computed. and is represented by the Sobel edge detector [2] and Canny Edge Detector [3]. The zero-crossing information is used for edge detection by computing a second-order derivative of the image values [9].

The tradition edge detection methods are capable of detecting the potential edges faithfully showing all the high constrast locations in the image [2-3, 7]; however, it is not suitable when our goal is to identify a cluster in the meteorite image. Our interest is to label only the cluster of image for analyzing the chemical compounds inside the cluster, while neglecting some small segments inside this cluster.

Meteorite images are featured by their massive size (Fig. 1) with different clusters integrated together. Each cluster was grouped by pixels with similar intensity values while the boundaries are marked with relatively different intensity values. As we mentioned earlier, the Mg image is the best candidate for edge detection. This image is used to identify a cluster of interest to allow enhancement [4] to be applied efficiently to this cluster in the other images.

Our proposed edge detection technique is based on the Sobel detector and modified morphology methods [8]. To begin, we select a rectangle segment on the reference, Mg, image. Inside the rectangle region, the histogram of the image is generated. The mean of the histogram is used as an automatic threshold level for generating a binary image where the pixels of the potential boundaries of a cluster object are marked as 1, and others are marked as 0. The initial operation of this thresholding using the Sobel detector finds all the potential boundaries blindly, which includes boundaries of very small segments. Based on this potential boundary image, *B*, the shortest Euclidean distance of each pixel to the potential boundary in image B is calculated, i.e. for each pixel represented as (i, j), $d(i, j)$ is defined as

$$d(i,j) = \inf_{(k,l)\in B} (\|(i,j)-(k,l)\|_2)$$

The boundary image, B, is updated to unify the multiple broken boundaries that belong to the same edge:

$$B(k,l) = \begin{cases} 1, & \text{if } d(k,l) < threshold \\ 0, & \text{if } d(k,l) \geq threshold \end{cases}$$

where the threshold is set for number 3. Note this threshold is different from the threshold used for edge detection. The binary value of 1 in the image, B, indicates the improved boundaries. This updated boundary allows multiple boundaries for the same segment to be unified together to show the geometrical features.

Finally, the largest connected component is identified; To do so, we identified all the connected components in the edge images, and then defined the size of each connected component, O_k, as

$$M(o_k) = \sum_{(x,y)\in O_k} I(x,y)$$

The largest component to be preserved is defined as

$$O = \arg\max_{O_k} M(o_k)$$

This method discarded all the isolated small segments initially being treated as boundaries. In addition, the morphologically operations, namely, a dilation followed by an erosion, are performed to close the potential gaps inside the boundaries, while to ensure the boundaries for a cluster are properly connected. In so doing, the major boundaries are identified. It separates the Mg image into several clusters that we are interested in. Only the inside of the cluster of interest was selected and preserved. The major steps for finding a cluster of interest for the Mg image is shown in Fig. 3.

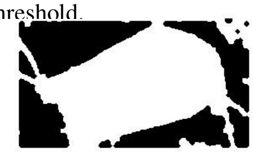
3. ENHANCEMENT

Enhancement of a low contrast chemical element image allows us to visualize the spatial density distribution of the compounds made from this element, and provides a base for counting the concentrations. When an image is in low contrast, the image enhancement sometimes involves deblurring and noise removal procedures [5]. The histogram of an image statistically demonstrates the the image intensity distribution and is typically the base for contrast correction. Direct contrast adjustment methods [2] and histogram equalization methods [6-7] are two methods generally used for gray image enhancement. To better preserve the chemical element concentrations, histogram equalization methods is used in our study. The histogram equalization methods map the input gray levels to the output gray levels which are evenly dispersed based on statistical knowledge. The existing image enhancement algorithm is improved to enhance the distribution of each chemical element image.

a) Select a rectangle area from the original Image.

b) A binary image was generated by applying Sobel detection with an automatic threshold.

c) The largest connected component with new boundaries defined and morphological operation.



d) An interactive selection of the cluster with closed contour.

Figure 3. Our proposed cluster segmentation

The traditional histogram equalization methods adjust the image intensity globally. It treats the entire image equivalent and usually yields poor local performance; therefore, in a localized region, the intensity may not be appropriately separated even after enhancement. Several improvement algorithms to enhance the intensity in a localized region have since proposed [6, 8].

An image enhancement algorithm is ideal only when it matches the unique image features; hence, when referring to a chemical element distribution image of the ureilite acquired from the Microprobe, the special features of these images needed to be considered. After the cluster of interested was segmented, image content inside the cluster was kept. Inside this cluster, Our enhancement technique combines the Gaussian smooth filter together with a modified histogram equalization method to map the majority of the image intensities into the maximum dynamic display range available.

We proposed to partially equalize the gray values Histogram equalization (HE) method. HE method is a statistical analysis of image intensities. The histogram of a digital image counts the number of pixels whose values are inside a set of ranges called bins. If we use $I(x, y)$ to represent an image, a histogram is defined as a discrete function

$$H(i) = \# \, pixels(low_i < I(x, y) \leq high_i), \text{i=1}, \cdots, \; n$$

The (low_i, $high_i$) is the range of the i-th bin, and n is the total number of bins used. The relative frequency histogram approximately defines the probability of occurrence at the *i* bin, as

$$P(i) = \tfrac{H(i)}{N}, \text{i=1}, \cdots, \; n$$

where N is the total number of pixels in an image taking into considerations.

A good enhancement result will have the histogram stretched to the highest dynamic display range. The histogram of pixels inside the selected cluster tends to gravitate to the lower intensity within a narrow range with outliers in both the high and low end in the low contrast chemical element images that we aim to enhance. The outliers are classified dynamically as

$$\text{Outliers} =$$

$$\{I(x, y) \in Bin(i), \text{ if } \sum_{i=1}^{\text{lowest}} P(i) < \varepsilon, \text{or if } \sum_{i=highest}^{\text{n}} P(i) < \varepsilon \}$$

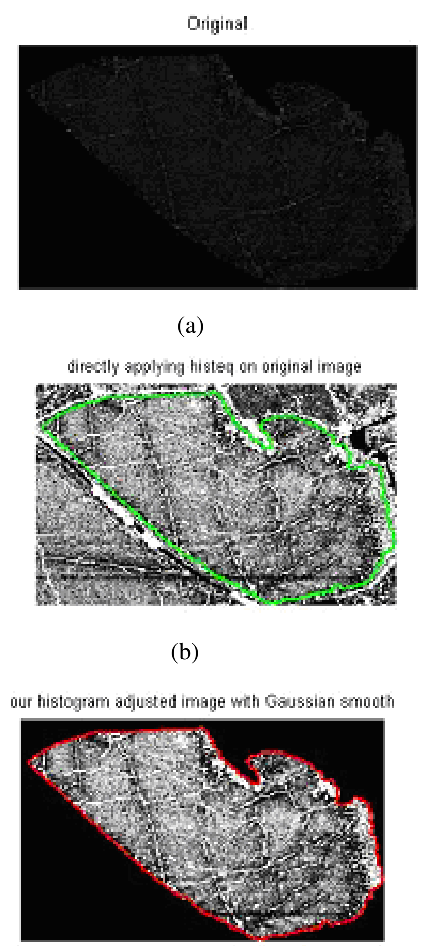
with the *lowest* and *highest* represent the landmark values used to define the outliers, which can be set to about three times the inter quartile range (3IQR) away from the median. In our case, we use the 0.1% data as outliers. After the outliers are classified, we set the

$$I(x, y) = lowest - 1, \text{ if } \sum_{i=1}^{\text{lowest}} P(i) < \varepsilon, \text{and } I(x, y) \in Bin(i)$$

$$I(x, y) = highest + 1, \text{ if } \sum_{i=highest}^{\text{n}} P(i) < \varepsilon, \text{and } I(x, y) \in Bin(i)$$

In addition a Gaussian smooth filter is applied for preprocessing to make sure the outliers are properly classified and a histogram of best fit can be resulted. Our new histogram image enhancement steps are:

1. Determine the lowest 0.1% outliers in the histogram.
2. Determine the highest 0.1% outlier in the histogram.
3. Generate new histogram using the intensity constrained between the lowest and highest outliers defined.
4. Apply histogram equalization.

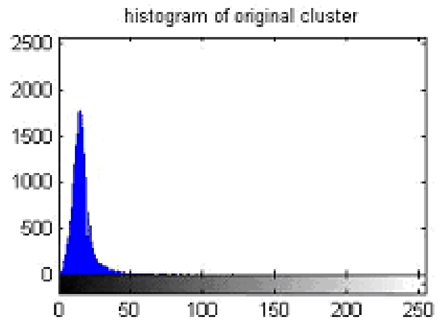


(a)

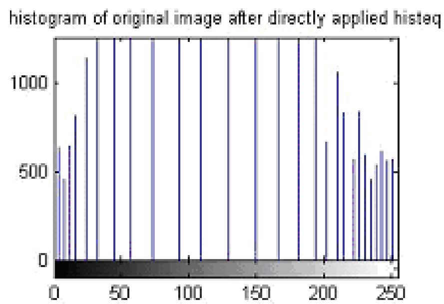
(b)

(c)

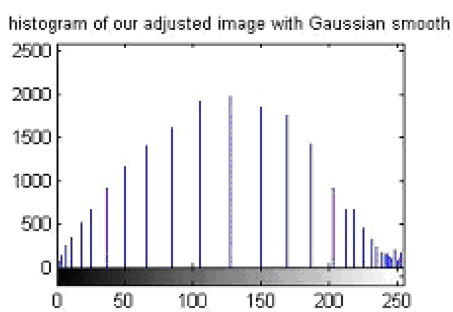
Figure 4: The Fe image segment (a) and the cluster identified (b), followed by the enhanced clusters (c) .



(a)



(b)



(c)

Figure 5: The histogram of the original Fe image cluster (a); the histogram of the cluster that histeq was directly applied (b); the histogram of our enhanced cluster (c)

In Fig. 4(a) is shown the cluster of Fe image. In Fig. 4(b) is shown the cluster of Fe image after the HE is directly applied; the cluster is marked in green color. In Fig. 4(c), our partial HE enhancement technique is applied; the cluster is marked red color. The resulting image in Fig. 4(c) has higher contrast than the image in Fig. 4(b). This is further shown in the histogram in Fig. 5, where the histogram of the Fig. 4(b) is shown in the Fig. 5 (b). The histogram of Fig. 4(c) is shown in Fig. 5 (c) with Gaussian filter applied. Fig. 5 (c) that is corresponded to the partial HE method has shown improved histogram with our partial HE method.

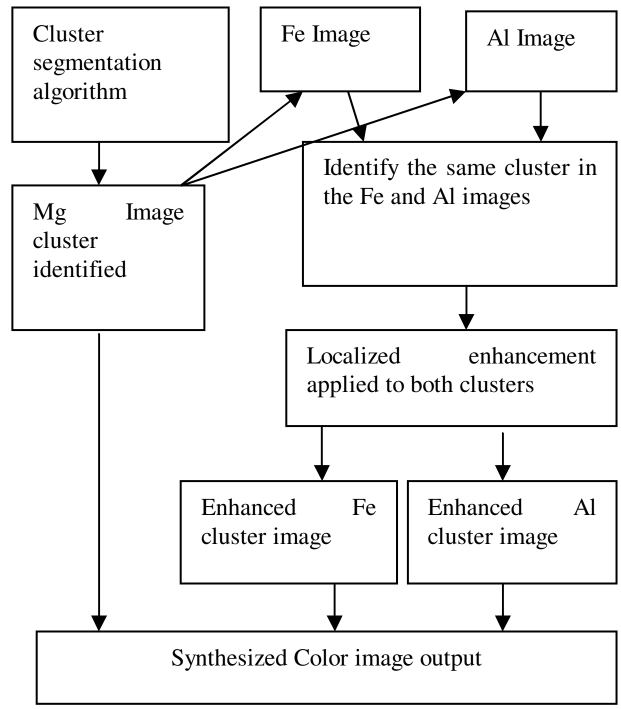


Figure 6. The diagram for generating the color synthesized cluster image.

5. SYNTHESIZED COLOR IMAGE

Human eyes perceive color from three types of cones in their retina-Red (R), Green (G) and Blue (B), corresponding to the three basic colors RGB. A color image is represented in (R, G, B) vectors. We can differentiate just noticeable difference in terms of little changes in color distance, which makes the color image rich to interpret.

Here, we have composed a color image using the three chemical element image clusters. The color images are generated after the segmentation and enhancement are obtained. A color image is the composed of vector (R, G, B) for each image pixel. Here we designed the color vector (R, G, B)=(Fe, Mg, Al). The whole processing is shown is the diagram in Fig. 6.

The synthesized color image is shown in Fig. 7 (a), in comparison to the Mg gray intensity image. The yellow color shown in the image likely indicated rich iron content region. This distribution color allows us to further study the compound distribution and display the distribution of different chemical compounds simultaneously in a color image.

6. CONCLUSIONS

In this paper, we have proposed to localize the cluster of interest in the meteorite images using the Mg image as the reference. We further applied an image enhancement to improve the visualization of the low contrast images, and eventually synthesized the three images of higher contrast into a color image after the segmentation and enhancement.

7. ACKNOWLEDGMENTS

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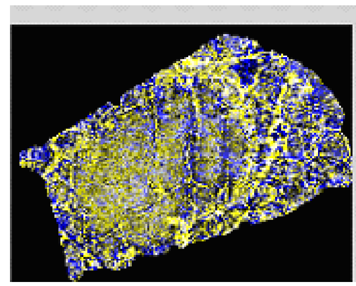
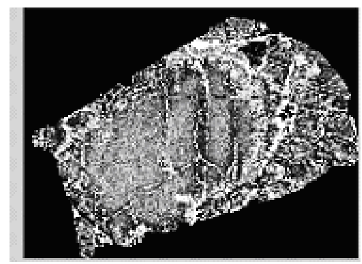


(a)



(b)

Figure 7. (a) The color synthesized cluster image. (b) the gray intensity Mg image.

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Technology in the Technical Mathematics Classroom

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Introduction

It's no secret that the use of technology in the classroom is increasing. However, it is less clear what effect that use of technology has on student success and instructor workloads. While there is some consensus in the research that the inclusion of technology in the classroom is typically neutral or positive, there is also consensus that more research is needed in this area [5, 6]. This is particularly true as the post-secondary student body expands to include more non-traditional, disadvantaged, and underprepared students. Aud *et al*, [1] report, for example, that more than 20% of post secondary students took a remedial course in the 2007-08 academic year. Of particular interest are case studies which address the implementation of technological interventions in specific contexts. Spence & Usher and Walker & Singer [4, 7] provide examples of this type of study. While lacking the generalizability of more broad ranging studies, case studies provide a level of detail that is useful for programs in making decisions about whether, and to what extent, to implement technology in the classroom. This paper reports a case study of initial results in the incorporation of instructional technology into traditional (face-to-face) mathematics courses within a professional-technical curriculum.

The Technical General Education program (TGE) at Idaho State University (ISU) is a part of the General Education department of the College of Technology. The College of Technology is a professional-technical education (PTE) institution which operates as a full college within ISU, a Carnegie Research High institution in Southeastern Idaho. According to the College of Technology website, the TGE program is formally charged with providing courses that assist in "technical training by providing general educational courses such as business/technical writing, math, oral communication, building job search skills, and understanding human relations issues pertinent to the workplace." (2009) One of the primary emphases of TGE is pre-enrollment courses used to orient and bolster student performance in math and writing prior to their entry into degree or certification programs.

TGE works as an independent general education program focused on the needs of PTE students. While courses offered through TGE are cross-listed with corresponding courses in academic departments throughout the University, courses are developed independently. TGE faculty are not considered members of these departments, though they do hold equivalent degrees and participate in similar levels of professional development as instructors of comparable courses.

According to a 2011 internal review, more than 75% of the students enrolled in TGE programs fit into at least one demographic group considered as academically at-risk, including groups such as learners who are economically disadvantaged, non-traditional, diagnosed with a learning disability, and those who are either displaced homemakers or single parents. Upon entry into TGE courses, students are assessed using the Test for Adult Basic Education (TABE). These TABE scores are used to place students in the most appropriate course level for their math and writing abilities. TGE math courses begin at the level of place value and continue to elementary statistics and other selected topics. Satisfactory completion of courses is determined by a grade of at least a 2.0 on a 4.0 GPA scale.

This study focus on two TGE courses, 100M and 100A, and the corresponding courses offered through the Mathematics department at ISU, 015 and 025. 100M/015 is a course in arithmetic and pre-algebra. It begins with place value and basic arithmetical operations and continues through an introduction to linear equations. 100A/025 is a course in elementary algebra. It begins where 100A/015 leaves off and continues through all subjects prerequisite for understanding a typical college algebra course.

Justification

In an effort to further improve student outcomes, TGE has begun implementation of a series of technological improvements to its classrooms and courses. For the last 5 years, TGE faculty have been provided training and materials to integrate instructional technology into their classrooms. However, the impetus for these efforts has been based primarily on anecdotal and circumstantial evidence and a desire to be seen as progressive in their teaching methodologies rather than on validated research to justify this work.

Before more effort, time, and resources are allocated to this effort, and before more emphasis is placed on this trend in the college as a whole, it is worthwhile to examine the results of previous efforts and to determine what impact these technologies actually have on student performance and retention.

It is also critical to examine these efforts in the light of budgetary restrictions that have increased as a result of recent economic downturns in the state of Idaho. Considering the outlay requirements in capital, resources, training, and support when implementing extensive integrations of instructional technology into classroom practice, hard and verifiable research is clearly warranted in order to progress further down this path.

The overall goal of the study is to offer a view as to the advisability of continuing to invest in technology upgrades to the professional technical classroom. Student success is the primary determinant of such advisability, but teacher experience offers a secondary determinant. Negative effects in student outcomes would constitute a strong argument against further inclusion, while positive effects would offer a similarly strong argument for it. In the absence of student effects, positive or negative effects on teacher experience may be sufficient to decide the issue. Although this study has a clear importance to policy construction within TGE, we believe it offers a further touchstone to similar efforts to introduce classroom technology in other departments and settings.

Methods

This initial study is a retrospective examination of the impact of instructional technology on student performance in Basic Math and Basic Algebra courses in the TGE program from 2004 - 2009. The study examines, specifically, the impact of two classroom technologies, Interactive White Boards (IWB) and lecture capture through Elluminate *Live!* recordings, on student performance and retention in TGE math courses when compared to performance and retention trends in similar math courses offered through traditional academic programs over the same time period, based on Information provided by the Idaho State University Office for Institutional Research.

This study used a mixed methodology to examine the impact of the implementation of technological aids in mathematics courses within the professional technical curriculum of a state university. First, a retrospective quantitative analysis of 6 years of student outcomes provides a baseline result demonstrating that the inclusion of such technology maintains the success and retention rates of students as compared to the rates prior to its introduction. Success rates in TGE courses were also compared to rates in similar courses offered by the Math department which did not undergo a systematic enhancement of technology in the classroom during this period. Second, structured interviews with the instructors who implemented the technological aids were conducted to determine factors that escape quantitative representation and indicate ways to improve the success of future implementations. While student outcomes are the most critical potential effect of technology in the classroom, there are other effects that may argue for or against its inclusion. If technology improves teacher efficiency, student comfort, or other such factors, its use may be warranted even if it has no effect on pass/fail/withdrawal rates.

The primary data set for the quantitative analyses consists of pass, fail, and withdrawal rates for two remedial mathematics courses offered through both the TGE and Mathematics departments. The primary statistical test was a series of two factor analyses of variance (ANOVAs) comparing pass, fail, or withdrawal rates for 3 year periods both before and after the introduction of technology. For all ANOVAs one independent variables was the technology. The second independent variable was either the particular course (100M, 100A, 015, 025), the department (TGE or Mathematics), or the course level (Arithmetic or Algebra). For each choice of second independent variable a two factor ANOVA was calculated with each of pass, fail, and withdrawal rates as independent variable for a total of 9 two factor ANOVAs.

Two instructors were primarily responsible for the implementation of technology in the TGE courses over the study period. Questionnaires were completed by each of the two instructors involved in the transition and followup interviews were conducted to further clarify and elaborate their responses. Structured interviews were conducted with these instructors to determine the impact of the technology on factors other than passing and withdrawal rates. Specifically, these interviews queried whether the technology has provided a substantial change in the effort required to teach the class, whether the technology has made the students more or less comfortable in the classroom, and whether instructors see the inclusion of technology in the classroom as a net positive or net negative. Interviews and questionnaires also included open ended questions to allow instructors to offer points of view on effects that the researchers may not have considered prior to the interview.

Results

Enrollment, pass, fail, and withdrawal data were collected for all sections of 4 courses from a 9 year period (2000-2009). To facilitate comparison, data was converted to percentage rates for pass, fail, and withdrawal data and enrollment figures were converted to standardized T-scores based on data from 2000 to 2009 for each course. The following figures the mea contains descriptive statistics for the courses. Dark lines represent TGE courses, light lines represent Math courses. Diamond marked lines are Arithmetic, square marked lines are Algebra.

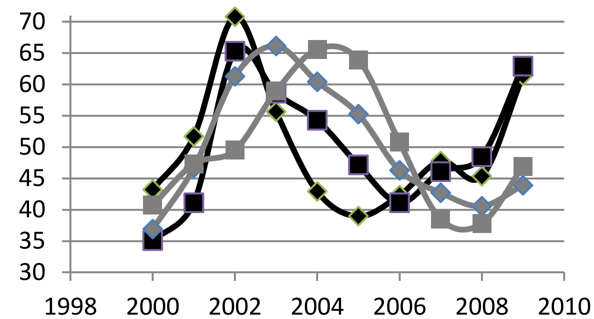

Figure 1: Enrollment by Year

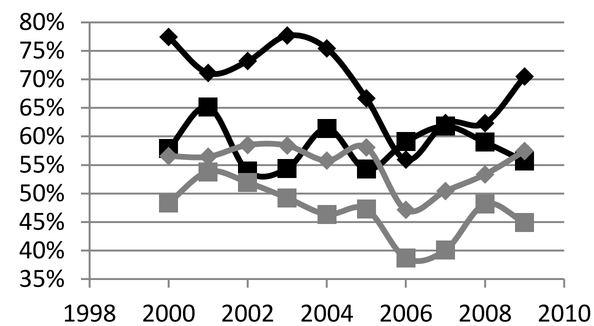

Figure 2: Pass Rate by Year

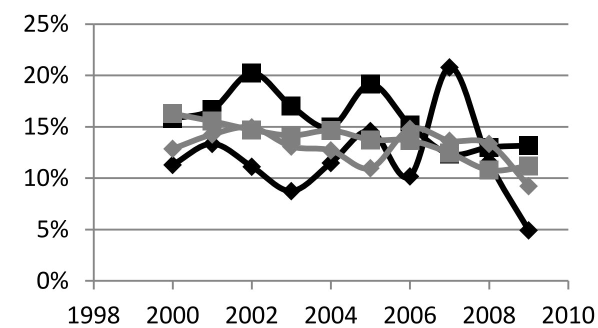

Figure 3: Withdrawal Rate by Year

Two-factor ANOVAs were calclulated to compare pass, fail, and withdrawal rates from both before and after the introduction of technology. No significant difference was found between the means of the pre and post technology groups. Nor were there any significant interaction effects noted between technology level and course, department, or course level (arithmetic vs. algebra.)

The instructors involved in the implementation of the technology presented a generally positive characterization of its impact, though they also noted some downsides and technical problems. On the positive side, they noted that the technology increased student access to material. Both technologies allow lecture material to be accessed by students online. Students were able to focus more on the presentation of material during class rather than on taking extensive notes. This material also provided a study resource for students who were unable to attend class. However, one instructor mentioned that some students seemed to place less importance on classroom attendance as a result. These students were often those who she felt would have benefitted most from that attendance. In general, motivated students were able to use the extra resources to their advantage while some less motivated students used the presence of the resources as an excuse to work even less. This was particularly true regarding the ability to “attend” lectures remotely via Elluminate. Because remote students only see what is projected on the whiteboard, and the instructor cannot see the remote students at all, it was felt that the lack of full interactivity and accountability made such attendance of less value. Indeed, the instructors are currently discussing not allowing such attendance in the future except by prior arrangement.

The instructors also reported feeling that some of the technology was not sufficiently reliable, especially the live recording capability of Elluminate Live! While it worked well most of the time there were problems when students came to rely on it and then, for whatever reason, it became unusable for a period. Factors contributing to these problems seem to be changes in the computer being used for recording, variations in browsers and computers used for viewing recordings, and difficulty keeping all software versions and drivers up to date.

The instructors were more positive about the effect of the IWB technology. This technology allows the instructor to keep multiple boards in computer memory and switch between them quickly. The instructors felt that this ability was helpful in lectures.

Discussion

Based on the results of this study, we cannot determine that the inclusion of IWB or Elluminate Live! technology has had a significant effect, either positive or negative, on student success or retention. However, this must be taken in the context of several limitations to this study.

From a quantitative perspective, there are features of the data that might obscure such effects even if they were present. As it happens, the time period of this study (2004-2009) was a time of substantial variability in enrollments generally. All four courses experience an enrollment peak of $T \geq 65$ between 2002 and 2004 and experience declining enrollments thereafter for a period of three to five years. Both TGE courses peaked in 2002 and bottomed out in 2005 or 2006 and then rose again to $T \geq 60$ by 2009. The Math department courses show a similar pattern in enrollment, but delayed by one or two years. Thus it is unlikely that the rise in enrollment from 2007 to 2009 in the TGE courses was due to the inclusion of technology. Instead this change in enrollment is likely due to unknown external factors. Importantly, a similar dip occurs in pass rates for three of the four courses, with the lowest pass rates occurring in 2006. Retention rates do not show this pattern. Based on the similarity between the pattern in enrollment and pass rates across courses in both departments, it seems most plausible that there were substantial external factors affecting the number, and likely the quality of students in the courses during that period. If the effect of technology use is substantially smaller than the overall pattern present in the data, an ANOVA would be unlikely to detect the effect. A more powerful statistical analysis might be able to detect such an effect, but it would also be helpful to use a larger data set as one becomes available.

The quantitative portion of this study examines a limited range of possible effects, primarily pass and withdrawal rates. Even if there is no effect on these measures, there may be significant effects on measures that we haven’ examined. For example, it is at least plausible that having access to recordings of lectures might improve student satisfaction even if it didn’t improve passing rates. Or it might be that even if the pass rate didn't change, students who did pass might have done so with higher grades, especially given the bimodal grade distributions that often occur in mathematics courses. Of course neither of these scenarios can be supported by the results of this study. Rather, caution is urged against concluding that because positive effects were not readily visible in the quantitative portion of this study that they do not exist.

Another important limitation of this study is that it does not include qualitative information from the viewpoint of the students. This should be addressed in future studies.

Conclusions

This study shows no change in student success rates after inclusion of IWB and lecture recording technology in the classroom. Teacher reactions to such technology are generally positive, though they also include some concern about possible negative effects on the lowest performing students and some frustration with technical problems in implementation.

However, the study has important limitations that should be kept clearly in mind before using it as the basis for policy decisions. The data examined seem to have been heavily affected by factors external to the study, possibly obscuring the effect of the technology change. The study does not take into account student viewpoints in qualitatively evaluating the impact of technology on student learning. These limitation should be addressed in further studies.

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Investigating the Need and Content for E-Security Training in New Zealand SMEs

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ABSTRACT

Studies indicate that small and medium sized enterprises (SMEs) face greater risk from e-security threats, compared to larger organizations. This is particularly important in New Zealand, where 90% of business organizations are SMEs. This study investigates the need and content for e-security training in New Zealand SMEs and is carried out in two stages: the status of e-security training among the employees in New Zealand SMEs is investigated first and then the status is analyzed to identify possible training courses and course contents and to make other related recommendations.

This study found that although the SME staff have reasonable understanding of basic e-security issues, SMEs need to improve and complete their e-security policies and the corresponding implementation procedures and employ more effective and appropriate e-security implementation tools. Only 40% of the SMEs that participated in this study have policies for password and internet usage and 33% stated that they have no IT security policies. Most SMEs don't have e-security training courses and procedures. E-security training is highly recommended for these SMEs. An e-security training system including course outlines for both, the IT staff and non IT staff is recommended. Other possible strategies and solutions for e-security are also recommended.

Keywords: E-security, Training, SME, New Zealand, and Knowledge.

1. INTRODUCTION

A transaction cost analysis study highlights the important benefit that internet use can provide in reducing an SME's transaction costs [1]. The results of studies on e-security in small and medium sized enterprises (SMEs) in USA, U.K., Germany and Japan indicate that SMEs face greater risk from e-security threats, compared to larger organizations. This is particularly important in New Zealand, as 90% of business organizations in New Zealand are SMEs [2, 3] and these SMEs make a significant contribution to New Zealand's economy [2]. Therefore, it is important for these businesses to have appropriate e-security management strategies to secure their business. E-security training and the attitudes of the employees toward it are very important to information security in New Zealand SMEs [4].

Over 87% of organizations experienced some form of security incident; the most common in New Zealand being virus infection, laptop/cell phone theft and insider abuse of net access/email [5]. It has been suggested [6] that more than 60,000 known virus threats exist in the current environment world-wide. The most important element in e-security systems is people, so it is important to keep employees updated [7]. Technology and training are important to protect customer data. A lack of awareness exists among office systems users about information vulnerabilities resulting from the use of personal workstation automation systems [8]. In 2004, the importance of information security training, awareness and education was considered, more than ever, a priority for all education providers [9].

The objectives of this study are to make owners of New Zealand SMEs more aware of the importance of e-security for the e-business environment in the digital economy; to analyze e-security training in New Zealand SMEs and recommend appropriate e-security training; to establish a baseline course in order to educate and train IT users in New Zealand SMEs.

This study is carried out in two stages: the status of e-security training among employees in New Zealand SMEs is investigated first and then the status is analyzed to identify possible training courses and required contents as well as to make other, related recommendations. This study is conducted from a number of aspects, including if New Zealand SMEs conduct e-security training for their employees; if employees attend/complete e-security training before they join and commence using IT facilities; where e-security training exists, what courses and contents are covered; where e-security training does not exist, what should be covered in an e-security training course for New Zealand SMEs.

The data was gathered using online surveys and individual interviews. In this study, SMEs are defined as businesses employing between one and nineteen full time equivalent people. The participants are from a sample of 15 SMEs out of 100 targeted candidates in the Auckland region who responded to the invitation letter. The questions were designed to find out the attitudes and knowledge of the participants and their organizations towards e-security. Two versions of the survey were conducted, one for IT staff, another for non IT staff. The selected IT staff had been interviewed to provide the necessary information. The results are discussed to identify the current status as well as existing issues and provide information for New Zealand SMEs to complete and improve their e-security training. Six training areas for non IT staff and eleven for IT staff are identified. Other possible technique solutions to facilitate e-security training are also recommended.

In the following sections, the data is described first and then the survey data and interview data are analyzed separately, and that is followed by discussion and suggestions for future work.

2. THE DATA

The online survey was conducted in two parts; a survey for IT staff and a survey for non IT/general staff. The survey for IT staff consists of 17 questions (ITQs) and the survey for non IT staff 20 questions (GQs). Most of the survey questions are multiple choice questions. The questions are mainly about attitude, behavior, background and knowledge of the participants towards e-security. The main purpose of these questions is to help us identify the need and the contents of e-security training New Zealand SMEs. Complete lists of the questions can be found in Appendices B and C of [4].

The interviews were only for IT managers or staff responsible for IT in SMEs to get a better understanding of the organization's/owner's views towards e-security. All participants who supplied their contact details to the survey from the sample SMEs were invited as participants for the interviews. Five staffs had been interviewed. The participants were asked 37questions about e-security covering the following 10 different e-security areas:

1) Securing New Systems
2) Password Management
3) Anti-Virus Measures
4) Software Maintenance
5) Backups
6) Physical Security
7) Network Security
8) Wireless Security
9) Intrusion Detection and Recovery
10) Disaster Recovery Planning

Each interview question (INQ) was provided with a few possible answers. However, the purpose of these answers was to stimulate the interviewees' thinking, not to limit their answers. All the interviews were semi structured, which provided sufficient flexibility for those issues not covered by the predefined questions to emerge during the interviews.

3. SURVEY DATA ANALYSIS

Fifteen valid and complete responses to the survey for IT staff and thirty valid and complete responses to the survey for non IT/general staff from the 15 sample SMEs were received. The data analysis started with non IT/general staff. For each question, the percentage of each selected option against the total responses to that question was calculated and the results were compared with the data from important e-security related reports to get an idea of how serious the issue is or how much content is needed. For example, the following is question GQ3:

Do you have Anti-Spyware software on your working computer?

- yes
- no
- don't know

The responses to this question reflect the attitude of the SME towards e-security and the knowledge of e-security of the participant. 60% respondents answered "yes", 20% respondents answered "no" and another 20% respondents answered "don't know". This indicates that only 60% of the surveyed SMEs installed Anti-Spyware on their PCs, 40% of the participated SMEs are not aware of the threats from spyware. 60% is low compared with similar data from the other reports, 65% from [10] and 69% from [11]. It shows that the participants' knowledge and the SMEs' attitude regarding to Spyware are not satisfactory, and the related knowledge should be included in the training process.

Another example is question GQ5:

Do you frequently change your passwords for your working computer?

- daily
- weekly
- monthly
- don't know

The answers to this question reflect the e-security policy of the SME and the e-security knowledge of the participant. 0% respondents answered "daily", 0% respondents answered "weekly", 13% respondents answered "monthly" and 87% respondents answered "don't know". This indicates that 87% people don't know that it is best practice to frequently change their password, which is not satisfactory when compared with only a quarter of organisations had the same issue reported in [5]. It is also much worse than 60% from [10] and 40% from [11]. It shows that the surveyed SMEs don't have an adequate e-security policy about password change, obviously those companies did not provide good e-security training for all employees, and it also shows those employees did not get the knowledge about password changing from the current and previous employers. This issue is very serious therefore training is certainly needed and it is critical to include password regulations in a training process. Similar data analysis has been done for IT staff.

Four examples are presented next. The first example is question ITQ5, where the square list indicates that multiple answers were allowed:

Does your company have a web usage policy?

- yes
- no
- don't know

The responses to this question reflect the e-security attitudes of the participating SMEs. 27% respondents answered "yes", 60% respondents answered "no" and 13% respondents answered "don't know". This shows that most of the participating SMEs don't have existing web usage policy, The internet has brought a greatly increased information security risk while providing many opportunities for organisations and information risk management is in the two top five in the lists of [10] (TABLE 4 and TABLE 5). These suggest that the participating SMEs should significantly improve their awareness of the internet risk. Therefore it should be included in all the training processes. The second example is question ITQ9:

Do you have additional measures (Software security lock?, physical lock?) to protect laptop computers that staff carry around with them when they travel?

- yes
- no
- don't know

The answers to this question reflect the e-security policy of the SME and the e-security behaviour of the participant. 27% respondents answered "yes", 60% respondents answered "no" and 13% respondents answered "don't know". This shows that most of the participating SMEs don't have additional lock to protect laptops when these devices are away from office. It is interesting to see that the distribution of the answers to this question is same as that for question ITQ5. It is obvious that most of the participating SMEs don't have an e-security policy in regards to physical protection of mobile devices that carry sensitive and confidential business information. Improvement of e-security strategy is needs to be addressed urgently by these SMEs [12]. This confirms that risks associated with the internet should be included in all training programmes.

The third example is question ITQ11:

What is your perception of e-security training?

- not important
- important
- very important

The answers to this question reflect the e-security attitudes of the participants. 13% respondents answered "not important", 53% respondents answered "important". This suggests that most of the participants consider e-security training important or very important to them. This strongly suggests that there is a need for e-security training. This positive attitude paves the way for introducing e-security training courses in the participating SMEs.

The fourth example is question ITQ12:

Does your company provide e-security training for all employees?

- yes
- no

This question can reflect the e-security policy of the SMEs and the e-security attitude of the participants. 7% respondents answered "yes", 93% respondents answered "no". Comparing the results of ITQ11 and ITQ12, it is interesting that although the participating SMEs require e-security training, most of them don't provide e-security training for all the employees. The cost of e-security training may be one factor that hinders the employers' decision [4, p44]. The answers to ITQ13 show that at least 60% of the participating SMEs have budgets of less than 5000 dollars for e-security every year. The answers to ITQ14 show that 80% of the participating SMEs have budgets fewer than 1000 dollars for e-security training. This suggests that most of the participating SMEs only spend 20% of their e-security budget on training, which is much lower that 40% reported in [10]. This means that these SMEs require that the e-security training course should not be too expensive and cover all areas of e-security knowledge. On the other hand, they do need to look at what benefit a well-established e-security system and business training can bring to them.

Table I describes the satisfaction of the survey results. A satisfactory result means that the results returned by the participating companies are acceptable in comparison to the similar results in the literature, on the other hand the not satisfactory means that is not acceptable compared to similar survey or study results as demonstrated in the above examples. The "Should be covered in courses" column indicates that the relevant knowledge should be included in e-security training courses.

TABLE I. SURVEY RESULTS SUMMARY

Question Type	Satisfactory	Not satisfactory	Should be covered in courses
GQs	1-2,4,7-9,12-13,18,20	3,5,6,10-11,14-17, 19	2-18
ITQs	10-11,13-17	1-9, 12	3-4, 8-10

From the survey summery of survey satisfaction, Table I presents that among 20 general staff questions, answers to 10 of them are satisfactory and another 10 are not satisfactory, and almost all the questions should be covered in training courses; among 17 IT staff questions, 7 of them are satisfactory and 10 are not satisfactory, 5 questions should be covered in training courses. These suggest that both of the SMEs and their staff have some understanding about basic e-security issues, however, they are far from satisfactory. Training is definitely needed. It is clear that those SMEs being surveyed need to improve their e-security policies, and an e-security training course covering the listed areas should be conducted.

4. INTERVIEW DATA ANALYSIS

The interviewees answered their questions based on their situation of e-security training in SMEs and supplied their own views from professional perspective. The targeted SMEs are members of New Zealand SMEs and are from various business organizations; they may present different views and answers regarding the particular interview questions, so it will be interesting to find out whether different business organizations have dissimilar opinions in this particular area. Five IT staff (one IT Consulter, three IT managers and one system engineer) from five different SMEs were interviewed individually. The results of these interviews are consistent with the results of the survey. In addition to that, the interviews provided more information about the actual implementation of their e-security system which can help us have a deeper understanding about the e-security status.

TABLE II. PASSWORD MANAGEMENT

INQ3: How often do you require end users to change their password?	every 4 weeks	40%
	every 12 weeks	20%
	never change	20%
	don't require to change	20%

For example, TABLE II presents interview data for question INQ3. 40% of the participated SMEs never or don't require end users to change passwords. This is not acceptable according to IDC's survey results [10]. These companies need a tool or policy to force the end user to change their password periodically [4, p50].

Each interviewee answered 37 questions. The interview results are summarized according to these ten e-security areas. Most of the participants believe that e-security training is definitely the way to keep all employees updated with the necessary knowledge on e-security issues and skills so that SME's information assets can be kept secure. The training is just like any other basic PC skills training, however, it can be a long process for SMEs to implement the training such that all employees stay updated on a regular basis [4, p59].

A. Securing New Systems

Most of the participants stated that SMEs expect a defined set of procedures to set up a new server or new client machine, and only 40% participants have checklists of how to secure new servers and applications. Furthermore, 60% participants installed firewalls and turned off unnecessary services, and fortunately all the SMEs rename administrator user names as appropriate and change default passwords. However, less than half of the participating SMEs don't have much knowledge about how to secure a new system.

B. Password Management

It's a good sign to see that most of the SMEs required end users to change their passwords frequently. Also 80% participants educate end users about good password choices, remove privileged access for an inactive ID and periodically review the administrative privileges on systems. But still 60% of participants don't provide tools to verify strong passwords and don't lock out the user's account after a pre-determined number of failed login attempts and 40% of the participating SMEs never or don't require end users to change passwords.

C. Anti-Virus Measures

Anti-Virus is a very familiar topic for most SMEs, and all the participants have anti-virus software installed on their devices. This demonstrates that New Zealand SMEs have a good understanding of using anti-virus tools to keep them safe from viruses. However, only 40% of participants have spyware detection software on server and client machines. Based on the data collected during the interviews, most of the New Zealand SMEs don't know the significance of using spyware detection tools, so there remains the need to improve the training in the use of spyware detection tools in SMEs.

D. Software Maintenance

Software maintenance is not an unfamiliar topic for most SMEs. This study found that all the participants frequently update security patches, hot fixes for the operating system, office productivity applications and other applications. About 40% of the SMEs have centralized management tools to update their devices. However, most of the SMEs don't patch laptop and mobile devices when users are off-site.

E. Backups

Around 80% of the participants backup their servers and 40% backup their desktops, and 60% employees consider it their responsibility to back up their data. But 60% participants don't know the last tested backup procedures to ensure the data can be restored. From the interview results, it can be concluded that most SMEs backup their data, but not often verify and test the backup system.

F. Physical Security

Physical security issues are easily ignored in SMEs, because most of them don't have the same amount of money to build physical security systems, and most SMEs depend on the property owner's physical security measures. SMEs that do not own their buildings are limited in what they can do to implement an adequate physical security plan. In 80% SMEs, only the business owner and IT managers have the keys and keypad passwords for secure areas. Around 80% of the SMEs keep their servers and critical desktops in secure areas. However, 40% of the servers, critical desktop computers, and critical systems areas are not protected by alarms or video security systems.

G. Network Security

In general, network security is the primary security issue for SMEs. 80% of participants don't have network auditing tools to monitor and analyze the unusual patterns of network traffic. Moreover 60% of participants don't examine the network event logs to check if their systems are under attack. Most SMEs think that if they have installed a firewall and have security on networking system, that is enough; unfortunately, network security not only refers to only the firewall, but also needs the right policies in place to secure SMEs networks from the most common threats, which require SMEs to take control of their networks and create a more secure environment.

H. Wireless Security

Wireless security represents one of the highest risk categories in SME security systems, however, most of the participants answered that they have encryption keys over the active Wi-Fi access points in their networks. Furthermore, most SMEs educate users about the risks of using wireless (Wi-Fi) networks, especially on unsecured open networks like hotels, airport and coffee shops.

I. Intrusion Detection and Recovery

Intrusion Detection and Recovery are not familiar words for most SMEs. Most of the SMEs have installed firewall systems on their networks, but 60% of participants don't examine or monitor their firewall logs to look for patterns of attack, also 60% of participants recover systems via formatting hard drive and reinstalling operating system and applications. This indicates that the SMEs don't have adequate procedures on Intrusion Detection and Recovery; SME's need to train their IT employees in Intrusion Detection and Recovery.

J. Disaster Recovery Planning

Disaster Recovery Planning is something not really considered as important in New Zealand SMEs. Although it was discovered through the interviews that most of the SMEs have disaster recovery plans in writing, most of them never update the disaster recovery plan. This area requires some more attention.

5. DISCUSION AND FUTURE WORK

A. The status of e-security in New Zealand SMEs

New Zealand SMEs and their staff have reasonable understanding about basic e-security issues. More than half the participants consider e-security training as important and the majority of SME employees' would like to receive e-security training. However, the SMEs and their IT staff need better understanding about e-security strategies, policies and implementation procedures. They need better understanding on how e-security can impact their businesses and how they can benefit from reasonable human resource and financial resource investment on e-security. These can be achieved via e-security training. E-security training is not a mandatory task for most SMEs in New Zealand, and only 7% of SMEs provide e-security training for all employees.

New Zealand SMEs should improve and complete their e-security policies and the corresponding implementation procedures. They should employ more effective and appropriate tools in their e-security implementation. Most SMEs do not conduct e-security training for employees and many also do not possess any e-security training before they join the company and commence using IT facilities. Only 40% of the participating SMEs have policies for password and internet usage and 33% of the participating SMEs stated that there are no IT security policies existing in their organizations. Furthermore, most SMEs don't have e-security training courses and procedures and there are no specific devices or places to store or contain the training contents. E-security training is expected and needed.

This study concludes that owners/IT staff/ non IT staff use non-formal, but well-founded practices, which are different but not necessarily inferior to large firm practices.

B. Recommended e-security training course for New Zealand SMEs

This study found that IT and non-IT staff in most New Zealand SMEs would benefit from additional training. An e-security training course outline covering ten areas is recommended. On the other hand, creating an intranet knowledge share point for e-learning packages to train and educate users is an effective way for SMEs to implement the e-security training. Furthermore, an initial induction program that involves face-to-face training will make it work well if SMEs prepare and invest in such training.

There is an increasing focus on e-security training of SMEs' staff in the work with information security today. There are some information security companies working with SMEs to raise the e-security training in urgent situations, and several publications indicate the best practices in this area. But many SMEs need to focus on the e-security training to correct their staffs' attitudes and behavior at work.

A good training program should include participation and active learning using interactive courseware [13]. E-security education and its associated training courses are different from the abstract academic discipline programs; they should help employees of SMEs to be better prepared to deal with actual tasks when they enter the work place [14]. In order to complete a successful e-security training program in SMEs, everyone has a role to play in the training process. Users are the majority audience in this training process and they are the most important people to help reduce unintentional errors and e-security threats. Users may include employees, contractors, guests and visitors. They must understand and comply with SMEs' e-security policies and procedures.

An appropriate e-security training system for SMEs has to include two parts:

- E-Security Training for SME Non IT Staff
- E-Security Training for SME IT Staff

Based on the previous analysis and discussion, an example of e-security training course for SME non IT staff should address in detail the fundamentals of e-security such as key principles, concepts, vulnerabilities, threats and how to counter them. Thus, the course outline for non IT staff is presented as following:

1) The Internet Risk
2) Password Management
3) Anti-Virus Measures
4) Acceptable Use Policies
5) Physical Security
6) Incident Response

To ensure SME e-security, it is important to establish a baseline training of e-security knowledge that every single IT employee in an SME must have. The e-security training course for SME IT staff should cover the following 11 areas:

1) The Internet Risk
2) Securing New Systems
3) Password Management
4) Anti-Virus Measures
5) Software Maintenance
6) Backups
7) Physical Security
8) Network Security
9) Wireless Security
10) Intrusion Detection and Recovery
11) Disaster Recovery Planning

C. Other Recommendations for New Zealand SMEs

It is difficult to recommend and endeavor to change certain areas directly applicable to New Zealand SMEs without any external impetus which stimulates their motivation for change.

The recommendations are summarized as following:

Complete e-security policies and the corresponding implementation procedures must be in place: Effective e-security policies must be completely developed. To develop the security policies, a noncompliance policy for e-security and e-security training should be considered as an important part of e-security policies. The implementation procedures should clearly identify the available e-security tools and how to use them.

Make e-security training as important as other skills training: This study shows that the amount of e-security training in New Zealand SMES is still very low and providing proper e-security training is becoming more and more important for most SMEs. Therefore, the first set of recommendations aims to raise the e-security training as an important skills training for SMEs:

- SME owners should consider e-security training as important as any other skills training
- SME owners should initiate a noncompliance policy for e-security and e-security training.
- SME owners should develop a recognized training framework to encourage lifelong learning

The communication of the survey and interviews indicates that SMEs should avoid abstract and tedious indoctrinations about the importance of e-security. Instead, it would be better to develop a well structured training framework with a fresh and emotional introduction that captures the attention of the audience such as real-life experiences in e-security skills and knowledge training at their organizations.

Reward employees upon completion of e-security training: When SME employees have succeeded in completing an adequate level of e-security training, it is time to reward those who carry out the organization policy and act accordingly. This could be achieved by certain measures:

- Issuing a formal e-security training certificate printed with employee's name and completion date
- Investing in their career -- offering employees more opportunities to learn new technologies and skills to motivate the IT professionals and non IT staff
- Integrating the training as a part of the annual review program

D. Research implications and limitation

The limitation is that this study does not aim at providing representative data and results as it is only studied the targeted and selected SMEs in Auckland. However, based on the pool of valid responses received, it is legitimate to make assumptions and "educated guesses" in regards to the e-security in the Auckland region. It was assumed that the participants would represent different opinions. However, most of the participants offered similar views in answering the questions. Most of the analysis was based upon the calculation of frequencies, because the limited pool of data it is impractical to conduct any more advanced statistical analysis such as correlations or regression [4].

E. Future work

The recommendations and baseline course are supposed to be used in practical work with e-security training. To see if this is possible and expedient, the baseline course must be developed and tested in some SMEs. Such testing has not been done currently, but it is considered a natural follow-up to this report. It is expected that some or all of the recommendations and baseline course are used to bring effective impact on attitudes and behavior of New Zealand SMEs and their staff. From this it would of course also be expected to find out if the baseline course could be used or not. Another output could be the identification and definition of many new e-security training baseline courses [4].

Also the recommended course has to provide a place for employees to find security information, letting them know that breaches in security could cost the company severely, and the e-security training is necessary for everybody. On the other hand, creating an intranet knowledge share point for e-learning packages to train and educate users is an effective way for SMEs to implement the e-security training. Furthermore, an initial induction program that involves face-to-face training will work well if SMEs prepare and invest in them properly.

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Using Robots to Teach Musical Rhythms to Typically Developing Children and Children with Autism

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ABSTRACT

Robot assisted therapies offer promise as training and educational tools for facilitating learning in children. Music training or therapy is often provided to school-age children. We are using commercially available humanoid robots to systematize music training sessions by providing consistent repetitive training that is also spontaneous and interactive. We use an embodied approach to musical training wherein the robot progresses from whole body rhythmic actions to finer drumming actions. In order to minimize the amount of control and energy needed to create rich sounds we took advantage of the forces in the system. In this way the robot was able to produce complex dynamics with minimal control. We were able to create multiple themes as basic behaviors. 10 typically developing children interacted with Nao across 12 rhythm training sessions within a robot-child-child context. Pre-, mid- and posttest data have been collected to examine the child's motor patterns during whole body action and drumming. Preliminary analyses are currently ongoing. We hypothesize that the children will improve their intralimb and interlimb coordination during rhythmic actions such as marching, clapping, and drumming following training. We also hypothesize that social interactions such as conversation bouts and rates of joint attention bids will increase across training sessions. Overall, we believe that the rhythm intervention context developed with a 23-inch tall humanoid robot called Nao (Aldebaran Robotics, Inc.) is a highly engaging context for children to facilitate social communication and motor skills. Robot child interaction based training shows promise as a modality for skills training and education.

Keywords: humanoid robotics, rhythm therapy, education, autism, music

1. INTRODUCTION

This work is based on a collaboration between several departments at the University of Connecticut and members of the community. We are looking at issues of human robotic interface and how it relates to real world applications in education and therapy. Our fundamental perspective is that communication and social interaction are embodied dynamical processes. [10,16,17] Aspects of perceptuo motor control are fundamental to attunement and interaction. Training that promotes motor control and awareness of the movements of others can improve basic social skills, communication, and quality of life. [5,11,12,13,14,17]

2. BACKGROUND

Robot assisted training offers promise as an educational and therapeutic tool to facilitate learning in children. [7,8,18,19,20,25] In robot assisted training the trainer works with a child using the robot as a tool to lead and motivate the child. The training contexts may involve one robot and one to two children. In all cases we have an adult mediate the interactions between the robot and the children. The trainer sets the mode of operation of the robot, the child and robot go through an activity. The activities address specific skill sets within motor, social, and communication domains. Kids are motivated to interact with robots. [20] Children in general find robots interesting and enjoyable to work with. This offers the opportunity to use robot interactions as a motivating context for repetitive activities. This is helpful in training regimens where part of the effort by the trainer is generally engaging the child to participate and then maintaining their engagement throughout the training session. Some time is often spent in re-engaging the child after they have been distracted from the task at hand. Robots are dynamically interactive and can participate in re-engaging the child and primary activity.

3. CAPABILTIES OF ROBOTS

In our research we are working to develop deployable systems that can be used in real-world clinical and educational environments. Commercial robotics has reached a level of maturity that has made available robust humanoid and mobile robots that could be used as training tools by clinicians and educators in the field. These robots have several capabilities that can be applied to robot assisted training. Robots have the ability to provide social interactions through the use of language and gestures [19,20]. The robot can be programmed to speak predetermined sentences. The phrases and sentences can be triggered as a response to speech recognition or initiated by the trainer. Various gestures can be programmed by these robots as part of their motor repertoire. Each of these actions can be modified in a systematic way so that the complexity of the interaction can be varied based on the level of training that is appropriate.

Currently available robots such as the Nao (Aldebaran Robotics, Inc.) can provide lifelike (real world?) interactions. The Nao has 25 degrees of freedom giving it a morphology that is very similar to that of a human. This provides the opportunity for the robot to engage in simple to complex motor activities with the children, for example, imitation games. The similarity in morphology also provides the opportunity for the robot to operate devices that can be used by people. These can be toys or musical instruments.

Several robots have the ability to move through an environment at various speeds. This locomotive ability provides the opportunity for interactions with the child such as chasing games or walking in step. [17] In some cases it is necessary to use a wheeled robot to maneuver with the children because of the greater robustness of the wheeled modality as compared to current legged walking robots.

INTERPERSONAL SYNCHRONNY

Moving in synchrony with another, entails entrainment to the other person. [12,21] This may be a form of mimicry which is an important social skill. [12] This entrainment is the bases for increasing interpersonal synchrony. This interpersonal synchrony is a dynamic process that emerges from the interplay between the members of the group. As they move together they mutually influence each other creating an emergent synchronous system that is self organizing. This system is an emergent social unit. [16,17]

Acting in a coordinated fashion with others promotes feelings of connectedness. [12] The activity of drumming with the robot and another child may promote social bonds. Wiltermuth and Heath found that synchronous activities can lead people to cooperate with others and further that this activity could lead to future cooperation. [26] This synchronous activity equips the actor with abilities that enable them to cooperate in the future.[9,26] Kirschner & Tomasello found that typically developing (TD) children can synchronize their drumming to a machine, but young TD children benefited from a social context where they were drumming with another child, enabling them to perform better in difficult tasks such as adjusting to a different tempo.

This is evidence for including a child-child-robot context[13]. The joint action task of drumming motivates the children to act in a cooperative way[13].

Musical synchrony interacts with the social synchrony during group music making .[5,17] Demos et al., 2011 found the synchronous activity acted as a social attractor that lead people to feel like they were synchronizing with other people. Interestingly the degree to which people felt they were in sync with others wasn't correlated with how much they were in sync to the other people, but rather to how much they were in sync with the music. The music acted as a social intermediary forming a bridge between the participants. [5] In this way the rhythm imparted into the group by the robot could act as a bridge between the two children. Other pro-social effects were observed by Hove and Rosen 2009, who found that interpersonal synchrony lead to feelings of affiliation. [11]

4. RHYTHM THERAPY

Therefore one of our training contexts capitalizes on interpersonal synchrony and is modeled on the principles of rhythm therapy. This application takes advantage of many of the features provided by the humanoid robots and provides many benefits sought through robot assisted training including cooperation and joint attention. [13,14] We have developed drumming activities where children could play drums along with the robot. This could be done in a dyadic context where a single child plays with the robot and in a triadic context where two children will play with a single robot. [14] Drumming is fairly complex yet achievable activity for the robot. With the appropriate programming, it is possible to achieve reliable drum hits that have a good sound using appropriate humanoid robots. Currently, we are developing clear drumming motions of the robot so that they are easily perceived and understood by the children[18].

5. ROBOT CONTOL

To support these activities the main capability necessary for the robot is the ability to successfully and repeatedly play a drum. The robot needs to be able to produce clear loud sounds in simple and complex patterns at a measured tempo. This seemingly simple set of requirements produces some interesting technical issues that need to be solved.

In order to produce a clear and loud report from the drum surface it is necessary to impact it with a quick forceful stroke. If we impact the drum with the robot's end effector (hands or fingers in the case of Nao) it will cause great stress and wear leading to failure of the mechanical structure. To overcome this we have the robot playing the drum with mallets or drumsticks. In this way the impact stress is taken by the mallet and is reduced by the time it reaches the robot's joints. Since the children are of varying motor ability we ask them to play the drum with their hands. The sounds generated by these two activities are similar and we have not seen any disconnect between the children and the robot based on the different drumming tools used i.e., sticks versus hands.

Figure 1. The Aldebaran Nao robot shown in position at the drum holding the drum mallets.

While drumming it is possible to over control the movements of the robot in an effort to be precise. The system has its own natural dynamics and cannot be completely constrained to a particular motion path rather it needs to move within its natural periodicity to produce the desired results[15]. If the system is over constrained to achieve an ideal movement it will entail additional mechanical stress and additional power to maintain the exact motion path needed to produce the desired result. Our solution to this problem is to use the forces in the joint system of the robot, mallet, and drum to our advantage. We are able to use simple control parameters to produce complex dynamics that emerge naturally from the system. These complex emergent dynamics are needed to produce the rich sound desired [6,15].

Another problem facing mechanisms that need to produce repetitive motion in synchrony with external events is accumulating error. As the drumming robot produces each stroke it is acting in a natural system where some of the forces are not under its control. These forces can cause one stroke to take a different amount of time than another stroke. If the system is running in a linear fashion with each stroke starting after the previous one is finished then the tempo of the strokes will vary randomly based on these effects. These errors will accumulate over time causing the system to move further and further from the original timing. Our solution is to enable the system to move dynamically from one action to the next without regard for its current or previous position. The system is able to interpolate from any given initial position to the desired position at the required time to support the tempo. This prospective behavior works toward a desired future state rather than working off of a previously achieved state. [22]

6. DYNAMICS IN THE SYSTEM

In order to achieve the desired dynamics we use a biologically inspired model where we use the morphology of the robot in different ways depending on where we are in the task. In nature muscles can play different roles with little change in activation depending on the context. Muscles can act as motors, struts, and springs depending on their activation and the physical orientation of the entire system. We also use the forces in the system to drive the performance of the system as a whole [4]

Grasping: One way that biological systems detect objects within the environment is through haptic feedback. [3] Contact with an object is indicated through deformations of the entire system. We use this same technique to detect that the end effector is grasping the mallet by comparing the actual or measured joint angles of the fingers to the joint angles that being triggered by the control software. If the joint angles are less than the requested angles then there is something there that is restricting the movement of the fingers.

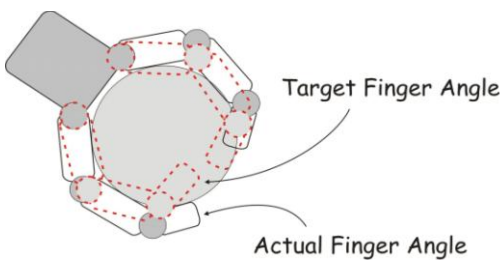

Figure 2. Here we see the end effector grasping the drumstick. The dotted line indicates the requested finger position. The solid line shows the actual resultant position. The difference indicates the presence of an object.

Arm Dynamics: The stiffness of the actuators is kept low throughout the cycle which enables them to be used as motors and dampers depending on where in the cycle at any given point. The elastic surface of the drum acts as a spring. The mallet is grasped loosely and can swing freely with momentum. The arm moves through an arc that is close enough for the mallet to swing to reach the drum head. The arm is beginning to return to the upswing while the mallet is impacting the surface of the drum. The mallet is being carried away from the drum head before it is able to bounce back into the drumhead eliminating any repercussive effects of multiple hits. The dynamics of the arm-end effector-mallet-drum run on a much faster scale than our program and we *do not have* to control it. We only have a projected joint angle trajectory as a sinusoid. Functionality emerges as a product of small parameter changes and context.[4,6,15,22]

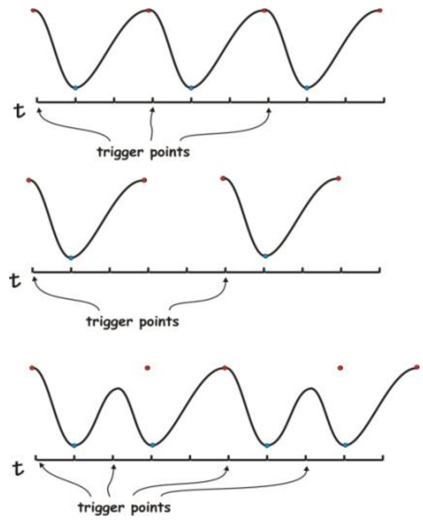

Figure 3. Arm Joint Angles over time. The top graph shows a continuous beat. The middle graph shows a tempo where the length of a cycle is longer than the time it takes to complete a down swing and an upswing. The bottom graph shows a rhythm where the time to complete the upswing is greater than the time before the next downswing. The arm only travels part of the way to the upper position before being triggered to go to the down stroke.

Arm Stroke Cycle: The arm is controlled by triggering the arm to move to a desired angle in a precise time t. At time t the arm is then triggered to move to the upper joint angle by time 2t. The speed at which the joint angles are altered follows a spline curve computed by a movement interpolator imbedded in the Nao's control software. Although the joint angles are being controlled the stiffness is low allowing the arm to naturally overshoot its target angle. The momentum of the mallet carries the head of the mallet into the drumhead. Due to the loose stiffness setting of the grasp of the end effector the mallet bounces freely off of the drum head without precise control. The time triggered for travel to up position is longer than down position time producing less force and stress on the system.

By using these principals we were able to take advantage of the forces in the task to and use minimal control whole producing complex dynamics. The end result is clear drumming that can be easily controlled to produce multiple rhythms.

7. EXPERIMENTAL DESIGN

Subjects: 14 typically developing children between 4 to 8 years of age have been observed over a 12 session training protocol delivered over six weeks (2 sessions per week). Two children with an age difference of approximately two years interacted with Nao and a mobile robot Rovio (Wowwee, Inc.) during each 45-minute training session. Pretest and posttest assessments were conducted before and after training.

Testing protocol: Pretests and posttests involved tasks-specific actions (rhythmic gross motor and drumming actions) within the training context with the robot. We also conducted generalized tests using standardized assessments such as the Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) [2] and the Sensory Integration and Praxis Test (SIPT) [1]. Specifically, the bilateral coordination subtest of the BOTMP measured changes in bilateral gross motor coordination and the bilateral motor coordination subtest of the SIPT measured changes in rhythmic coordination of arm and leg movements such as hand patting, leg stomping, and foot tapping. Lastly, we also have a generalized synchrony test wherein the two children who worked together with the robot were engaged in rhythmic activities with each other in a novel testing environment excluding the robot. The children moved together during dual-limb clapping, multilimb march and clap, symmetrical and alternate drumming, as well as "walk in step" actions.

Training Protocol: During each training session, the two children stood beside each other and in front of the Nao robot. The first six sessions involved rhythmic themes such as start and stop motions, slow and fast motions, move on a steady beat, small and large motions, move in turns, and move on a count. The last six sessions were a combination of these themes. Each training session involved the following conditions:

a) Introductory statements: Nao greeted the children and asked them about their day.

b) Warm up: Both children performed stretching exercises with Nao as a warm up activity.

c) Action: The next three conditions involved three, 30-second components: "copy robot", "move together", and "free action". Both children were asked to move with the Nao during whole body rhythmic actions such as clapping and marching.

d) Drumming: Both children and Nao performed symmetrical and alternate drumming based on the musical theme of the day. During later sessions, the robot and the children performed various complex quarter and eighth note patterns.

e) Walking: Both children followed Rovio along different spatial paths based on the themes of the day. The paths followed were simple shapes or letters. Later, the children were asked to guess the shape or the letter. Children were allowed to draw out the path on paper to help them guess the shape or letter produced by their path.

f) Leave taking: The Nao robot ended the session with a good bye statement.

Data Analyses: Standardized testing scores: Raw scores and standard scores from the standardized tests will be used to examine training-related improvements in gross motor coordination as well as rhythmic coordination for each child. Generalized synchrony test: During this test, we collected hand, foot, and joint kinematics from both limbs of both children using retroreflective markers placed on the children's body segments which were tracked using the Vicon Motion Analysis System (Vicon, Inc., Sampling rate: 120 Hz). We will be comparing the kinematic patterns of the two limbs of each child to measure intrapersonal synchrony or complex motor coordination. We will also compare the kinematic patterns of the two corresponding limbs of the two children to measure the interpersonal synchrony between the two children. Using continuous relative phase (CRP) analyses, we plan to assess the percent of data wherein children move in "complete synchrony" (values ranging from 0-60°), "opposite synchrony" (values ranging from 120-180°), and "off synchrony" (values ranging from 60-120°). Verbalization and joint attention patterns: We will also code the changes in frequency of spontaneous verbalizations and spontaneous joint attention patterns (shifts in eye gaze and/or head turns between the robot and the other child) across training sessions to measure the quantitative changes in socialization between the two children.

Expected Results: Children may show improvements in gross motor coordination, rhythmic coordination of hands and feet, and sociability (i.e., increased rates of child-directed verbalizations and rates of joint attention bids). In addition, these changes may occur within the training context as well as in the generalized testing context.

8. CONCLUSION

Overall, we believe that the robot-child-child training context is an engaging context to facilitate motor and social skills in school settings. Such a training context may be a valuable tool to facilitate socialization between typically developing children as well as children with social and motor impairments such as children with Autism Spectrum Disorders. We were able to achieve good robotic performance of the drumming actions using biologically inspired design principles. These techniques show promise for further development for optimized robotic performance. This ongoing work is the result of an interdisciplinary collaboration of psychology, physical therapy, education, electrical engineering, and computer science.

9. ACKNOWLEDGEMENTS

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The International Digital Divide: Education and Wireless Technology in Developing Countries

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Abstract. The impact of wireless technology on society is indelible, and its implementation is vital for the advancement of developing countries. In addition to having access to localized wireless networks, the ability to take advantage of the Internet and its worldwide possibilities can provide a new medium for education, both on a local and a global scale. The social impact wireless technology can have are almost beyond imagination once the world is opened up to isolated populations. The goal of this paper is to define important wireless technologies and demonstrate and analyze the importance of wireless technology for education in a developing country such as Haiti.

Keywords: Digital Divide, developing countries' economy, Haiti Internet Initiative.

1. INTRODUCTION

Identifying the needs of the country and people is the first process to complete the concept of appropriate technology. Appropriate technology is designed to take under consideration the whole environmental, ethical, cultural, social, political, and economic aspects facing a specific country. Using appropriate technology methods for countries with very low resources is the best way to educational opportunities. Appropriate technology is very easily maintained and requires few resources. The appropriate technology is harmless to the environment and works within its confinement, i.e., unusual weather, topology or geography [1]. Appropriate technology was created under the idea that certain types of technology are often inappropriate for certain countries. Haiti, for example falls under the category of a developing country; that is, a mainstream and costly technology would be inappropriate for their current economic climate and dissembled state at this time.

The island nation of Haiti will be used in this paper as an example of a developing country with a unique situation but needs for technology and education which are universal in nature.

1.1 The Tragedy of the Earthquake in Haiti

The country of Haiti is a republic in the West Indies on the western part of the island of Hispaniola. Although a country rich in language, culture and music, it is the poorest and most illiterate nation in the western hemisphere [2].

A devastating 7.3 magnitude earthquake struck Haiti on January 12, 2010. It left approximately 230,000 people dead and more than 1.2 million people homeless [3]. It came to light that their communication system was inadequate as areas affected by the earthquake could not communicate with each other. This highlighted the differences in availability throughout the population: the communication system in Haiti was not only weak, but not available to most. The rebuilding of the country telecom infrastructure and the increase access to fixed, mobile, and Internet access have been in the forefront of the reconstruction efforts.

1.2 The Communication System in Haiti

Haiti is among the developing countries that have strived to provide the benefits of the Internet to most. The need for reliable telecommunications system in Haiti is growing due to a large expatriate community living in the United States, Canada, France, and elsewhere [4]. However, the current telecommunications system is unable to support the high demand. There are a few working telephone lines; most of the telephone services are provided by three wireless companies: Voilà, Digicel, and Haitel [5]. The Internet services are limited and available to a low percentage of users due to their expensive monthly costs. Some Non-Governmental Organizations (NGOs) provide free wireless access to their network. The rest of the population relies on "cyber cafés" to use the Internet or make telephone calls using Voice Over IP (VoIP). It is very difficult for public school students to have access to a computer system, let alone the Internet.

1.3 The Educational System in Haiti

Education in Haiti is provided according to the French educational system. Most of the schools in the country are privately run; countries like Canada, France, and The United States run some of the private schools as well. That is, over 90% of the schools are managed by the communities, religious organization or NGOs [6]. Enrollment at the universities represents a bare 2% of the youth population between the ages of 18 through 24 [7]. However, most of the schools were destroyed by the recent earth quake; Higher education was the hardest hit with 28 out of 32 universities destroyed and the remaining 4 were severely damaged [8]. In addition, the education system is anemic of qualified teachers and professors. There is a limited pool of qualified professionals living in the country since more than 84% of Haitians with a university degree live outside of the country [9]. Again, the recent earthquake has worsened this situation with the loss of many teachers and professors.

1.4 Do Haitian students have access to computers and the Internet?

In Haiti, only the elite schools which represent a very small percentage provide computers and internet access to their students. There is about one computer for every 1,111 people and outside of the capital it is one for every 5,000 people [10]. Students from non-elite schools mostly use "cyber-cafés" for access to a computer for their homework or access to the Internet to do their research. The cost of five minutes usage of a computer is about 25 cents while the average Haitian family earns $2.00 a day. Several organizations are trying to provide computer labs and Internet access to the Haitian youths. That is the case of Educah via the *Wentworth Internet Initiative* and Hope Haiti Learning Center that provides free computer access and practical skills training [11].

2. FEASIBILITY OF WIRELESS TECHNOLOGY IN HAITI

The telephony system, longed dominated by the state-run Teleco, was opened up to private companies in 2000. Today, two main companies, Digicel and Voilà, capture more than 95% of the overall market. The state is fighting back by allowing a joint public-private partnership (PPP) to make Teleco more competitive. Such a strategy aims at modernizing Teleco's infrastructure and provides more services to its customers. It will enable the new venture to provide telephony and Internet access to remote areas and to low income citizens [12]. John Stanton, who owns the second wireless company in the country, Voilà, would like to see Haiti become "copper free" [13]. That is, the first-all wireless country in the world. Those remarks were echoed by former President Bill Clinton. Stanton envisions that "Haiti can have a first class telecom infrastructure without landline service-based completely on wireless technology [14]."

2.1 The Technological Climate

The World Wide Web (WWW) and the world's internet usage have increased dramatically in recent years. World internet usage increased by an annual average of 14.1% between 2004 and 2009, reaching above 1.8 billion users worldwide [15]. High speed internet, or "broadband," is becoming the dominant technology for internet distribution in developing countries [16]. With internet usage being in such high demand, it is hoped that the educational systems in developing countries will advance. It is vital that the proper products and services be available and at hand. Internet access in third world countries will likely be driven by wireless technologies due to geographic distances and differing topologies. Wireless technology is less costly than wired connections and fits the model of economic need. As a result predictions have it that near universal mobile telephone access is likely to be achieved by 2015-2020 in third world countries [17].

In many different rural environments around the world satellites are being implemented to provide access to remote parts of countries. The speed with which an online or hybrid educational-delivery solution can be deployed means that more villages and schools can be brought into the system. Many of the rural environments in developing countries have created affordable broadband and wireless technologies which allow new and improved ways of teaching and learning [18]. Wireless technology has been proven to work fairly well in the rural environment of the developing countries. It is often used to connect rural schools and colleges to many different urban institutes. This will facilitate the spread of education in a persistent manner.

Today, information can be transmitted from remote areas to anywhere in the world. For example, wireless internet technology has brought together communities in Costa Rica, Rwanda, and India. By using scooters, bicycle messengers or buses, wireless internet is brought to people in remote places. In each village there is a terminal that stores a web browser and e-mail information on a local server. When a vehicle moves into town, it gathers all of the information wirelessly. When the vehicle gets to a town with a nearby connection to the Internet, it sends out the data to the internet. This means that all the information stored in each town's terminal is updated each time the vehicle comes around [19].

3. CURRENT WIRELESS TECHNOLOGY

Advances in Wireless technology make it appealing to provide Internet access to places where there is limited infrastructure. There are many different types of technologies available today:

3.1 Fixed Wireless

Fixed wireless refers to the process of connecting fixed locations –most of the time antennas mounted on top of buildings—using radio or Laser Bridge [20]. It uses transmission towers that communicate with each other via directional antennas to send and receive data signals. They send their signals through the air using the microwave spectrum. However, line-of-sight is needed to communicate with each other. That is, antennas cannot be installed anywhere; hills and trees must be avoided [21].

Fixed wireless can be used for broadband access to the Internet in areas where there is a lack of wired- infrastructure such as fiber-optic cable, Digital Services Lines (DSL), or cable television. It does not require the presence of satellite or telephone service to be operational. It brings broadband bandwidth to remote areas where there is little to no infrastructure. Due to the quick deployment and affordable cost, this technology is in high demand especially in developing countries [22].

3.2 Wi-Fi

Known as Wireless Fidelity, Wi-Fi is mostly used by end system devices like personal computers (PCs) or smart phones to connect to the Internet while within range of a wireless access point (WAP); the signal is diffused around the access point. Wi-fi is used to create a wireless local area network (WLAN) by covering a large area and creating overlapping regions between the access points known as hotspots. They are often used by organizations and businesses to provide free-of-charge public access in order to attract customers. Wi-Fi is convenient to provide wireless access in spaces where cables cannot be run like historical buildings [23].

Wi-Fi-enabled devices can create their own network when connecting to each other, known as an ad-hoc wireless network. It creates a peer-to-peer (P2P) communication network where each client or node can forward data to the next.

3.3 WiMax

WiMax stands for Worldwide Interoperability for Microwave Access. It is the telecommunications protocol that allows access to fixed and mobile wireless; its standards are set by the IEEE 802.16. [24] Existing WiMax technologies can provide between 30 to 40 Megabits/sec. WiMax devices are used to implement wireless networks. WiMax differs from Wi-Fi in that:

1. It is similar to Wi-Fi but can go over longer distances. It provides wireless connectivity access across cities and countries.
2. The access of WiMax network is based upon a scheduling algorithm while Wi-Fi users compete for access.
3. WiMax uses a connection-oriented MAC (Machine Access Code, the unique address of the network interface card) protocol while Wi-Fi uses a connectionless CSMA/CA protocol.

Because of its low cost, long distance range, and ease of deployment WiMax is widely used to establish WLAN. It is a more cost-effective last mile broadband access than cable and DSL [25]. As of last October, the WiMax consortium claims that over 592 WiMax networks are deployed in over 148 countries [26].

3.4 Wireless Mesh Networks

A wireless mesh network is based on a mesh topology where each device represents a node in the network. Mesh devices use a small radio to connect to each other via their wireless access point. Each node receives data from adjacent nodes to forward to the next nodes sometimes far away which result in a larger network. Instead of having a centralized system that is responsible of forwarding data, each node routes the information along. Unlike a centralized system, if one node fails, adjacent nodes will forward the data [27]. Because of its non-centralized and redundant nature, wireless mesh topology is quite reliable. Fixed Wireless, WiMax, and Wi-Fi technologies can be used in tandem to create a mesh topology. Due to its low cost, ease of implementation, and adaptation to geography, wireless mesh is appropriate for a developing country like Haiti to provide Internet access to urban, remote places at an affordable price.

4. OUR CONTRIBUTION WITH THE HAITI INTERNET INITIATIVE

The Haiti Internet Initiative recycles used servers and network devices into networks created by Wentworth students in the Computer Networking Systems major. These networks will be deployed in Haiti to support educational goals and job creation. It will also address the issue of the "Digital Divide," or the limited access to technology based on poverty. The network will be extended to more schools until a mesh WAN is able to be created. Through the annual networking seminar course, students will continue to be engaged to contribute to its evolution as well as encouraging donations of obsolete networking equipment. Having a network system in Haiti will enable collaborative work with Wentworth and provide a medium for distance learning.

A typical wireless mesh network is made up of a set of 802.11 compliant wireless routers running one of the link state wireless mesh routing protocols. All nodes are connected with each other and arranged in full or partial mesh topology. Wireless Mesh Network (WMN) is very scalable and it can handle hundreds of nodes. This network is connected through a set of border routers to wired or satellite connections that will facilitate connection to the internet. To reduce cost and bandwidth usage our students decided to implement proxy servers throughout the network to allow for content caching.

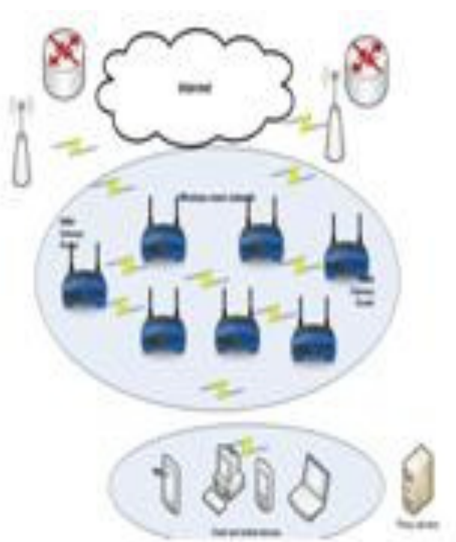

Fig. 1. Here is a diagram of a typical WMN.

The Wentworth Institute of Technology's Haiti Internet Initiative is a significant, vital and multifaceted project that will be an ongoing feature of the curriculum. This provides benefits to everyone involved. Faculty is able to maintain up-to-date skills by working on a functioning telecommunications system. The students are able to participate in a meaningful experience and sharpen their skills just before graduation. Educational goals for Haiti's youth will be more effectively supported and new skills can be introduced to them. Job creation will occur as the different locations are brought into the WAN.

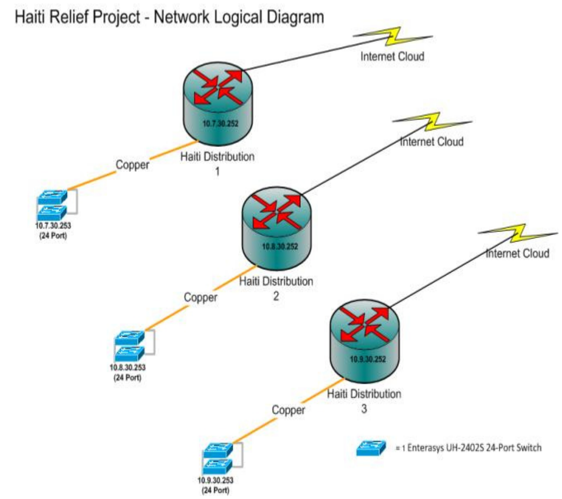

Fig. 2. A WAN topology for the *Haiti Internet Initiative* Three Pilot Sites

4.1 How can access to a wireless LAN network impact The Digital Divide in Haiti?

Being online will empower Haitian students. With online libraries and online resources students will be able to complete their assignments, conduct research, and take online courses. A non-profit organization like the University of the People has been providing access to tuition-free online post-secondary education. This initiative is aimed at qualified students that are impeded access to higher education due to geography and financial hardship [28]. They have recently launched a program with the Clinton foundation to offer online associate degree in Business Administration land Computer Science to 250 qualified Haitian students.

4.2 Collaborative Initiatives between Wentworth and Universities in Haiti

A year after the devastating earth quake not much has been done. Students are being taught under tents. Yet, they are motivated to learn, knowing through education they can reach the sky of opportunities. The Wentworth Institute of Technology has a longstanding tradition of hands-on education. It also maintains a strong commitment to community service and service-learning. The Institute is assisting the Haitian students in making their aspiration a reality through the Microsoft Imagine Cup Competition.

Microsoft organizes a yearly international competition for students to present software solutions to existing problems. The competition gathers the best designs for the final at the end of each year. A national competition will be held for Haitian students to come up with new concepts. They will work in teams of five to come up with solutions of existing problems that they are facing, work on proposed problems, or present their own innovations. The different categories will be: web applications, desktop applications, game applications, and phone applications.

Graduating computer science students from different universities will be working on the winning projects. Out of this group, we will select the best two prototypes. Students will be provided with appropriate tools like: Microsoft.net, SQL Server 2000, and Windows phone 7 toolkits to complete their projects. The two teams selected will be working directly with students at the Wentworth Institute of Technology. Given available technology, our students will be able to collaborate over the Internet with those in Haiti mostly through an established wireless LAN.

4.3 Collaborative projects

This network system can be used to teach our students taking Network Administration how to manage a network remotely; it can be used by our students in the network security courses to learn how to compromise and secure a network remotely. Finally, as Wentworth is contemplating providing remote classes to the citizens of the world, doing collaborative work with schools and universities in Haiti via our network, will be a good model to test the effectiveness of the content delivery.

5. CONCLUSION

Wireless technologies are expanding and becoming increasingly better: higher speeds, lower costs, greater accessibility. Wireless access devices are no longer limited to PCs but include devices such as highly functional mobile telephones. The proliferation of new wireless technologies, smart phones and PDAs can be used to create new learning communities and provide for more opportunities for the underprivileged in developing countries. This also provides opportunities for those who wish to make a significant impact in their lives and the lives of others: teachers and students at home and abroad collaborating together to create synergy and build active learning communities. Using wireless technology will allow underdeveloped areas to “leapfrog” past many of the developmental stages of technological advances. Countries such as Haiti can reap the benefits of a reliable, available and extensive communications network without heavily investing in the costs of fixed-line telephone infrastructure or other guided media technology. These cutting-edge devices such as iPads and Internet-ready cell phones not only allow connection to the Internet but can become nodes for propagating the network themselves. Efforts such as Wentworth Institute of Technology’s *Haiti Internet Initiative* will provide educational and economical benefits quickly and efficiently, bringing underdeveloped and struggling nations into the next century.

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The Solving of Knowledge Processing for the Automation of Teaching and Learning Activities

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ABSTRACT

Knowledge is an important resource in engineering education. Despite the high level of ICT, a software is not yet available for their processing, especially at the level of an individual. The article describes a long-term solution of information and knowledge processing at this level, i.e. for a client-personal computer. This began in industrial research. In a university environment, it was continuously programmed for the needs of Technology Enhanced Learning in engineering education. The result of a long-term development is a personalized environment with the working title BIKE (Batch Information and Knowledge Editor). This allows individuals to work with the huge amount of knowledge. The teacher has at one's disposal a set of the multi-purpose informatics tools which can be applied in teaching undergraduate students. The importance of a balanced pedagogical – informatics approach is emphasized for solving Technology Enhanced Learning, unlike the prevailing technology - driven approach in the current state-of-the-art. This technological support is to be understood as a "solution of automation" of the entire teacher's activity. Such an approach can-result into an entirely new form of pedagogical – informatics' outcomes in teaching. In this paper, several examples are presented in relation to the solving of knowledge processing.

Keywords: technology enhanced learning, knowledge processing, engineering education, database applications, personalised learning environment

1. INTRODUCTION

Information and knowledge play a key role in the research and educational activities. Despite the huge progress of Internet and Communication Technologies, the appropriate software and informatics tools on the market lack processing tailored to the individual user (researcher, teacher, and student). In the period 2000 – 2005, the database application Zápisník (WritingPad) was developed within an industrial research environment; it was built on the FoxPro for Windows database. This served for computer support of a research - development laboratory of surface treatments and some research projects (for example, the laboratory's information system was developed). After the modification of the WritingPad at the University, the processing of information was extended to the processing of knowledge. In this case, the power and advantages of conventional database technology of the nineties was used and was tailored for the processing of the huge amounts of data. During that time this advanced technology, could not be fully used by individuals due to the lower level of ICT. However, the introduction of an entirely new paradigm of batch processing of information and knowledge was needed, because in a conventional DBMS (Database Management System) the data are processed in another way based on a relational model. This gradually resulted in the development of the pre-programmed environment BIKE that was used for support of engineering education of bachelors. The existence of such an informatics tool allowed for teachers to solve the first stage of processing the knowledge flow between information sources and the 'knowledge' database tables. User outputs led both to the

BIKE environment and HTML - format, which is readable by the common Internet browsers (browsable outputs). In this case, the default is set to Internet Explorer and Opera, and in some cases the browser Google Chrome is used. At this stage, a knowledge base and library with educational materials was created on an open web-domain and on the faculty server. This engineering content was processed using the BIKE or its selected standalone Zápisník / Writing Pad (file GeniusV.exe). The outputs supported a variety of educational activities (support for teacher's personal activities; for blended, informal, distance, active learning). After analyzing the state-of-the-art, the issue of the more or less empirical research was categorized into the field of Technology Enhanced Learning (originally the issue seemed to be eLearning) [1]. In the continuously published results the BIKE was presented as the informatics tool (an in-house software) which was designed in the Technology Enhanced Learning for processing of content [e.g. 2, 3, 4, 5].

2. KNOWLEDGE PROCESSING WITHIN AN ENLARGED APPROACH FOR TECHNOLOGY ENHANCED LEARNING

The processing of knowledge (engineering content) needs to address the flow of knowledge between the produced learning materials and the libraries (tailored for courses of study) and between individual educational activities. This represents the second phase of the solution for the flow of knowledge within which it was also automatically created a personalized virtual learning environment (VLE). Computer support of educational activities at this stage was more technology - driven than educational (pedagogical) - driven. Fig. 1 shows both stages of knowledge flow between information sources - knowledge tables (DBMS) and the teacher's activities.

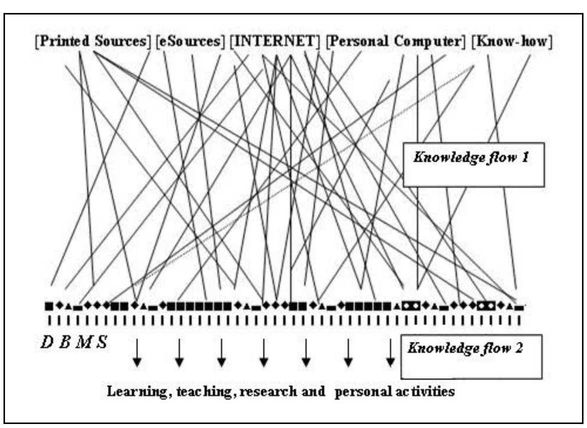

Figure 1. Knowledge flow (information sources – the BIKE – teacher's activities)

The empirical research has showed that the work of university teachers in engineering knowledge is highly sophisticated. From an informatics perspective, this means that support of mental, learning activities and teaching is characterized by the use of unstructured information and knowledge. Moreover, the actual learning activities are unstructured and are not defined by their exact procedures. Teachers usually do this quite unconsciously. Thus, each type of learning activity should be studied, analysed, (repeatability, elements, action sequences), this is the basis of the program codes. This creates a way to gradually set a menu as optional and also as specific tools. Each menu item can be tested directly in teaching and if it is successful it can lead as an introduction to the default menu BIKE environment.
Two new elements come into play in practice. One is that the teacher selects different pedagogical approaches and teaching methods according to his needs to address communication with students (feedback). The second element is that it has to address the need to automate all kinds of normal teaching activities. This also applies to students, researchers and R&D staff in general. Therefore, the mechanical application of some existing general software (e.g. Learning Management System, Virtual Learning Environment, Educational Technology, Web 2.0) is not possible. It should also be taken into consideration, as already mentioned, for the need to promote the "automation" of mental activities. One can imagine this as an external chip, "Mind-ware", this is to say that technology is a partner of a person and creates a "social memory of individuals" linked to "global social memory" [see Saljö in 6]. As the teacher plays a key role technology must adapt. This is the principle of any automation solution. Computer aided education should be focused on those two elements on the level of educational quality and automation activities of the teacher and students. If we hold to Technology Enhanced Learning, the priority must be given to a pedagogically (Education) - driven. This principle expresses the scheme presented in Figure 2.

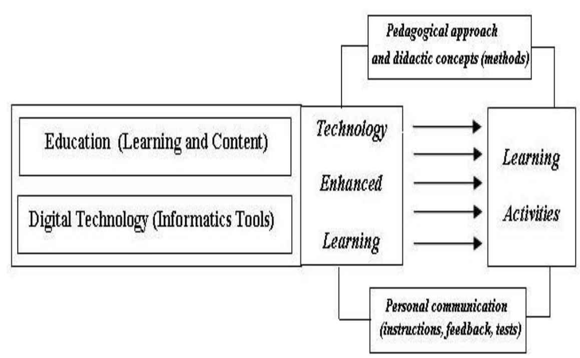

Figure 2. Schema of Technology Enhanced Learning enlarged with educational aspects

From an informatics point of view it can be noted that the need for the above-mentioned processing of unstructured information, knowledge and activities, in this case, it is appropriate to use procedural programming (object-oriented and visual programming at this stage seems to be inappropriate). Conventional database environment FPW 2.6a running under all Windows operating systems makes it possible.
Moreover, from the perspective of an individual it is very user friendly because it has its own text editor and allows one to create an exe - application. In addition, currently available databases that are commercial or free programs or office suites (MS Office, Open Office) are normally not suitable for the processing of unstructured knowledge.
In the next stage of empirical research in engineering education, therefore, blocks of activities began to program which took into account both the pedagogical quality of teaching (pedagogical approach, didactic methods, communication) and pedagogically - driven automation. The programming codes gradually expand the menu of BIKE. It should be mentioned in particular that the solution to personal communications was in by adding the programming of the application PHP/MySQL. The application is launched and edited in the BIKE environment. It is installed on the computer of the teacher as well as on the faculty server. The combination of PHP with the MySQL database is used for activities in the on-line mode, i.e. mainly on personal social network programming between teacher and students.
A particularity of the integration of computer-aid into the engineering education is demonstrated by the fact that on one hand the teacher has the BIKE environment with optional information tools (menu items), and on the other hand, their use can not make students or does not enable the education itself or technical equipment of computer classes. For example, a teacher wants to improve the quality of teaching by introducing elements of support in technical English. However, the subject is only taught in their mother tongue. Thus, the application of programming itself is not sufficient. The difficult part is in how to figure out away to incorporate the teaching of (time, content, methodology). This experience was gained when dealing with the support for teaching technical English (a teacher has mastered the application WritingPad - Text To Speech Technology, but students did not use it). A need to harmonize informatics and pedagogical approaches is therefore needed.

Another specific example from the practice may be the implementation of batch internet retrieving. Here we have experienced such a paradox that a group of students to whom have been described and explained in great detail, a demonstration of how to work with the WritingPad on batch retrieving in collaboration with the Opera browser did not manage this activity. Conversely, it was managed by a group of students, even without the presence of a teacher. It was enough just to tell them: "Go to class on your computer, click the icon Genius in the top menu, click SvDopl2 and type the keywords into the box then see what is displayed on your interactive screen, be sure to first open Opera". Here was important also the fact that one or two students understood and explained to others.

3. SOLUTION OF APPLICATIONS IN EDUCATION ON THE BASE OF AUTOMATION

Practical solution of harmonisation of pedagogical - driven and technology-driven approach in Technology Enhanced Learning (as illustrated in Fig. 2) is shown in detail in Fig. 3.

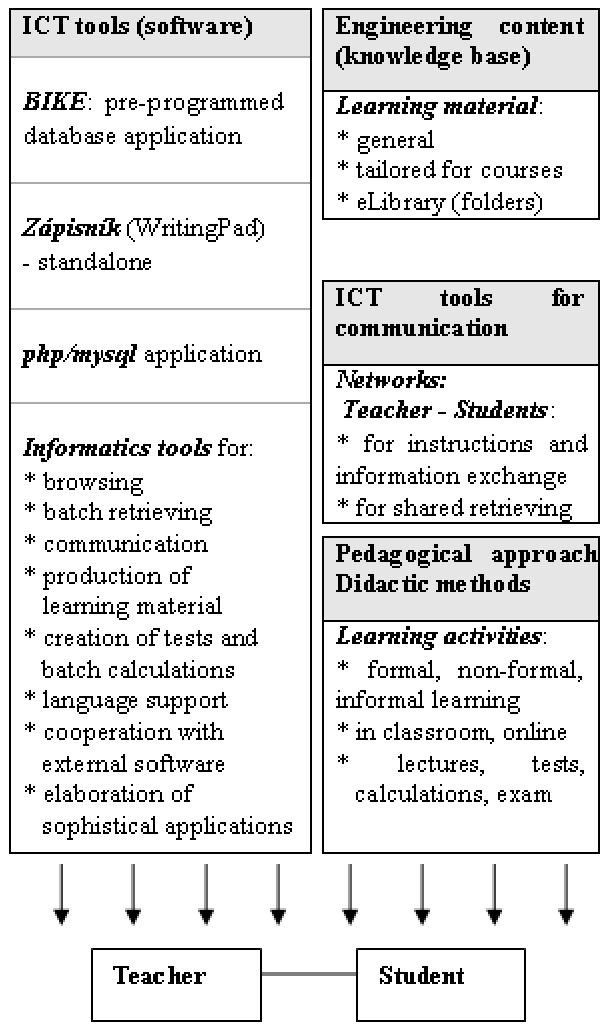

Figure 3. Pedagogical – informatics background for solving the automation of teacher's / student activities

Below are descriptions that illustrate a solution of the informatics tools in common teaching activities undertaken and progress of activities which one may contemplate on how they can be integrated into the education of bachelor students. The following pictures display some of the processing solutions of knowledge and automation representing pedagogical – informatics approach according to the scheme in Fig. 3.

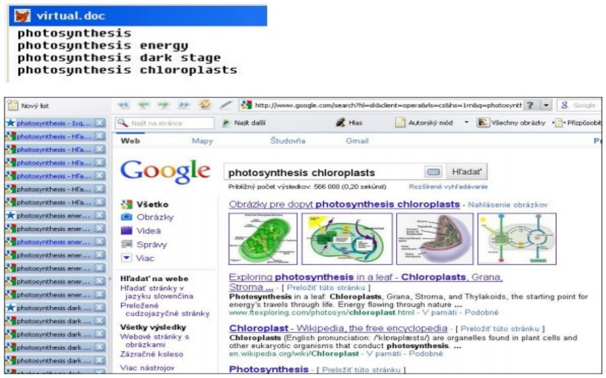

Figure 4. Sample output from the batch internet retrieving of students that was conducted within the course of study "Background of Environmental Protection"

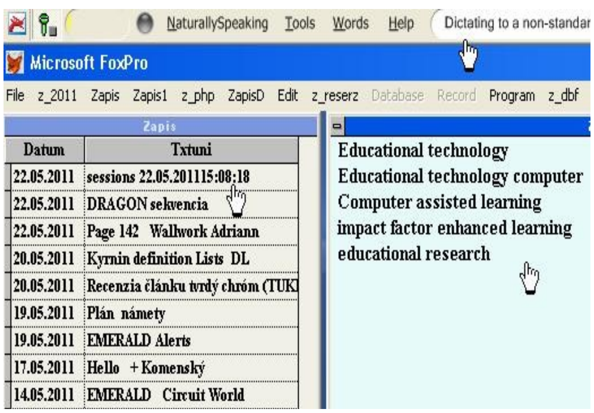

Figure 5. Screenshot of the BIKE environment from the solving of the by voice controlled batch internet retrieving (using also the external speech recognition software Nuance Dragon-naturally speaking)

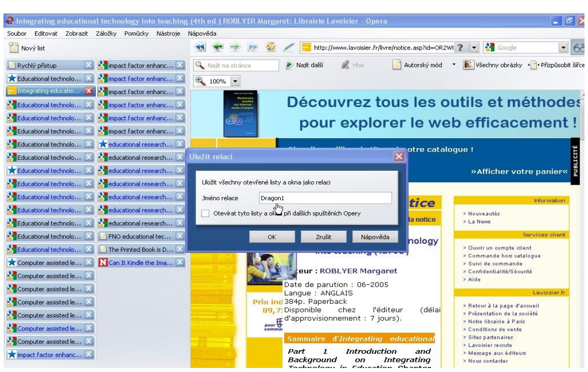

Figure 6. Example of batch internet retrieving by teachers in the survey of literature (scientific support for writing the article)

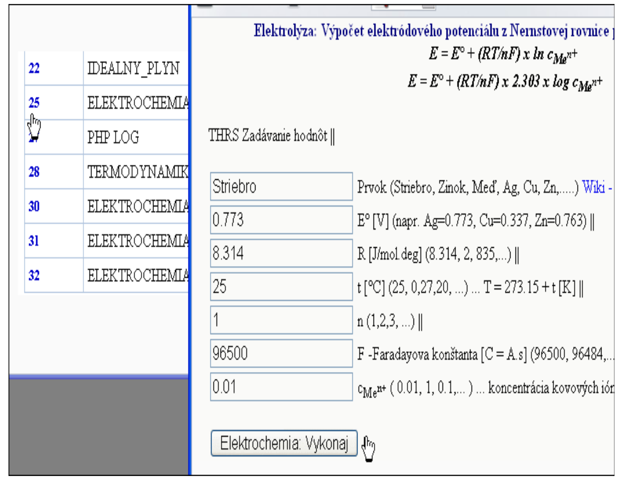

Figure 7. Demonstration of tutorial of batch processed chemical calculations (Application of BIKE - PHP - MySQL from the server of the faculty)

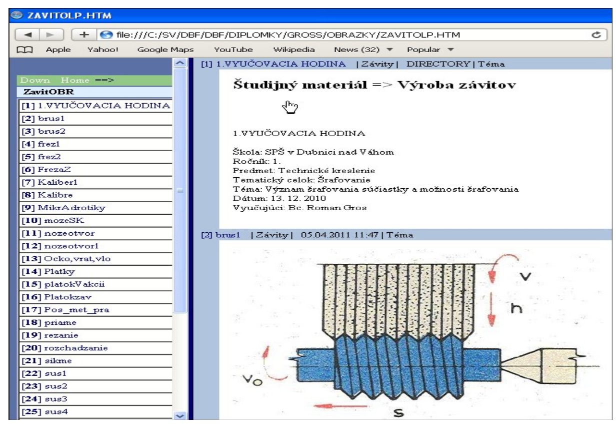

Figure 8. Demonstration of solutions from diploma thesis - Secondary school study material for production of threads (R. Gross)

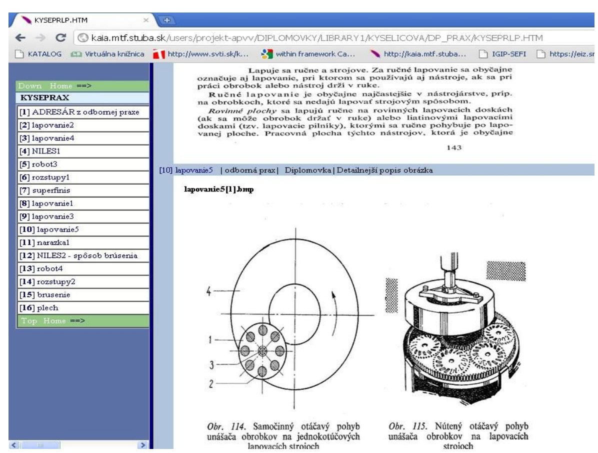

Figure 9. Demonstration of solutions from diploma thesis - Secondary school study material for lapping (Z. Kyselicová*)*

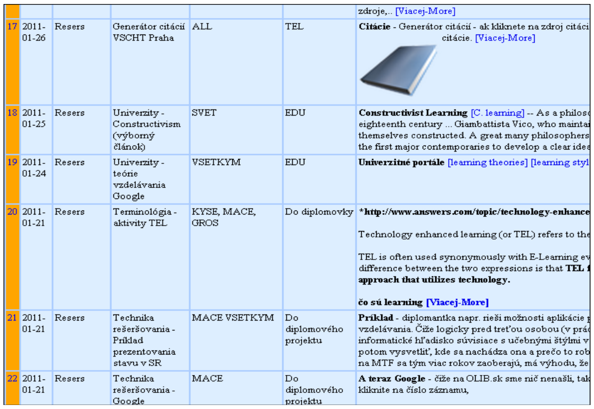

Figure 10. Preview of personal social networks between teacher and students (shared area with instructions and forum for retrieving information sources)

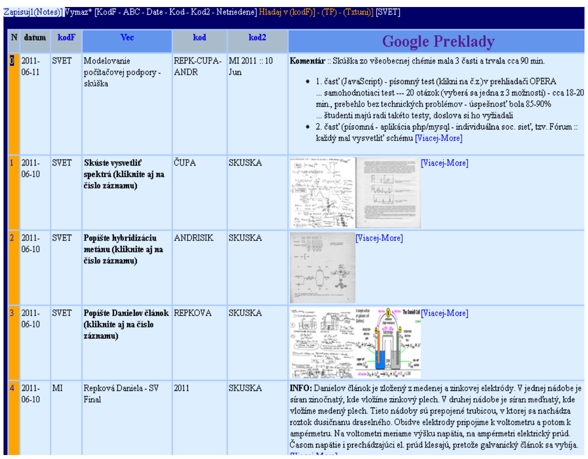

Figure 11. Example of modelling a written examination on a personal social network between teacher and students of chemistry basics
(students had to receive a paper and pencil to write chemical formulas, because it can not be done on the current software)

4. CHALLENGES FOR KNOWLEDGE PROCESSING AND AUTOMATION OF TEACHER'S ACTIVITIES

The introduction of the pre-programmed BIKE environment to support engineering education created a basis for common personal support for activities of teachers, and students of bachelor studies. The teacher has a knowledge library (engineering content) and portfolio of informatics tools in the environment of BIKE. Based on the previous one it has a choice of how to support their daily activities (teaching, learning, publishing, other personal activities). Furthermore, when the real learning in the classroom takes place the previous can be combined where appropriate (e.g., learning material with self-evaluated tests and calculation exercises, etc.). The Standalone application WritingPad created from BIKE was introduced for use on computers in the classroom and was also used in some diploma theses. The theses showed that the future teachers of technical subjects can create e-learning materials using the WritingPad, to solve technological transfers from old books (based on digitization) or to support learning styles. Two students similarly designed small information systems within their technological focused theses. It has been shown that the BIKE environment can produce user-friendly applications, i.e. the common informatics skills, software and hardware are sufficient. Moreover, ICT specialists can create sophisticated applications with this.

It should also be noted that if one does not start from the bottom-up concept of automation of the teacher's activities, the programmer using the technology - driven approach (top-down: technology to teachers) would often not even think that certain procedures must be programmed. This concept leads to the fact that in practice there can be completely new and unknown programming, because from an informatics point of view variants of support of mental activities should synergistic pedagogical - informatics outputs created. There does not exist a common system of be solved, and a set of informatics' tools, communication and educational activities proposed. Practically, this means that if we want to automatize even the simplest learning activities this will cause the creation of hundreds, thousands to an infinite number of solutions. Here it is also important for the harmonization with the Windows operating system, programming of which is often very onerous (BIKE is solved in such way so that it can use the maximum number of functions for which users are accustomed to, e.g., Explorer for off-line work).

5. CONCLUSION

The paper presented the solving of knowledge processing for the automation of teaching and learning activities in teaching undergraduate studies at the Faculty of Material Sciences and Technology of Slovak University of Technology in Trnava. The key to the solving was the development of the pre-programmed BIKE multifunctional environment (in-house software), which uses the power and advantages of database technology. This works as an informatics tool for Technology Enhanced Learning, which allows individuals to work with a huge amount of knowledge (it enables batch knowledge processing). It helped to solve the processing of engineering content in two phases. In the first phase as the processing of the knowledge flow between information resources and the environment of BIKE, and the second phase, as the processing of knowledge flow between the environment BIKE (knowledge tables) and individual teaching, learning and personal activities (see Fig. 1). However, the creation of tools and solutions only for processing the content was not sufficient for the needs of teaching, because this technology - driven approach did not take the pedagogical aspects of education and the key role of the teacher into account. Therefore, the further programming of BIKE within the Technology Enhanced Learning was extended to computer support of pedagogical approaches, teaching methods and the establishment of communication between teachers and students (see Fig. 2 and 3). Practically, this meant that other items were programmed to extend the user menu of BIKE, as well as a personnel social network enabling on-line feedback communication between the teacher and bachelor students of various courses of study and the teacher and students – undergraduates (working on their diploma thesis).

Practical experience has shown that not all informatics support is automatically suitable for teaching because it failed for students, or it was not allowed by the extent of teaching or the technical equipment in the classroom with computers. It is addressed so that part of the programmed application is therefore incorporated in the user's menu BIKE, and part is being developed. The BIKE environment works on a teacher's computer (author of the software). For students and other teachers it is available as a standalone Zápisník / WritingPad (as geniusv.exe), which is installed on twenty computers in a classroom. They also used it in five diploma thesis for the creation of personal technical information systems, eLearning materials and as a solution for the transfer of cultural heritage from in the form of technical content of books before the period of the internet.

From an informatics point of view, the next solving also showed a need to understand the information processing to support teaching and learning activities such as "automation." When programming is focused in this direction, it became clear that when dealing with the simplest of activities a large amount of alternatives are available. Moreover, it is always strictly necessary to establish default and optional menu items; one should start thinking about programming a comprehensive user menu. Here you have to be aware that such a user menu essentially represents a separate software development. This is already a challenge for the following programming the BIKE environment. Its further development will probably relate to the creation of intelligent software, which processes knowledge in a similar way that living systems do, just as cells do in cooperation with the brain.

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DHM simulation in virtual environments as a training tool: a case-study on control room design

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Abstract.

This paper will present the workflow we have developed for the application of serious games as a training tool for the design of complex cooperative work settings. This project was based on ergonomic studies and on the development of a control room work environment considering participative design process. The main concerns were 3D human digital representation, human interaction simulation, workspace layout and equipment designed considering ergonomics standards. Unity3D platform was used to design virtual environments and to control digital human models on the virtual dynamic scenario, in order to evaluate new work settings and simulate work activities. The results obtained showed that this method can drastically change the design process by improving the level of interaction between final users, managers and human factors team.

Keywords: digital human model, simulation, virtual environment, motion capture, training

1. Introduction

The research in serious games has been a focus issue for Government and corporate organizations, applied on training, simulation and education. There is a clear need for considering new frameworks, theories, methods and design strategies for making serious games applications and virtual world technologies more effective and useful as part of education, health and training. Virtual simulation has been used in Ergonomics for the design of control centers, transport design and product evaluation. (SANTOS, V., et al. 2009, SANTOS,V. et al. 2008, GUIMARÃES, C. P. et al. 2010).

The aim of this paper is to discuss the use of serious games applied in a control room design and how virtual reality and game engines may improve the workflow for the design of complex cooperative situations.

The context of this project has been to develop a method to improve and "accelerate" the process of a participative design for a new control room work environment by using serious games as a simulation, training and design platform.

Due to a low level of availability and dispersion of stakeholders, it was decided to explore how serious games may improve the participative design. From a human factors point of view, there are strong constraints because: (1) future users must not only "see" their future work-settings in a virtual space but also be able to project their future actions in order to anticipate the pros and cons of the new situation, (2) the workflow must be very dynamic in order to maintain a momentum for the participative process. The different versions of serious games must be synchronized with the organizational process. With modern game engines, this constraint may be easily satisfied; and (3) reusability of virtual material (both objects and movements) is also an important issue.

Another important aspect regarding this specific project is to reproduce cognitive features. In other words, one should be able to visualize the others' intentions, processes and actions trajectories in order to make decisions, such as where someone is looking at, their reactions to adversities, "volume" of communication, dispersion and others.

In this context, one of the main concerns was the 3D human virtual representation. Other important issues studied were human interaction, workspace layout and equipment including their GUI (Graphic User Interface).

2. Materials and Methods

The project's stages consisted in (1) gathering information of existing control rooms and of operational personnel in different shifts by a multidisciplinary team that evaluated ergonomics and architectural aspects, personnel data (interviews, filming and analyzing activities, motion capture, 3D human scanning), internal communication, displacement and quantification of work volume, in order to design alternatives, (2) developing these alternatives in walk-around 3D virtual scenarios, so their evaluation is more effective, (3) developing a simulator from the chosen alternative.

The development of the simulator were segmented in a couple of stages: (1) building the 3D environment based on 2D CAD representation of the chosen proposal, (2) implementing furniture

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and workstations from an existing database with ergonomic recommendations and the application of Brazilian and International standards, (3) development of equipment and instruments' 3D models, (4) development of the DHMs based on 3D scanning and motion capture technologies and (5) implementation in the game engine with scripts and other setups.

Each 2D CAD proposal (Figure 1) was transformed into 3D virtual models, where later in Unity3D were applied interactive elements such as doors and windows, external scenarios, materials and textures, so that the environment is as realistic as possible, providing the user a more lifelike experience (Figure 2).

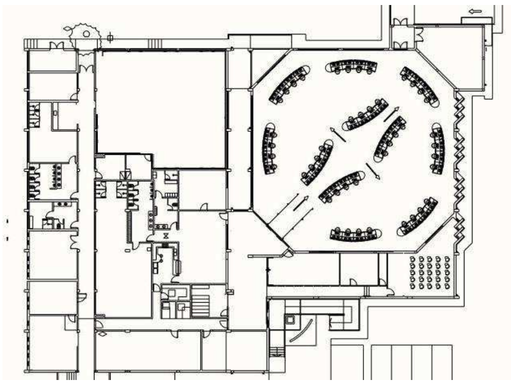

Fig. 1. 2D CAD floorplan

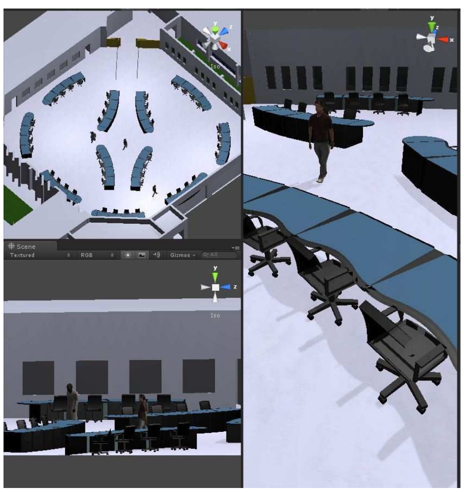

Fig. 2. 3D environment in Unity3D

Furniture and workstations present in the virtual laboratory are reproduced based on ergonomics recommendations and standards, modeled in SketchUp software and implemented in a database including 3D equipment and other instruments (Figure 3). The 3D database allows direct exporting to the game platform in *.FBX format. The software allows the segmentation of interactive components in groups, which in Unity3D can be easily set up by its hierarchy characteristic. It also exports their textures in *.JPEG, which are reproduced using their own pictures as textures (Figure 4), providing clearer understanding and faster recognition of each equipment by their respective users.

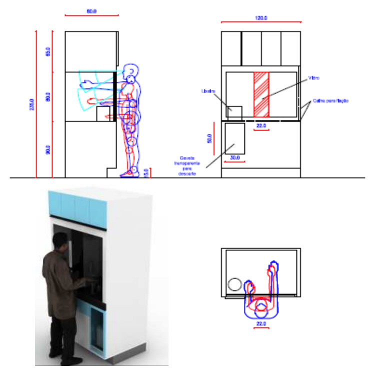

Fig. 3. Furniture recommendations

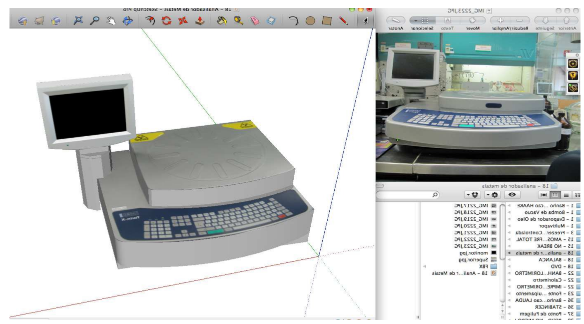

Fig. 4. Equipment 3D database.

DHM used in the simulation have been obtained starting from high resolution DHM (more than one million vertex) obtained by 3D scanning of employees using “Cyberware Whole Body Color 3D Scanner” and “Cyberware Head and Face Color 3D Scanner”. To import the avatars into the virtual work environment in Unity3D, their meshes must be seriously reduced. The high poly scan is imported into a 3D software to make a manual re-topology - doing this process manually allows us to control edge-flow of each model, therefore, keep expression details enhanced by subdividing the T-zone - eyes, nose and mouth. For the body, it's important to maintain articulations also with higher poly count to avoid deformations in the low poly mesh and keep the movements fluid.

To generate a planar texture which can be edited in graphic software, the process of retopology must consider the following step of marking the loops for UV mapping, so it can be opened properly (Figure 5).

To apply the texture in the low poly model, there are two approaches: (1) capturing photographs during the scanning process in order to have several pictures in different angles, which provides better resolution (Figure 6) and (2) rendering the high poly model, which enables sectioning the model in order to have hidden surface images, such as armpits, inner legs, top and bottom views.

The result of such a process is a virtual representation of the user (low poly and detailed mesh of the user) that respects with high fidelity the morphology of the person that was scanned (Figure 7). Most of the animation were acquired using "Moven" Motion capture suite. The motion capture sessions took place in the laboratory with personnel performing daily activities. The motion capture files were exported to an animation format recognized by 3D Max (*.bvh format), then were edited and imported into the digital human models.

In this process, the low poly model (*.obj format) is imported into 3D Max, where the biped structure is placed, correctly skinned to respond to each bone movement and exported to MotionBuilder.

Inside MotionBuilder, the biped structure is characterized to follow the bones naming conventions and the motion capture files are imported, animations are then divided into full animation and cycle animations, as walk and idle, animations that play on loop, avoiding that the animation loading takes too much time.

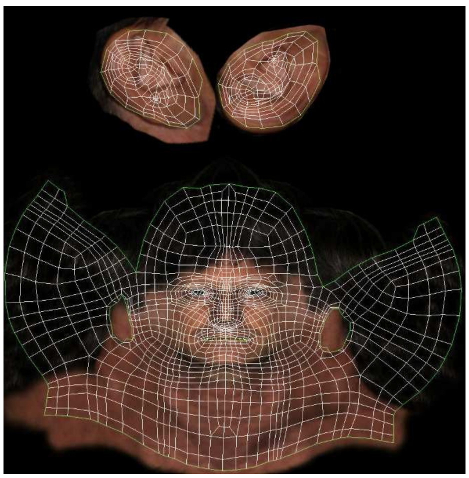

Fig. 5. Planar texture and UV map.

Fig. 6. Example of captured pictures during the scanning process.

After all animations are correctly set to its character, the animation is plotted to the skeleton and the DHM is sent back to 3D Max were the empty skeleton animation will be updated for those sent by MotionBuilder. At this time the file is already set to be exported to Unity3D with its correct media and animation.

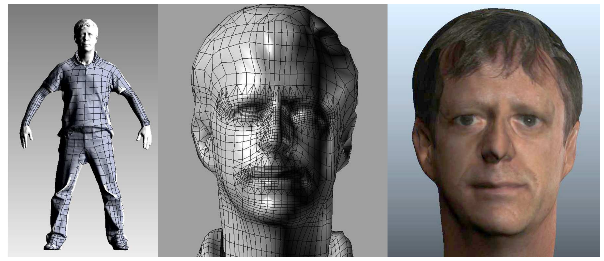

Fig. 7. Retopology and painting process/result.

3. Results

One of the simulator's goal is to allow multiple users to interact with each other using their own avatars. It will provide the team the ability to train activities, learn more about how their colleagues proceed and train new personnel (Figure 8).

In the final steps of the development of the project, the network function is set among all the 3D models. This setup involves: (1) scripting the objects (most of them are in java language - e.g. interactive doors, drawers, equipments, picking up and dropping objects), (2) scripting the scene (menus, cameras, interactive cameras, networking, illumination, layout, possibility to enable or disable a trail renderer in order to map users paths across the laboratory). All these components are brought to the users through a friendly GUI (Graphic User Interface), which makes the simulator as intuitive as possible, so the users can focus on the activities and not on how to work with the engine.

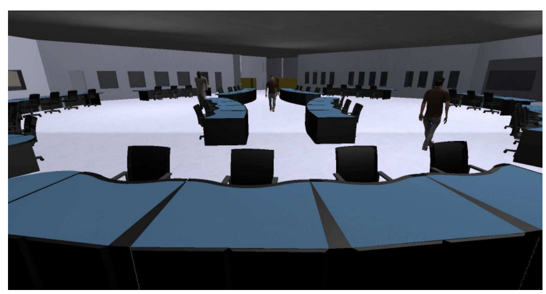

Fig. 8. Control room simulator running.

4. Conclusion

Nowadays, industrial projects are developed with the use of 3D software engines instead of 2D tools, allowing the main focus to be human labor and not only the project itself. Allying it to the study of social interactions at work helps to project better environments and also better training methodologies.
The use of virtual environments gives the possibility to discuss, change, create and deliver a better result as it is more graphic and

visual for non architects and designers professionals, to understand and discuss the new layout of the work space where can be chosen a better design alternative, optimize the interfaces, integrate countless projects and a great number of professionals involved.

Transparency of the future project allows adjustments and error recovery throughout the design process. Projects become more robust, since the scenarios and future activities may be simulated and also the risks involved studied.

These simulations may be used to evaluate technology, industrial safety and/or human performance. One may map process risks, ergonomic and architectural problems, escape routes, displacement of people in crisis situations, assembly and maintenance problems.

Therefore the conclusion is that virtual simulators of social interactions contribute towards: the activity of designers in the occupation of three-dimensional space; evaluation of possible alternatives; detailing the environment; validation of the future project by users, managers, and others; safety, health and environment evaluation; training of human resources.

Even if character interaction cannot always be done in the virtual space, stakeholders can easily project their knowledge of the working situation in order to assess part of the new working space characteristics improving the participative dimension of the project.

Organizational decisions were taken around these tools; they help people to project themselves in their future working spaces and furthermore it was a great tool to improve the feeling of participation.

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USING CONTRACTS FOR DEVELOPING AND TESTING SOFTWARE SYSTEMS

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ABSTRACT

Software development techniques need to be equipped with quality views too. Quality factors like reusability, extendibility, compatibility are important factors in component based development. To support component based development and to build more reliable software systems new techniques, methods and tools are needed.

In our paper we discuss recent research areas, available tools which support the "design by contract" methodology. The reliability of the components can be increased using the contracts introduced by Bertrand Meyer. The number of tools supporting contract based development is increasing. From the available tools which support contract based development we choose two one in Java (Contracts for Java) and one in .Net (Code Contracts) environment. We also compare these tools and for this we choose some main point of views like do they support static code analysis, dynamic checking or can they help the testing processes. The educational aspects of contracts are discussed as well.

Keywords: Components; Component Based Design; Software Testing; Contracts; Design by Contract

1. COMPONENT BASED DESIGN

If we talk about component based development we can talk about the development of each component and about the development of the system from components. We will use the definition of H-G Gross about the component:

"A component is a reusable unit of composition with explicitly specified provided and required interfaces and quality attributes that denotes a single abstraction and can be composed without modification." [13]

As we can see based on Gross's component definition one of the important attributes of a component is its reusability. Using components can make the development process faster. If there are prebuilt components, the system can be built from them, maybe some glue code, or a middleware is necessary, so the components can communicate with each other. For the communication between the components and between the components and the environment well defined interfaces are necessary.

In the paper we will see, how the first level contracts can help to define the interfaces, but the main parts in the paper are related to the behavior level (second level) contracts.

The interfaces which belong to a component are categorized into two types. The first type is the *necessary* interface, which is needed by the component to work properly. The second type is the *provided* interface where the component provides its services.

The KobrA approach addresses the problem that the Component Based Software Engineering (CBSE) is typically focused on the component implementation. The focus in the KobrA method is on the entire software development process, not just the implementation and deployment, by adopting product-line strategy, the creation, maintenance and deployment of components [1]. It is very important to use modeling languages like UML. Creating the UML model of the component can make the analysis and design processes component oriented. After the model based design the components can be implemented using any of the available component models CORBA [19], DCOM [25], EJB [26, 27] etc.

The KobrA approach can be used for educational purposes to because it tries to merge the benefits from more software development methods OMT [23], Fusion [5], ROOM [24].

There are three main dimensions in the KobrA development process. From these three dimensions there are six basic orientations for the development. These are composition/ decomposition, abstraction/concretization, generality/specialization.

When designing a system it will be decomposed into smaller parts, and when each of the parts are implemented the whole system can be composed from the components. Using abstraction and concretization can help to understand and develop the software system starting from an abstract model and converging to a concrete implementation. First a component can be developed in a generic way and whet it is needed a more target specific version can be created from it.

Component models

Software systems can be built from different functional and logical components. Using component models the components can be implemented separately in different developer teams. To build the system software support is needed. This support can be a middleware which runs on top of the Operating System and provides some functionality for the components (maybe written in different programming languages), so they can be connected together and they can communicate with each other.

There are many well known component models like Common Request Broker Architecture (CORBA [19]), Distributed Component Object Model (DCOM [25]), Enterprise JavaBeans (EJB [26, 27]), but there are newer architectures too like ICE from Zeroc [15].

2. DESIGN BY CONTRACT

Design by contract is an approach to design more reliable software. Reliability is defined here as the "combination of correctness and robustness" [17] as Bertrand Meyer suggests it. Reliability is even more important in object oriented programming and in component based software development where there are many reusable parts in the system.

In the development processes classes are defined as "implementations of abstract data types" [18], but these definitions are only attributes and routines. With the usage of contracts the semantic properties can be added to the definitions. With these axioms the properties written down in the specification can appear in the software systems. These can help de developer in the design, development, debugging and testing processes.

Contracts

The theoretical background of the contracts is the correctness proof methods of programs, software. A software system is correct with respect to its specification, so the software correctness is a relative notion. A specification can be expressed by assertions [12, 14, 18].

Let P and Q assertions about program variables and S a statement or a program, then the notation $\{P\}S\{Q\}$ denotes a correctness formula informally meaning that if P is true before the execution of S, then Q is true after execution of S. You can find a very good introduction in Bertrand Meyer's book [18] to create and introduce assertions into software texts. Several proving methods for sequential and parallel programs have been developed by this time [12, 14, 16, 20]. At our university there are lectures related to these methods. These lectures give a good basic understanding of the contracts and the usage of the contracts in practice. Practicing these methods the students will be well-skilled for creating contracts during developing reliable software from verified components.

One of the main aim of introducing contracts to decrease complexity [18] because the more complex is a system the more errors can be in the design or implementation. Contracts can help because all the necessary checks related to correctness can be put in the contracts so there is no need to check these properties in other places in the implementation.

When defining the behavior of the system with contracts there are three main variants of them which are preconditions, post conditions and class invariants. These variants define obligations and benefits related to the participants in the system. If there is a provider and a client in our system the benefit for the provider is an obligation for the client and vice versa. At the provider side in the preconditions there are the obligations for the client. If the client wants some services it needs to satisfy the preconditions, but if the preconditions are satisfied the post conditions assure that the provider makes its task correct which is a benefit for the client, but an obligation for the provider. With the third kind of contracts (invariants) we can describe such axioms which must hold through the execution of the routine, or method.

These main three contracts can be used to define the behavior of an object when preconditions, post conditions and invariants are used in the routine implementations. But when bigger and more complex systems need to be built, there is a need for more levels of contracts [3]. These contracts can be used to define not only behaviors in the system, but connection and synchronization related aspects or quality properties too, between software components.

Using contracts in the development process can help to make more correct software but it has documentations values too. The specifications which are identified at the analysis phase of the software development process can be written down by contracts. So it will be easier to check the working system against the specification. The other value it adds to the development and debug processes is that the developer or maintainer can see the specification in the source code when developing or searching for errors or bugs [18].

Four levels of contracts: As in real life contracts can be found in different levels, so the contracts used in software systems can be available in different levels too [3]. The main four levels are syntactic level, behavioral level, synchronization level and quality of service level. On each level there are different techniques for contracts.

On the first syntactic level IDL can be used to define the "connectors" between the components. There are many IDLs that can be used, which one to choose depends on the system environment and the communication methods between the parts.

On the second behavioral level using preconditions, post conditions and invariants the behavior can be defined.

The third synchronization level is needed, because the first two levels do not recognize for example parallel executions. The third level contracts specify the synchronizations between method calls.

The fourth level is for quality of service. This is necessary to write down contracts related to latency or the precision of the result. These attributes can be negotiated between the client and the provider.

Handling the contract violations can be different related to the level. On different levels if a contract is violated the program can behave differently it can ignore the violation, reject it, wait or on the third level negotiation is available too.

In this paper the focus is on the first two levels, the IDLs and mostly contracts related to behavior on the second level. In our tools the contract violation handling is in most cases exception handling.

Contracts in middleware

To connect different components in a system well defined interfaces are needed. In a system where the different components are written in different languages, the necessary interfaces have to be available on all programming languages. For this there are many IDLs (CORBA IDL, Java IDL (Figure 1), Slice [15], etc.). From these IDLs interfaces can be generated for the different components. These interfaces will connect together the software system built from different components.

```
interface MultiplyNumbers{
        void multiply( in int a, in int b, out double result);
};
```

Figure 1: Java IDL

The simple IDL (Figure 1) is an interface description where the multiply method has two input parameters ‘a’ and ‘b’ and an output parameter the result.

There are different kinds of middleware’s like Babel [2, 8]. Babel was developed to be a common middleware for components implemented in different programming languages. For the supported programming languages an interface could be generated from a SIDL (Scientific Interface Definition Language) so they could communicate with each other through the middleware. SIDL is extended for scientific applications with the support of dynamic multi-dimensional arrays, complex numbers, In-process optimizations, etc. These extensions were necessary for the scientific community to develop applications.

There is also an opportunity to use contracts in the SIDL specifications so the generated interfaces for the different languages will contain the contracts. The usage of contracts in interfaces makes available to check whether the connected components can interact, communicate with each other.

Support for contracts in different programming languages

There are many programming languages (Eiffel, D, Lisaac, Spec#) which support design by contract in a native way. These languages were designed to support contracts. These contracts are on the second level, so they define the behavior of the component.

Recently there are many third-party tools that can add the opportunity to use contracts in the software implementation phase for programming languages which does not support the contracts in a native way. There are tools for C/C++, C#, Java, Python. In the next chapter there is an introduction of two tools which support contracts in Java and .NET programming languages.

The common part in almost all of these extensions of languages, that they use the keywords require, ensure and invariant for the contracts. The *require* keyword means the precondition, the *ensure* means the post condition and the *invariant* means the class invariants. There are some other special keywords, but these may differ in different programming languages, these are the *old* and the *return* keywords. The old keyword refers to the value of a variable when the method execution starts, and the return keyword refers to the return value of the method. With these keywords more meaningful post conditions can be written related to the methods behavior.

Contracts and security

If a software system is built from components it is very important to know how these components will work individually or together in a common environment. Contracts can be used for checking the components behaviors. Security properties can be structured in different ways. Like properties relate to security functionality, software quality, monitoring, certification. Based on security properties four different kinds of security related contracts can be identified. These are functional interaction, interaction protocol, security-specific interaction and infrastructure [28]. Using single level contracts to create secure systems is not enough when creating big or complex systems different levels of contracts are necessary.

3. CONTRACTS IN DEVELOPMENT, DEBUGGING AND TESTING

As we see many programming languages support contracts in the development processes. The usage of contracts in software development spreads slowly, but there are many research projects related to develop and create tools which support very well the contract based development.

From the development view contracts can be useful in the source code. There is a connection between Test Driven Development and Contract Based Development. In both cases the tests and contracts can be written before the actual implementation. The contracts and the tests are created based on the specification. Using contracts the source code contains the specification. Changes in the specification and so in the contracts have immediate impact on the source code.

When contracts document the specification in the source code, it will be available for the later code maintainer, and also if the component with contracts will be reused in another system, makes the search for errors or bugs easier, and helps the component integration into new systems.

In this paper we focus mainly on two (Contracts for Java [4], .NET Code Contracts [6]) tools which support the contract based development. Both tools are under continuous development. There is a short introduction of the tools followed by a comparison.

Java environment

Contracts are supported in Java too. There are many projects (Modern Jass, Contracts4J, jContractor) related to develop contract support for java. These projects were started formerly but there are some projects where the further development stopped for some reasons. There is a project under continuous development the Contracts for Java. Contracts for Java [4] is based on Modern Jass with an enhanced version of compilation model. Their goal is to develop a robust standalone framework dedicated to contract programming in Java. Contracts for Java consists of three parts an annotation processor, an instrumentation agent and an offline byte code rewriter. Contracts can be written into the java source code (Figure 2).

```
interface MultipleNumbers{
        @Ensures({“a>=0”, “b>=0”})
        void multiple(int a, int b);
}
```

Figure 2: Contracts for Java

There is a precondition in the example, that the multiplied numbers ‘a’ and ‘b’ must be larger or equal to zero.

.NET environment

Microsoft Research develops an extension for the Microsoft Visual Studio which supports contract based development for .NET programs. There is a simple example for the usage of Code Contracts [6].

```
public void AddToList(int num)
{
Contract.Requires((num > 5) && (num < 10));
Contract.Ensures(list.Count ==
(Contract.OldValue(list.Count)+1));

list.Add(num);
}
```

Figure 3: Simple .Net 4.0 source code with method precondition and postcondition

This simple method (Figure 3) adds a number to a list, but with the precondition and post condition checking the behavior of the method is available. With the precondition (requires) the value of the input number is checked and with the post condition the method behavior is ensured. In this case the method can add the number only once to the list, so in the post condition the count of the list is checked that it was increased by one.

4. COMPARISON OF CONTRACT BASED DESIGN TOOLS FROM DIFFERENT ASPECTS

The tools we compare in this paper is the Microsoft Code Contracts integrated into Microsoft Visual Studio 2010 and the Contracts for Java extension. The main aspects of comparing are how the extensions support static analysis, dynamic checking, the testing processes and documentation, document generation.

Static analysis

Static analysis is performed without executing the software. The analysis can be made by an automated tool, or manually by another developer. Right now we focus on automated tools. Static analysis may include finding coding errors or formal methods to prove properties based on the specification.

Contracts for Java does not support static analysis only dynamic contract checking is available.

Using the Microsoft Visual Studio and the Code Contracts extension it is available to make static analysis during the development process. With static analysis the source code is analyzed at compile time, so finding errors is available before the software execution. Fixing the errors can be made earlier and faster especially if the run environment is big and complex. The static checker can decide if there are any contract violations without running the program. It can check implicit and explicit contracts. Implicit checking contains null dereferences or array bounds checking.

Dynamic checking

Dynamic checking is a runtime activity. The analysis is performed when the program is executing.

Contracts for Java supports only dynamic checking. When a contract is broken a java exception is thrown. There are two techniques for contract checking.

Using the first technique a separate file is generated at compile time for the contracts. The checking of contracts is made with the usage of java agents at runtime. This has some advantages, because the contracts can be handled separate from the source code, which makes easier the later reuse of the contracts. Also the application source code can be built separately.

The other technique is an offline byte code weaving. Where the generated separate contract file is weaved into the programs byte code before execution, and the contracts are checked runtime, there is no need for java agents, and so there are no Contracts for Java dependencies.

With the Microsoft Code Contracts a binary rewriter modifies the software injecting the contracts so they are checked at runtime.

Documentation (document generation)

The usage of contracts in the source code is already some type of documentation. The contracts contain the specification of the software system, so it can help the developers, and the maintainers to understand the semantics of the software system.

Contracts for Java supports the extension of classes and interfaces with contracts, so it is available to create documentation in the source code with contracts.

Microsoft Code Contracts also supports the documentation in the source code but it is available to generate external documentation from the contracts in the source code. With the document generation it is easier to maintain the documentation related to the software. The modifications in the specification, in the contracts can be updated faster in the additional documentations.

Testing

To support software testing is very important. Contracts can help in the development processes, but they can be used in testing too. Contracts can help in white-box testing. With the usage of contracts more meaningful tests can be created.

The exceptions can help to find errors, because if there is an exception related to the precondition, the client who tries to access a given service made an error, because the input is not appropriate. If there is an exception related to the post condition there is some error in the service provider, so the error investigation should be there. The usage of contracts can help to find the errors easier.

In java environment jUnit can be used to create unit test. If there is a contract violation a java exception is thrown.

Code Contracts can be connected to support the test phase of a software system with another extension for the IDE, the Pex tool [21]. Pex is an automated parameterized unit test generator for .NET programs. With Pex automatic test generation is available with high code coverage. It is also a research project. These two tools can work together so when Pex is analyzing the source code to generate tests it considers the contracts so there can be more meaningful test cases generated.

Like in Figure 3., there is a precondition which says that the input parameters can be integers between five and ten. With this contract information Pex can generate automatically parameterized unit tests related to the input values.

n	result(target)	Summary/Excepti...	Error Message
0		ContractException	Precondition failed: (num > 5) &...
6	new Test{}		

Figure 4: Automatically generated test cases by Pex

Pex generates automatically test cases with input values 0 and 6 (Figure 4). If the input value is 0 a ContractException is thrown, if the input value is 6 there is no exception, the method can be executed properly based on the given precondition. With these values Pex tries to cover every available execution paths.

5. USAGE IN EDUCATION

There are some courses at our university where the students can learn about the correctness proof methods of sequential and parallel programs, or how to build component based software systems and verify them. During their studies they develop skills for applying development methods and tools for building software systems from verified components. In the lectures the students learn about partial and total correctness of structured programs by Hoare methods,

To create verified software systems formal methods can be used. These methods, like those based on temporal logic or Floyd's and Hoare's methods for proving correctness need the necessary mathematical background and the tools which support formal specification and verification at model or implementation level. Extending these more abstract methods to create correct, verified software systems contract based design tools can add a more practical approach. These are needed to turn an abstract representation of the system into a more concrete representation, for example an executable, deployable component.

To figure out which tools support the best these approaches the comparison of the available tools is needed.

Contracts for is available for free, but it has not so many features like Microsoft Code Contracts and it is a newer project. It is quite easy to setup the development environment and it can be integrated into the Eclipse IDE [9]. With the usage of annotation processing in the Eclipse IDE it is much easier to write contracts, because if there is some missing variable in the contract IDE will indicate it.

In contrast to Contracts for Java, Code Contracts is not free but it supports more techniques static analysis, document generation and more meaningful test cases with Pex.

These tools can help the developers to write more formal specifications with contracts, based on the requirements. They can help to create software systems with better quality. The process of the contract based development could be similar to test driven development, when the development of test cases precedes the implementation.

Contract based development could be made as test driven development, where the developer starts the development with the test cases and after the tests comes only the actual implementation of the methods. Using contract based design the contracts could be created first. After validating these contracts they can be used in the developed system.

Contract based development could be part of software quality lectures or lectures related to software testing also.

6. CONCLUSIONS

There are many continuously developed tools (EiffelStudio [11]) and programming languages (Eiffel [10], D [7], Python [22], etc.) which support the contract based development. Further research is necessary to compare more available tools and functionalities they support. These tools can help during software development, testing including debugging and maintenancing. The contracts could be used in the debug code to help find errors.

Building the different components with contracts a built in checking is available for the components. This type of checks can be very useful during integration tests when the components are composed into a software system, in such cases when a component is changed in the system, or if the component has to work in a new environment.

Contract based development should be used to create more reliable and better quality software.

7. ACKNOWLEDGEMENTS

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Application of psychometrics methods to Library and Information Science research methodology

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ABSTRACT

Common patterns and interrelationships in Psychometrics and research methods in Library and Information Science suggest a need for systematized methodologies for research and assessment of information processing and human perception and use. This exploratory study shows where psychometrics may be practically applied to usability assessment of library online databases, bibliographic management software, and digital/virtual learning tools.

Usability, user perception, competencies, assessment are placed within various contexts of psychometric concepts, such as validity and reliability, and applied to an *Information Search Process* (ISP) model. Triangulation, integration, and broadening of commonalities are analyzed in contexts of usability of library online resources.

The wide variety of theories related to research methods in psychometrics, combined with the changing technological landscape of LIS brings expanding subjectivity to both quantitative and qualitative inquiry; review of literature shows a need to reconcile the qualitative/quantitative dichotomy for development of practical applications.

This research provides background for development of assessment tools, such as instruments and rubrics related to human-computer-interaction (HCI) and usability studies. Such tools facilitate design and re-design of software packages used in LIS and interdisciplinary social sciences and related cost-benefit analyses.

Keywords: Library and Information Science, Human-Computer, Psychometrics, Research Methodology

INTRODUCTION

Library and Information Science (LIS), a social science metadiscipline, occupies a practical/theoretical mid-ground where social sciences and Information Technology (IT) meet. Research in IT draws from the social sciences for the development of research databases, and the social sciences draws from IT for analyses of HCI, sociometrics, and related areas of psychometrics. LIS draws from both. This paper seeks to identify and flesh out areas in which psychometric measurement testing is well-suited to the research methods of LIS.

IT, the tools of which increasingly use common language search terms, is a participant in the growing practical demand for assessment that can combine empirical, quantitative analyses with meaningful and useful qualitative interpretations. Budd (2010), verifying need in the literature for postpositivist social science (including LIS) methods, offers a syntheses of critical realism and phenomenology by providing theoretical base for the ontological reality of aspects of perception. The need for psychometric quantification of information-seeking behavior research is particularly applicable to modern LIS and HCI, with wide-ranging implications. Groenen (2006), in his general discourse on the current state of psychometrics, notes the expanding and ever-broadening nature of psychometrics, and focuses on the dual interest—by academics, researchers in statistical software packages, and educational and social psychologists. That several disciplines are concerned with modeling of choice behavior—utilizing research areas of as test theory, item response theory, factor analysis, structural equation modeling, and multidimensional scaling—is of great interest to educational software marketing, which is itself contributes to sociotheoretical contexts.

Systematized bridging of psychometrics and LIS will bring clarity to the decades-old qualitative and quantitative debate. Practical problems associated with the debate are described in Hanson (2008), who asserts that the basis of separation is not supported by theoretical examination of the concepts of subjectivity/objectivity; that systematization and quantification adapt to generalization, and that sociopolitical traditions may lurk behind the split. Hanson suggests that the advancement of inquiry and method involves transcending the qualitative/quantitative issue, to move towards more pertinent issues of validity and causality. Movement toward such transcendence is shown in studies such as White (2007), which developed the pennant diagram—a visual 'cloud' display of word clusters that combines bibliometrics and psychometrics—using Sperber and Wilson's (2001) relevance theory (RT)—in attempts to facilitate problems of perception and intent in information-seeking behavior. Such research will be enhanced by systematized, qualitative methodology, and is further supported by Madill (2008), who adds that qualitification will lend to coherence and further interactions across different methodologies.

This exploratory paper presents an exploratory model graphic (Fig.1) showing where need in LIS research to extrapolate both the qualitative and quantitative methodological rigor from psychology research is applicable to modern LIS and HCI. Important implications for technological advances, for example in research database design studies using predictive information-seeking behavior psychometrics, provide supportive justification.

PRACTICAL/THEORETICAL RELEVANCE

Psychometrics is rigorously applicable to assessment of library services. LIBQual (Heath, 2002) is a measurement tool of library services which can be administered in-tandem with assessment of user perceptions, satisfaction, and other patron-centered measurements. Multidimensional scaling is noted by McGrath (1984) as applicable to assessment of library circulation, collection management, funding, and online retrieval. Information Literacy assessment is of great relevance. Classical test theory can be applied to LIS, and is itself in need of regular assessment and updating. Mery & Newby (2011) found that test questions tailored for localized institutions were successful according to application of both classical test theory and item response theory to evaluate the validity and reliability of the Standardized Assessment of Information Literacy (SAILS). SAILS utilizes the Association of College Research Libraries (ACRL) *Information Competency Standards for Higher Education*, which is comprised of the following eight skills areas: developing a research strategy; selecting finding tools; searching;

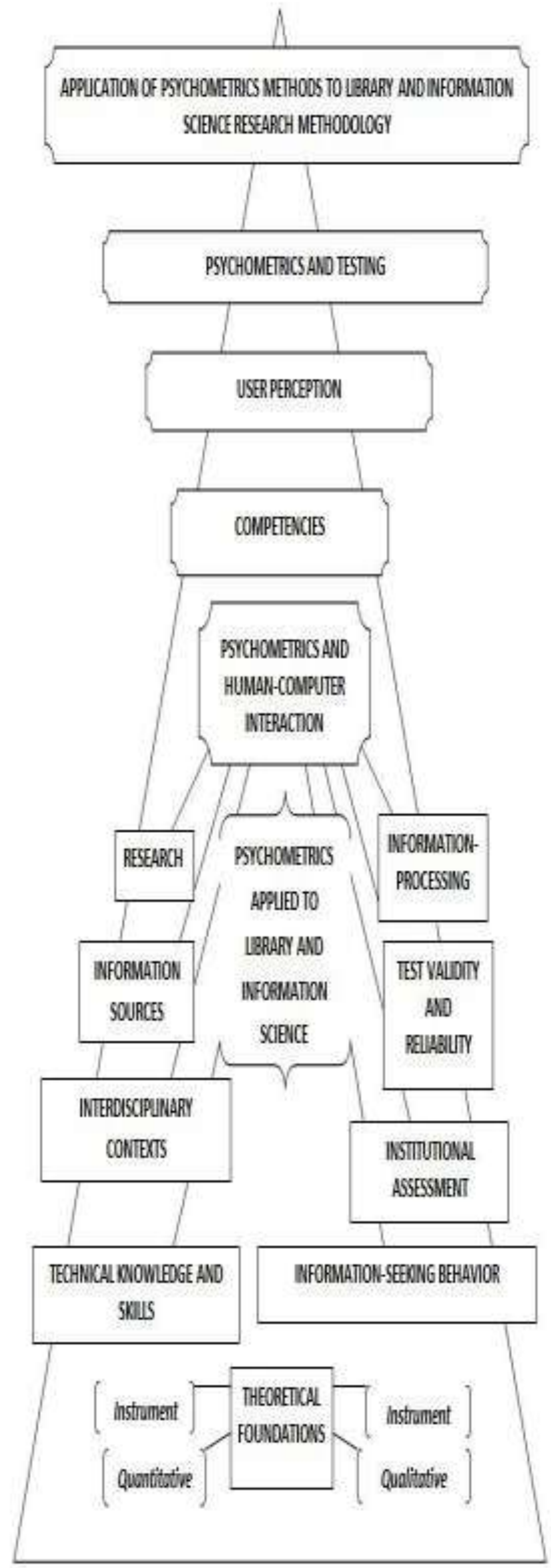

Fig.1: Psychometrics and LIS applicability

using finding tool features; retrieving sources; evaluating sources; documenting sources; understanding economic, legal, and social issues.
Competencies, usability, and user perception—in application to information-seeking behavior—are foundations of LIS and information literacy, and are highly relevant areas for psychometric measurement. For example, Information literacy involves multi-dimensional information-seeking behaviors. For measuring multi-dimensional concepts such as practical knowledge, Meijer (2002), in attempting to increase testing instrument validity, applied the technique of multi-method triangulation. O'Brien (2010), in developing and evaluating a survey to measure user engagement, says that user experience is a vital factor in interactive system design. Reliability analysis and exploratory factor analysis may identify attributes of engagement, such as perceived usability, aesthetics, focused attention, felt involvement, novelty, and endurability. It was found that these attributes have complex interrelationships across user and systems. Rigorous usability and user perception cohort testing projects are in planning stages; the authors of this paper will use regression analysis and analysis of variance in the development of a research question leading to a hypothesis-formulation testing stages. This research will result in a contribution to the systematization integration of psychometrics with LIS.

INFORMATION-SEEKING BEHAVIOR AND PSYCHOMETRICS

Information-seeking behavior is a fertile and widely-applicable ground for research and psychometric quantification in LIS. Kuhlthau (2004) created a six-stage theory—the Information Search Process (ISP)—which isolates stages an information seeker experiences, and notes accompanying feelings (apprehension, uncertainty, optimism, relief). Information professionals such as librarians formulate appropriate response strategies and also anticipate subsequent behaviors. These factors may be used in experimental psychological research measurement, particularly involving predictive behavior. These measurements will be of great interest to the designers of keyword-based research databases, where the fluid, multidimensional mental processes of an information search, if quantitatively measured, can be of great use in HCI experimentation. Of note is that nearly twenty years after the six-stage ISP model became disseminated into the literature, in the context of modern keyword-search based research databases, Kulthau's stages have been tested and empirically shown to be still useful for LIS research. (Kuhlthau, 2008).

In the initial stages of a search, where awareness of a need for information to accomplish a task or goal may be accompanied by apprehension, perception surveys indicating dissatisfaction about source knowledge and search techniques will be lent perspective from systematized psychometric application. When assessing, for example, the effectiveness of a particular database, dissatisfaction may bear unique implications if seen as a stage in a process. User engagement, as asserted by O'Brien (2010), plays a major role in the exploration stage. User engagement is related to perception and user appraisal of information sources; all involve skill sets involving conscious and unconscious mental processes. Perceived usefulness—before, during, and after an information search—an important area for psychometric measurement, LIS, and assessment in every stage of an information search—is relevant to psychological experimentation in predictive behavior, and its measurement.

The exploration stage of information-seeking behavior is most readily associated with keyword searching in research databases. Tann & Sanderson (2009) find that search engine queries fall within categories including navigational, informational, and transactional. Their findings suggest that whereas in the past some queries would have been classified as informational, web searching has evolved to where they are now classified as navigational. It is surmised that modern large websites specializing in a particular type of information, such as *Wikipedia* and *Facebook*, contribute to such changes in searching characteristics. This attention to public websites and the development of skill sets outside of formalized learning environments—involving tracking data—is of great use to psychometricians; the use of information-seeking behavioral statistics—of primary interest to marketing research for decades, will benefit from the development of a systematized integration with LIS research. Relevance Theory (RT) may be applied to the study of human-computer dialogues to account for, for example, the human tendency to apply the least possible amount of effort in order to obtain a result. This is important for the designers and re-designers of software, if they are to be cognizant of human information-seeking processes. In keyword searches, randomness—mismatch irrelevancy and hit-and-miss—are cited as contributing factors to less-than-satisfactory HCI (White, 2007). These factors are in need of further research into evolving software, psychology, and HCI.

TEST VALIDITY, RELIABILITY AND LIS

As Mery & Newby (2011) found with the SAILS testing, validity and reliability are central concerns for LIS. There is a need for continual revisiting of the concept of validation, as technology evolves, and conditions change. Validity clarification—the establishment that a test measures what it is intended to measure—is a topic for continual revisiting. Kim (2009) in a study on psychometric research instrument validation finds a need for standards on validation processes and reporting, which will provide structural ballast for a noted increase in attentions to specific validation issues. Kim's article offers ways for researchers to implement improved validity reporting. Tojib & Sugianto (2011) assert that research literature in information science suffers from a lack of agreement about definition of terms—in the case of their article, the terms are convergent and discriminant validity. This lack of agreement evidences the need for a broad-based, systematized integrated foundation of research methodology bridging psychometrics and LIS; whereas LIS is at the forefront of the human-computer interface and of information-seeking behavior, and whereas the measurement of skill sets for the use of technological tools for information searches inevitably bleed into each other.

Among the many aspects of validity, instrument construct validity—the primary form of validation underlying the trait-related approach to psychometrics—wherein the entity the test is measuring is normally not measurable directly, but is evaluated by examining the relationship between the test and the various phenomena that a theory predicts—is of great complexity in LIS and HCI, owing to the multidimensional nature of human neuroprocessing and computer processing of digital information.

All aspects of validity are readily applicable and useful for psychometric considerations of LIS, HCI, and information-seeking behavior. For example, face validity—the assumption of the validity of a test according to its appearance, content, or context—addresses the complicated assessment of internet and database keyword searching, whereby there are so many approaches to an information search. There are no defined right or wrong approaches, and if a test-taker has searched a certain way for certain kinds of information, if presented with choices outside of their experience, may assume a test is invalid. This can affect the outcome of a test, and is particularly problematic for HCI and psychometrics. Content validity is of relevance whereas the relationship between the content and the purpose of a test may be unclear regarding search techniques. A searcher naturally has more aptitude for familiar topics, and the level of information-seeking engagement changes during the process, depending on topic familiarity. Furthermore, there may be completely fluid and changing goals and tasks from one minute to the next. Criterion-related validity establishes the relationship between scores on a questionnaire and a criterion measure which should be indicative of something. For example, in an information search for a biology reference table, if a user is unable to identify source material, the test ought to show whether it was because of subject ignorance or database ignorance. Predictive validity and its measurement bear particularly important implications for database design. Database searching is a skill that develops according to different personal mental processes, and therefore the scores of a given assessment should accurately predict, for example, the potential for a patron to use a given database that is designed in a similar way to the one the patron was tested on. This should take into account how knowledge cross-pollinates over time and experience.

An estimate of the accuracy of a test, the concept of reliability is important to library and information science and, in-particular, the assessment of article database and bibliographic management software. For example, if users get similar or very different results from taking tests in different circumstances needs to be noted. Several ways of measuring reliability—test-retest, parallel forms, and split half—are pertinent to library and information science, and are shown to involve aspects the measurement of which beg for systematized integration into the research methodology.

Test-retest, whereby respondents are given the same test, may be problematic for psychometrics in that not only the respondents of a given test may remember their responses on the second occasion (the common solution being have a long interval between the two administrations of the test). In the case of LIS, and, for example, internet or database searching, such searching skills are developed in a variety of ways in everyday internet use, as well as use of a variety of databases. There would appear to be a continuum of skill-set development that transcends the concept of reliability in any traditional sense, in terms of Library and information science. This special consideration could be taken into consideration in a systematization of psychometrics applications to research methodology. Parallel forms, whereby two different tests are created with questions that are meant to be equivalent—for correlation—involve problems whereby equivalencies in database keyword searching are difficult in that search processes are nonlinear and related to prior subject knowledge. Parallel form reliability applied to multidisciplinary keyword-search based databases seems naturally adaptable to LIS. Research methodologies in both psychology and LIS therefore would stand to benefit from an integrated, systematized supportive framework when conducting interdisciplinary information-seeking behavioral research.

Mery (2010), noted that SAILS testing involved the need to establish complicated criteria framework design/redesign, including external validation related to other similar tests, item reliability related to level of difficulty, individual and cohort-score correlation, and other editing of the instrument. This was achieved over a three-year period, following which the final skill sets (Developing a research strategy; selecting finding tools; searching; using finding tool features; retrieving sources; evaluating sources; documenting sources; understanding economic, legal, and social issues) were configured successfully to ensure that what was being was measured conformed to the construct of information literacy. This complex design/redesign is further indicative of the need for a systematized integration of psychometric and LIS/HCI research methodology.

SUMMARY, CONCLUSIONS, FUTURE RESEARCH

The literature review suggests a strong need for a systematized integration of psychometrics into the research methods of the field of Library and Information Science. Demonstrated affinities are evidence that they can be efficiently and effectively applied and integrated. Applied to usability studies in conjunction with fundamentals of information-seeking behavior and human-computer-interaction—both components of the field of library and information science, psychometrics applications will broaden, triangulate, and further highlight commonalities, and facilitate their integration.

The expansive volume of theoretical literature related to research methods in psychology—and the various ways in which psychometrics may be applied to them, combined with the changing landscape of LIS, bring broadening subjectivity—and a need for flexibility—to this inquiry. Whereas theoretical literature may tend to complicate and frustrate goals for objectivity and practical implications and applications, this is evidence of the need to anchor such related theoretical fields with practical controls.

The development of assessment instruments and tools—such as rubrics related to human-computer-interaction and usability studies—relies on practical systematization; to integrate psychometrics with LIS and HCI will contribute to the kinds of cost-benefit analyses research institutions and institutions of higher education are increasingly in need of in times of economic uncertainty. To plan for the future design and redesign of software packages and electronic research databases utilized in the field of Library and Information Science—in-tandem with psychometrics and other tools of the social sciences—is the driving force behind this project.

The authors are developing a theoretical research question leading to a hypothesis that will be rigorously tested with regression analysis and analysis of variance, using cohorts of primarily undergraduate students in an urban college environment. The results will be submitted for publication, with the goal of wide use of the hypothesis in the development of systematized psychometric application tool for LIS. The results will benefit the broadening interdisciplinary fields involving digital information and its processing, usability and competencies involved in its use and assessment— in theoretical, practical, technological, and psychological contexts.

What is happening inside the human mind during information-seeking behavior? Are there correlations to what is happening inside a computer? Can any such correlations be measured, analyzed, and put to practical use through the development of tools? Can those practical tools and their uses be assessed? Changing perceptions of Library and Information Science, human-computer interaction, and social sciences in general call for new applications of psychometrics that can facilitate integration across such related fields. This calls for new rigorous structural methodologies in research, which will result in practical development of widely-applicable assessment tools, and suggestions for the building of navigational tools for the information highways and byways ahead.

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SpeechIndexer: A Flexible Software for Audio-Visual Language Learning

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ABSTRACT

This paper presents SpeechIndexer as a software tool to create teaching and learning material for language courses and as an e-learning program to train the oral comprehension and speech production. We introduce the player function where students can follow speech and text closely and the role play function that allows the learner to get involved in a dialog. Teachers can create material from the vast amount of speech recordings available (audio books, radio and TV podcasts, language learning CDs, etc.) that specifically match the knowledge level and interest of individual students or the whole class. The software may complement regular language courses or may serve to teach languages where teaching and learning material scarcely exist, e.g. endangered languages that have a pure oral tradition.

Keywords: e-learning, language learning, teaching and learning material creation, oral comprehension and speech production training

1. INTRODUCTION

Current language learning software contains a variety of different functional blocks such as read speech, grammar modules and vocabulary exercises [1, 2]. These programs are highly interactive, the learning progress is constantly evaluated and the student can advance at her own pace. Some of the programs even provide a pronunciation training where the user speaks words into the microphone and a built-in automatic speech recognition component checks the utterance for correctness. However, state-of-the-art language learning programs have a very static design. They contain a control logic that presents the functional blocks in some order, accept inputs from the user and check it with fixed stored values and they contain jumps into predefined subroutines, e.g. in the case of automatic checks of pronunciation correctness. There is no way to adapt or extend the data content of this e-learning software, i.e. it is not possible to add material to it, namely, additional speech files or new vocabulary. Yet, a teacher in face-to-face instruction observes the level of knowledge in his class and provides additional training when needed.

In this paper, we consider the SpeechIndexer software as a platform to flexibly create both teaching and learning material and to serve as a language learning program. We present two functions of the software that specifically support the audio-visual learning of a language. These functions are described here for the first time in detail.

The SpeechIndexer software has been developed at ETH Zurich and EMPA in Switzerland by two of the authors. The original goal was the documentation of endangered aboriginal Formosan languages that have a pure oral tradition and where large archives of recorded speech exist [3]. The language teaching aspect, however, has always been kept in mind during the development since endangered languages need also be taught to keep them alive [4].

The structure of the paper is as follows. We give an overview of the SpeechIndexer software in Section 2. Then, we describe how a learner trains his listening comprehension and speech production using SpeechIndexer's player and role play function in Section 3 and 4. We present the flexible creation of teaching and language material in Section 5. Finally, we draw conclusions and give an outlook to future work in Section 6.

2. SPEECH INDEXER OVERVIEW

SpeechIndexer has been developed for the indexing and retrieval of speech files. The core component of SpeechIndexer is its semi-automatic indexing where segments of speech are correlated with their corresponding text segments. The textual transcription for a given speech file is entered via the program or is loaded from outside. A built-in pause finder automatically divides the speech file into pause and speech segments. A speech segment denotes a flow of speech uttered without breathing and contains a few words, a phrase, a sentence or even more than that. The user manually combines corresponding speech and text segments to form the correlations called indices [5]. Text belonging to an index (indexed text) is marked and appears red, bold and underlined. The speech segment behind an indexed text can be played directly. Fig. 1 shows the SpeechIndexer main window that contains the audio window with the speech signal and the text window. The text window shows some unindexed text (black) and indexed sections (red, bold and underlined). The audio file is a section of Churchill's famous speech "A United States of Europe" [6]. Furthermore, the user can mark speech segments of individual speakers with different colors to see at first glance which parts of speech belong to the same speaker. Fig. 2 shows an indexed speech file with two speakers (Brian and Jane) that are marked differently – each of which with a different color. The speech file in this example is from the audio CD of an English language course [7]. The user can define marking colors of speakers individually. The speaker profiles are saved under a so called extras file. All loaded and created files (audio, segmentation, text, indices and extras file) are captured under a project name. It is possible to load all files of a project at once and to save a set of files as a project. In addition, SpeechIndexer provides two search functions: (1) searching within the same file and (2) searching across collections of speech recordings. In both cases, the search results are listed and each result can be played immediately.

A number of helpful visualizations have been implemented. First, the speech signal is always visible, i.e. the user sees where the signal has low- or high-energy and where there are pauses in the signal. Secondly, a cursor in the speech signal follows the waveform when the signal is played, and more importantly, the indexed text currently played is highlighted. Finally, the aforementioned speaker coloring scheme provides a better overview in an indexed speech file with multiple speakers.

Fig. 1: SpeechIndexer main window with signal and text window. Indexed text appears red, bold and underlined.

3. LISTENING COMPREHENSION TRAINING

Given a fully indexed speech file students train their listening comprehension in the following way. They play the speech file and follow the played text. The currently played text is highlighted for clarification, i.e. it appears in a different color that the user may specify. (Behind the scenes, the program checks for each play position whether there is an index that contains this audio position and it highlights the corresponding text segment. The played text is set to its original state as soon as playing the corresponding speech segment has finished.) Students can always stop the recording and repeat playing a previous segment if they did not understand it. They can look up unknown words offline. After doing this listening exercise again and again, the learner understands the speech recording without looking at the text. In fact, this is the final goal of listening comprehension training, namely, being able to fully understand a piece of authentic speech.

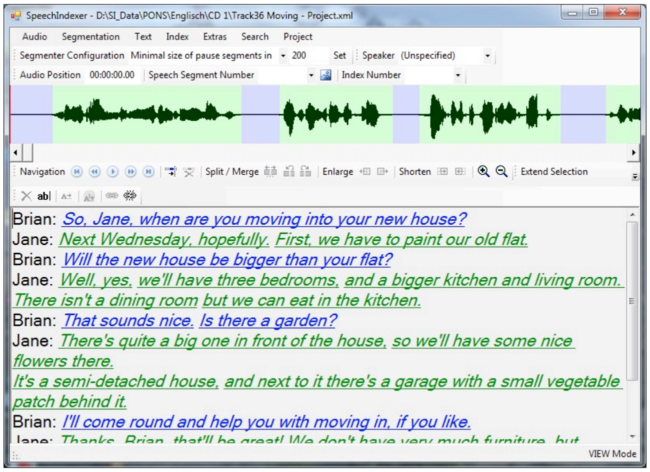

Fig. 2: SpeechIndexer main window with speakers marked individually.

4. SPEECH PRODUCTION TRAINING

Speech production is trained with SpeechIndexer's role play function. The role play function operates on indexed dialogs as they often occur on CDs that are delivered with language learning books. The readings of language books are typically dialogs in everyday situations (in the supermarket, at the bus station, in the restaurant, etc.). Those speech recordings are indexed by the teacher and the speakers are marked individually. The role play function lets SpeechIndexer take over the role of one dialog partner while the learner speaks the role of the other part. For this purpose, the program plays the speech of one dialog partner and mutes the speech of the other. The student can always compare his given utterance by listening to the speech part he is supposed to take over in a second round. This way, the student learns to speak whole sentences in typical life contexts.

The role play function is activated by declaring one of the speakers as muted speaker. As a consequence, all text of this speaker is made invisible. When playing the file, the speech of the muted speaker is played soundless. Fig. 3 shows SpeechIndexer with the role play function activated. The text of speaker Jane that is visible in Fig. 2 is cleared in Fig. 3 and Jane's speech is muted. The learner is supposed to speak Jane's role.

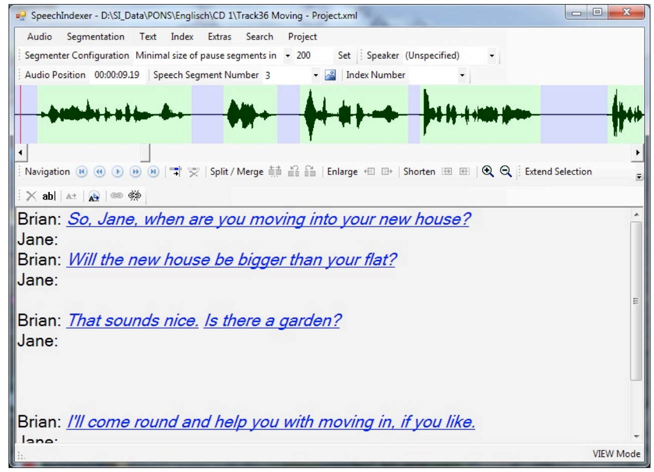

Fig. 3: SpeechIndexer with role play function activated.

In fact, we believe that the role play function of SpeechIndexer is a better way to train the speech production of a learner than an automatic speech recognition component that lets a student speak single words only. First, state-of-the-art automatic speech recognition component often make errors and will recognize utterances as correctly pronounced if there are not and vice versa. But more importantly, the proposed role play function lets a learner to become involved in a dialog and trains a natural way of speaking.

5. LEARNING FROM AUTHENTIC DATA

With SpeechIndexer the teacher flexibly creates teaching and learning material suited for the needs of the class or for individual students. Speech recordings nowadays can be gained from various sources, e.g. from CDs associated with language books, from audio books and radio or TV podcasts. The audio tracks of these media files are converted into the WAVE file format by freely available programs and loaded into SpeechIndexer. Some radio stations provide transcripts of their broadcasts and also audio books often come with the texts. Given transcripts can be converted into UTF8 files and loaded into SpeechIndexer. The teacher enters the text of an audio section within the program if no electronic transcript is available. The final step is the synchronization of the audio file with the texts by creating the indices and the marking of the speakers if needed. The set of files can be given to students for listening comprehension and speech production training.

It is a particular advantage of SpeechIndexer that it allows the creation of teaching and learning material from current, authentic recordings, e.g. from news broadcasts of yesterday. Thus, teaching and learning material for the present-day use of the language is created. This is specifically helpful in cases where the teaching and learning material is outdated or when it hardly exists. For instance, there is only very little language teaching and learning material available for endangered languages that mostly have a pure oral tradition.

6. CONCLUSIONS AND OUTLOOK

We have considered SpeechIndexer as a flexible tool to create language teaching and learning material from authentic speech recordings. From its original design goal it lets the learners train their oral fluency, namely, their listening comprehension and speech production.

SpeechIndexer gives the language learner a new view on the spoken language and makes it more transparent. It shows aspects of the spoken language that cannot be seen otherwise. It shows the speech signal and the position played, it highlights the text currently played and lets the text segments of different speakers appear in different marking colors. This way, the learner perceives spoken language as concrete. We believe that it is also a well-suited e-learning tool for primary and secondary school children since it has an uncomplicated user-interface and is easily learned.

Currently, SpeechIndexer is intended to complement existing language learning material to specifically train the oral fluency and comprehension. However, we plan to evaluate SpeechIndexer in language classes in order to get feedback on its usability and effectiveness. Key questions are whether teachers create teaching and learning material in a user-friendly and effective way and how well learners improve their oral fluency when using SpeechIndexer. A corresponding project with the Swiss National Science Foundation and various partners, e.g. with the University of Teacher Education Central Switzerland, is in discussion.

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Empowering Instructors to Become Effective Content Curators

Using the Building Blocks of Today to Manage Dynamic Curriculums for the Education Space

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ABSTRACT

This paper will examine key technologies that exist in the market today which can be used to enable instructor content curation and idea growth through direct student collaboration. Existing tools can be used to not only recreate the in-class collaborative experience in a distance-learning environment, but can also be used to support growing collections of knowledge on topics/subjects than just what can be gained from a single class or semester.

This paper envisions a method for both instructors and students to help them effectively curate content and helps empower them to communicate through references to a combination of text and digital media. These references originate from multiple platforms across the Web, but relate to a single topic or idea. This "compilation" of material can then be treated as its own form of content and can be assignable, consumable, and gradable in the well-established pedagogy of standard learning management systems.

This form of content would allow instructors or students to present ideas that are greater than the sum of their individual parts and provide a platform for further discussion and learning, ultimately, growing the value of the content itself.

KEYWORDS

Content curation, learning management, content management, social media, content compilation, collaborative learning, multi-dimensional content growth

1. INTRODUCTION

Don't reinvent the wheel. The key systems that can be used as the building blocks for effective content curation have existed in multiple forms for many years. The key systems are the Content Management (CMS), Learning Management (LMS), and Social Media platforms.

In standard implementations, each one of these solutions caters to the specific needs of the corporate, educational, and consumer communities. They can be implemented by themselves, or in combination to support the various needs of enterprise organizations. Together, these systems can provide the specific features for the creation, management and distribution of content, as well as an increased depth of conversation and detail through social collaboration. Through proper configuration, these systems can be focused to support educational needs by providing instructors with an easily accessible library with which they can identify areas of interest and build "compilations" of content for their students to consume and collaborate on.

In a web-based world content can be identified as any digital resource, including text, video, audio, visual activities, quizzes, assignments, and assessments. As a content curator, the instructor's responsibility would be to identify the selections that they wished to combine and build them into a new type of content, a Compilation. Like all educational content, Compilations would be distributable, consumable, gradable and a starting point for collaboration, but each Compilation would hold a depth of information greater than any one item, representing an idea, greater than the sum of its parts.

This paper includes a breakdown of the technologies involved, their capabilities, and the opportunities for integration with each other. While the goal is to introduce the concept of the Compilation content type, the principles of content curation, and user-driven content growth, it is not the aim of this paper to suggest a single software product or even a collection of tools that easily integrate. Instead, the goal is to highlight the opportunities that are available using existing software solutions to enhance the instructor's and the student's educational experiences.

2. CONTENT MANAGEMENT SYSTEMS

The Content Management Systems (CMS) that exist today are descendants of Document Management Systems (DMS) that were introduced to the market in the late 1980s and early 1990s. These systems were typically standalone solutions that were created and used mainly to manage imaging, storage, and workflow of corporate document assets.

With the introduction and rapid growth of the Internet in the mid- to late-1990s, these document management systems were pushed to become more web-centric, which allowed for wider access to what were still primarily internal corporate assets. With this growth, the need for external user and client access to corporate information increased, and web-accessibility and an increasingly granular structure for content became a necessity. Over time, key features of collaboration and categorization were introduced to support an even broader, web-centric environment. Using these building blocks, content management systems were then capable of supporting both the business and marketing needs of individuals and corporations, and had effectively established a standard set of methodologies and terminologies used to establish business practices and solve problems.

Currently, Real Story Group (formally CMS Watch) tracks and evaluates forty two unique, enterprise-level Web CMS solutions. These products range across technology platforms and each solution either attempts to present a single generic approach to all CMS needs or to provide specialized support for individual business types (including education-focused models). While these products vary in both cost and effectiveness, ranging from free open-source solutions to those that cost millions of dollars in licensing, at the core, they all support the following four key elements:

1. **Structured Content** that allows for the version-based storage of a list of well-defined content types – each with their own set of fields enabling differentiation between various "types" of information that may be managed within the organization
2. **Hierarchal Categorization (Taxonomy)** structures which support the definition of multi-level topics and ideas, across which content can be linked and interrelated
3. **Users** who can be defined as not only those that create and manage content, but also those that consume content
4. **User Groups** who represent the different ways that different types of users will interact with the content or sub-sets of users that need to collaborate on a smaller set of content

The above elements of a CMS allow this type of product to be configured to support an organization's educational needs effectively. Using structured content, educational material can be broken down to its most granular level. Granularity is of upmost importance to effective content use. The more individual parts a content item can be broken into, the more effectively it can be linked to all the unique ideas it may present. The better the breakdown of content, the better the system will be able to understand its value.

With hierarchical categorization (taxonomy), content can be interrelated not only in common ways like a book's table of contents, topics, or state standards but also in less obvious ways like difficulty and learning objectives. Since any content item can be linked to any number of taxonomies, this information can be presented to consumers, searched, or browsed against in any number of ways at the same time. The better the content structure and the better the categorization, the more effective the user experience will be.

In advanced CMS solutions, the definition of these structures can be made not only at the original content publisher level, but also at the consumer level. This allows the individual users (be it the instructor or student in an educational environment) to not only consume the structures provided to them, but to also introduce new content and taxonomy structures as they see fit. This allows the user to enhance their own experience, albeit not always the experiences of others. It is this feature of CMS that most specifically supports the concept of a Compilation content type, and its creation through user content curation.

CMSs provide content producers with an easily repeatable and maintainable process for creating, relating, and distributing the content, and if properly configured, allowing users to consume and enhance that content in the way that works best for them.

While CMSs do support the sharing of user-generated content and configuration, they typically view all users as equals. This makes Content Management Systems by themselves not particularly well-suited for the educational environment, where a well-controlled, well-structured instructor-to-student relationship is necessary to support educational progress.

3. LEARNING MANAGEMENT SYSTEMS

Learning Management Systems (LMS) and Learning Content Management Systems (LCMS) support the core instructor-to-student workflow elements that are not found in a CMS. The primary focus of these solutions is to provide the functionality for the assignment, consumption, grading and tracking of Learning Objects (LO).

Learning Management Solutions have also evolved significantly from their early forms in the 1980s. However, unlike CMSs, LMSs' core tenants have remained consistent since the time of their inception, as they were based on the real-world classroom experience. Currently, similar to the CMSs, there are approximately forty significant LMS platforms supported at the enterprise-level. These solutions typically have been developed to support content consumption and work-flow through key standards of structure and e-learning methodologies like SCORM. While several such products support generic LMS implementations, many focus their toolsets on key areas of education, such as K-12, higher-ed, or corporate models.

While individual toolsets may vary, current LMS functionality standards have expanded beyond its core tenants in several ways in order to support its wider use. Thanks to an increased reliance on automation, LMS has become far more effective in distributing dynamic sets of requirements, randomized tests, auto-generated algorithmic questions, etc. This functionality has vastly expanded the instructor's ability to not only distribute unique assessments, but also continue to track a student's progress against learning objectives in a standardized, non-subjective manner.

Learning Content Management Systems (LCMS) have taken the Learning Management workflow and added elements of Content Management, enabling not only the distribution of learning objects to students, but also their authoring within the same system.

While many LCMS solutions available represent a good integration of these two technologies, they typically do so in a way tailored to current educational needs and limitations. Instructors, for example, may be the only ones who can create content, or users may be limited to the creation of only very specific content types. For that reason, such systems may not allow for the broader requirements of Complication creation available using the capabilities of free standing, best of breed, CMS, LMS, and Social Media solutions.

The key functionality that LMS brings to the table is its dynamic representation of the core interaction of education: the distribution of information from an instructor to a student and the student's subsequent interaction with that information. Both LMS and LCMS solutions may be capable of supporting this requirement for any given implementation's needs. While these solutions provide effective mechanisms for the interaction between instructors and students, they do not typically support broad levels of student communication or collaboration. This functionality is best supported using existing Social Media platforms.

4. SOCIAL MEDIA PLATFORMS

Social Media platforms are ubiquitous in today's society, both online and off. Like CMSs and LMSs, they got their start in the early 1980s with the creation of Usenets and Bulletin Boards as areas for discussion of specific topics. Those technologies, like the Facebooks of today, interconnect people with like-minded ideas. Social Media platforms like Learning Management Systems were born from real-world scenarios of social interaction taken digital. Unlike LMS however, where the relationships supported are directed and small (between an instructor and his/her student), Social Media platforms focus on the support of the larger community, believing that ideas, updates, images, etc. should be shared widely, and not require one-on-one interaction. To complete the functional picture the Compilation content type, this tenant of social media is required.

Social Media platforms are primarily solutions developed to support two key types of user interaction:

1. **Direct communication** between individual users or specifically managed groups of users
2. **Broadcast communication** from an individual user to whomever might be listening

These types of interaction take the forms of direct asynchronous messing (email), direct synchronous messaging (chat), broadcasting of individual ideas (feed updates or tweets), or broadcasting of larger ideas (blogging).

While today much of the popularity of these tools relates to the recording and tracking of an individual's everyday life, the key strength in their ability to support extensive discussion and debate over specific individual topics remains the same as that contained in the original Usenets and Bulletin Boards.

The mechanisms for discussion in standard Social Media platforms are the foundation for our online communications, and while useful to Education in a communicative sense, are not particularly "revolutionary." However, recent advancements in key Social Media platforms can be viewed as being significant specifically in the capacity for discussions to grow *multi-dimensionally* (See Figure 1).

Discussions are no longer limited to a stream of comments going back and forth between a group of users, and no longer need to be comments at all. Current Social Media platforms support the integration of additional content into conversations and the spawning of additional layers of discussion from that content. By understanding this point, instructors/students can enable the growth of conversation around any specific topic to go well beyond a simple class discussion. Social Media platforms encourage the start of a class conversation, allow the students to break off into groups to discuss sub-topics, and then provide them with the ability to rejoin the class to present (and further discuss) the multiple outcomes.

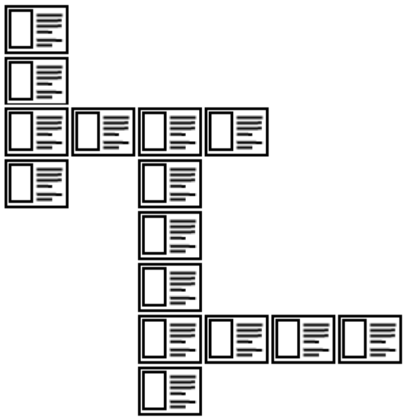

Figure 1 – Multi-Dimensional Conversation

The educational challenge with existing generic Social Media platforms is that without specific guidance, they are incapable of identifying the important elements of that conversation. Existing platforms typically base a discussion or a comment's relevance on how old it is or how popular it is to the entire group – an understandable method of automated management considering that not all information could or should be shown.

For its proper use in education, however, the rules of social media management must be different and they must be configured to support the possibility that an idea achieved many months ago may still be more valid than any idea recently identified. In order to support this idea, educated management must become the user's responsibility to identify the most relevant discussions and highlight them for future use.

5. INSTRUCTORS AS CONTENT CURATORS

Now that one has a sense of the different functionalities available through existing CMS, LMS, and Social Media platforms, it is important to realize that any system populated with information cannot by itself identify the correct subset of information that should be used to educate a class of students on any given topic.

The Internet, for example, with all its wealth of information and search algorithms, cannot manage exactly how a specific topic or idea should be presented. The instructors therefore are responsible for identifying the appropriate information, ordering the content, and providing the context for the information that they highlight and choose to present.

By effectively implementing the structured content and categorization model of a CMS, instructors can use this platform to identify and combine the content that they deem relevant to the topic.

With the appropriate solution and adequate resources, an instructor can identify key elements of content across the breadth of the Web and use these elements to create a Compilation for future consumption (See Figure 2).

Figure 2 – Creating a Content Compilation

The system supporting such an action would enable instructors to select pieces of content they desire and let them perform various actions to it like highlight a particular paragraph in a page of information or identify a 30-second segment of a 15-minute video. The system enabling content curation would keep track of these selections and present these related pieces together as the primary information source. Students would always have the ability to view the content items referenced in entirety. But the content curated by the instructor would continue to act as the key information vehicle. In this manner, the Compilation becomes an entirely new content artifact, helping explain a topic or an idea with further information that makes it greater than the sum of its parts.

6. DISTRIBUTING AND GRADING CONTENT COMPILATIONS

Considering the educational goal of this solution, the content Compilation created by the instructor can be distributed within the instructor-student workflow supported by the integrated LMS. As LMS solutions typically depend on grading methods being implemented for student response, assessments could be included as part of the compilation and a student's combined grades on those assessments could be used as the overall grade for the student on that assignment. Alternatively, a student's success on the assigned Compilation could be entirely dependent on their social interaction with the content itself and their collaboration with other students in the class about the curated content.

Ultimately, the LMS would be responsible for tracking a student's progress on the Compilation and providing the student with the ability to submit their progress for review by the instructor. Depending on the design of the application and the contents of the Compilation, grading methods would need to vary and in many cases would need to be subjective instead of automated. Using core LMS functionalities, rubrics could be introduced to the assignment of these content Compilations so that subjective grading could be standardized as much as possible across an instructor's course.

7. ENHANCING COMPILATIONS WITH SOCIAL MEDIA SOLUTIONS

As suggested above, the core features of a social media platform can be used to provide students and instructors with the ability to expand upon any content item in a multi-dimensional way. This feature can provide instructors with an effective method for tracking and grading student interaction on assigned Compilations. If alternative grading methods are not defined, an instructor could view this collaboration as being similar to class participation on a given topic. Students not only would have the ability to simply comment on any given idea, but also to contribute new content to the discussion, which could in turn kick off further discussion.

In addition to grading methods and unlike the standard LMS approach of a single request and response, the breadth of student contribution on specific Compilations could actually become part of the Compilation itself – enabling further learning. A Compilation of content curated by an instructor would no longer be limited to only what the instructor found and selected, but could be expanded to include the entire depth of student discussion held on the subject. This deeper Compilation of content could then be used as the original/base assignment for instructor's courses going forward.

8. TOOLS FOR CONTENT CURATION

CMS, LMS, and Social Media platforms provide the infrastructure, workflow, processing, and storage necessary to support content curation, but they do not provide the web-centric tools needed to properly select the desired content.

Bookmarking, highlighting, video cropping, audio cropping, and image tagging are all techniques that are becoming widely available against standard web content. These techniques provide the user with the ability to single-out specific pages, paragraphs, video/audio segments, or even elements of images for specific review further enhancing the user's experience with the content. The suggested content curation platform would provide users with the ability to perform all these actions through a centralized interface and use them to specifically identify parts of existing content that they wanted to curate into a Compilation.

The end goal is for the user to be able to access and integrate content from any source on the Web. Certain sources (especially multimedia sources) may be more highly favored than others as they would provide the necessary video, audio, or image formats that would be required to properly crop and tag information.

Once selected for use in a Compilation, the content itself would remain served from that original source. The CMS solution would simply be responsible for managing the structure and details of the content Compilation itself. The LMS would enable the assignment, consumption, submission, and grading of the content Compilation. The Social Media platform would manage all communication, comments, and collaboration that may occur on any Compilation or element of the content that it is made of. In this manner, each platform and tool implemented to support the individual action that it is known for, would when implemented together, supply an integrated experience which would allow instructors to build out significant foundations of knowledge and learning on the topics that are pertinent to them and their classes.

9. ADDITIONAL USES FOR THE CONTENT CURATION PROCESS

As an alternative, instead of distributing content Compilations to students for collaborative review, instructors could simply assign a topic to which each student would be responsible for developing their own content Compilation. This methodology would provide instructors with the capacity to assess a student's abilities to not only consume and contribute information on a specific topic, but also to use standard technological tools to find and highlight pertinent information across the Web.

10. EDUCATIONAL PUBLISHER CASE STUDY

In 2010, NorthPoint Solutions, LLC (NorthPoint) was engaged by a leading educational publisher to develop a system to deliver and enhance the usability of its "For Print" educational content. This content was already available in electronic form, but this feature did nothing to provide the reader with any additional functional capabilities. While additional media assets were offered as part of the existing solution, this material was not well integrated into the overall presentation of the publisher's material, and was not widely used by the instructors or students.

Through a collaborative effort, NorthPoint and the publisher developed a content distribution platform that supports not only the effective display of their published media, but the creation of new content by site users, the curation and assignment of site's content by instructors to students, and the full assessment of student activity based both on standard testing practices and subjective grading of the student collaboration.

The platform's original goal was to increase the level of standard online communication and interactivity between students and their instructors surrounding the publisher's editorial content, but eventually, reviews and class testing lead to the implementation of more advanced features that became part of the core system.

The platform supports both the creation and management of well-defined educational content types such as quizzes, homework, writing assignments, peer reviews, etc. and also more dynamically-defined content that enables the introduction of specific tools and functionality to the platform to meet individual educational discipline needs.

A key element of the platform is the ability for an individual instructor or student to add content to the system from any desired external source and use that information as part of a lesson plan, topic discussion, or assignment. The content added can be then shared during and after the course, commented on, and consumed by both the instructor and other students.

This new platform will be launched along with a specific set of the educational publisher's content in 2012 and will be the platform for the delivery of all their educational content going forward.

11. CONCLUSION

As instructors or students try to get their heads around the massive amount of digital information they are confronted with, they will look to a framework that provides them with the tools to easily curate that content into a more consumable idea or message. The act of curation around a specific topic or idea represents a valuable step in education, and can, in fact, be perceived as "content creation".

To this purpose, the building blocks from content management, learning management, and social media systems can be used to provide instructors with an educational "toolset" that enable this curation into content Compilations. Interaction on Compilations by both instructors and students can support greater learning and expansion of ideas – a process which has not yet been fully taken advantage of in today's marketplace.

The technology frameworks, used in conjunction with web-based tools, provide the ability for today's instructors to demonstrate expertise, gain visibility, and build thought leadership. The single content Compilation can provide instructors with new techniques for the collection and creation of information on educational topics – thereby making the aggregated content's overall value greater than its individual parts.

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Use of Micro Multimedia learning Objects (MMO[i]) in distant learning environment (First phase)

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ABSTRACT[ii]

The new, modern student is no longer content with passively listening to lectures. His ability to concentrate has decreased, while the use of communication devices, such as mobiles, tablets or laptops, has increased. Besides, this new student wants to participate and be active, in the same way he is accustomed to interact using social media.
He is eager to experience different forms of interactivity. Quizzes, forums, group projects. Offering him micro multimedia objects related to well-delimited knowledge elements, increases his commitment, his level of interest and, above all, his capacity to make connections with the practical world, as well as to transfer knowledge in the real work environment. This paper presents a micro multimedia objects experiment and offers a grid to help with their implementation.

This paper presents an overview of HES-SO e-learning center Cyberlearn's expertise on design, implementation and use of micro multimedia objects.

Keywords: Distant learning, Interactivity, Grid, Multimedia, Micro Knowledge Objects

MULTIMEDIA AS INTERACTING OBJECT

Pressing buttons to animate a virtual technical drawing, choosing objects and interacting with associated sequences, playing a video resource and understanding how a theoretical notion is used in the field: all these actions are based on the use of multimedia in learning and distance learning.

Because the technical aspect is fully grown, together with the advent of multimedia resources, simple to produce and to carry out, distance learning more frequently includes (especially in a blended learning model) small multimedia elements, such as videos, podcasts or interactive flash type animations. These resources, far from being mere playful toys, can illustrate a technical point, materialize abstract knowledge or allow students to integrate theoretical notions, applying them to situations close to reality. They are usually produced as a contribution to solving or illustrating a micro specific learning issue; they are simple to manipulate and allow interactions between student and resource.
We call these resources: Micro Multimedia learning Objects (MMO). This notion covers all types of multimedia content associated to knowledge which needs to be acquired.

The concept of multimedia was defined by various authors in the learning field. We selected Depover's [3] proposition: "all communication options (text, sound, still images, moving images, videos), closely integrated and whose overall consistency is provided by the computer system that manages these options."[1] This definition clearly highlights the complexity of multimedia, as well as its heterogeneity and proves that the object constitutes a computing system in itself.

However, the nature of multimedia has evolved since the decades between 1980 and 2000. The world of interactivity has significantly changed from a once comprehensive system (MOO[2], platforms, micro-worlds), heavy to implement, quite costly and complex to use.
Quick design, quick implementation, cost-effective, technically efficient, "modern" multimedia (since 2005) is characterized by its power, its effectiveness and the increasing number of devices on which it is able to run (computer,

[1] Free translation
[2] A **MOO** (*MUD, object oriented*) is a text-based online virtual reality system to which multiple users (players) are connected at the same time (source : http://en.wikipedia.org/wiki/MOO)

smartphones, mobile tablets etc.). All these features promote multimedia as a mass consumption pedagogical object.
As far as we know, one of the most interesting "modern" multimedia characteristics consists in being able to quickly and easily illustrate abstract or professional micro learning issues, using simple means but with a real high impact on knowledge acquisition.

We argue that by articulating an element of knowledge together with one or more MMO, this will contribute to improving the learning process and make it more efficient, rather than just using the MMO itself, as it is designed in MOO or Virtual Environments.

This will be verified in phase 2 of our study. We intend to lead a project which will investigate a large panel of learners to measure how they improve their skills when regularly using MMO, or not at all.

In phase 1, reported in this paper, we aimed at providing our professors with an operational grid to help them with the design of an efficient MMO and with implementing the best object for a specific issue they intend to address and solve.

Since 2005, as part of our activities in the e-learning center of our university, we have developed 47[3] small to medium sized MMOs. So far, we have worked empirically and intuitively, through a both technical and didactic approach.
Never have we assessed whether learners progressed more easily, better and more in-depth using this kind of MMO. Most of our MMOs were designed by professors, with our didactic and technical support. In this survey, we intended to validate our approach, and help professors with designing better objects faster. We organized our survey in a cascade sequence: from researcher to teacher to student.

We performed as follows:

- We carried out a comprehensive review of theoretical contributions about multimedia and learning;
- We designed a theoretical grid with guidelines to design and implement a MMO;
- We elaborated a questionnaire on MMO and sent it to two classes of students who had recently used a MMO;
- We improved our grid by integrating their comments and poll results;
- We operationalized our grid to make it concrete, practical and useful.

We have theoretically described conditions of an effective design and have worked on multimodal aspects and the construction of knowledge. We have worked on a model of interactive environment integrating Carter [10], [9], Kozma [4], Chomienne [2], Marton [9], Benazet and Réseau [12] contributions.

The results of the survey show that a majority of students are receptive to the playful interaction offered by the use of MMO; they like to interact with other students when using their MMO and are motivated by elements, such as playing against time, receiving funny feedbacks, challenging other students or comparing each other.
They also appreciate personalization and contextualization of knowledge and, as our university is an applied university, training professional, MMO should be concrete, realistic and practical.

Designing an effective grid

The grid is devised to integrate theoretical concepts, students' contributions, technical and pedagogical aspects (i.e. learning evaluation). Every theoretical concept has been translated to concrete questions, so as to help professors with the application of this grid. We tested our grid by evaluating an existing MMO and by designing a new one.

At each iteration step, we integrated our three sources (theory, technical aspects and students' feedback) in order to improve our grid.

THEORETICAL FRAMEWORK

Chomienne [2] covers different approaches to enable understanding of the true nature of multimedia. The author complements his works by mentioning which criteria can be used to judge the quality of a multimedia resource.
He points out that multimedia consists of three systems: text, icon and sound. When all three elements are well designed technically and pedagogically, they help with achieving a pertinent and efficient approach, as the three systems blend with each other.
He relies on the double encoding theory (Paivio [11]) which claims that memory storage capacities become more efficient when two encoding systems are called upon.
He also reports that collision between the multimedia systems and the representation systems used by the learner, positively contribute towards the process of knowledge anchoring.
He reminds us of the importance of the metaphor when developing a multimedia environment, which should guide the interactivity principles, the objects on which the learner will act upon.

[3] Some available here : http://cyberlearn.hes-so.ch/ecreation

Very often, interactivity is given limited scope when applied to multimedia objects. There are five intervention levels:

- The **perceptive** level activates the learner's senses. It deals with choice, number and organization of the physical aspects of messages (sound, image and text);
- The **transactional** level is concerned with examining how the system and the participant interact;
- The **cognitive** level concerns tools made available to the learner in order to facilitate his intellectual effort;
- The **pedagogical** level consists in choosing the nature of the object to be learned and how the learning process can take place;
- The **evaluative** level refers to the elements in the system which produce the model on which to base the learner's state, and then to propose appropriate activities.

Quality criteria are applied to each of these levels:

- **Clarity** enables the learner to immediately understand the messages he receives, whether they be in an audio, visual or written form; it also makes it possible to know if it is the system or the learner's turn to react; the user is informed of which items are being assessed and is given feedback;
- **Coherency** concerns the standardization the designer will apply to environmental elements at every intervention level;
- **Pertinence** ensures that targeted objectives are met. Analogies must make sure that the similarity between two different objects is well understood;
- **Redundancy** implies that data is repeated in various forms to take into account differences between learners;
- **Supervision** refers to the possibilities the user is offered to act upon the environment;

Marton [7] states that the use of multimedia systems in the educational field is very promising. Learners show interest and a high level of satisfaction in the use of such systems. The learning process is effective, time-saving (50 to 60%) and economical, according to Marton, Giardina and Duchastel (1987) [8]. However, the author points out that several drawbacks hamper these systems, namely because of the rapid change in technology, the few modules available, teachers' unawareness of the potential of such systems, or resistance to change from the people in charge of the educational system.

He believes it is necessary to study in more detail the relationship between the sophistication of the implementation and the planned pedagogical approach, the possible profit and also the development costs.

These writings and researches raise some questioning:

- Why was multimedia investigated when it appeared between 1995 and 2000, and no longer since? Is the subject exhausted? Did the undertaken research definitely close this topic?
- Why did the recent multimedia features (ease of design, widespread broadcasting on the internet…) not spur researchers' interest in this field?
- Could focusing on smaller learning multimedia objects be a starting point for operating a pushing effect on the learning process of abstract or concrete notions?

In this research paper, we aimed at replying to the last question and restricted our pondering to the use of multimedia in total or partial distance learning situations.

GRID AND SURVEY

We relied on the works by Rézeau [12] and Chomienne [2] to build a grid for guidelines on how to operationalize our hypothesis, which could also be used as a working tool by the people concerned. We proceeded in two steps. Firstly, we led a quantitative survey among a sample of students having used an MMO. Secondly, we polished the grid by integrating the remarks made by the students, as users of the systems. The objective was to make the grid for guidelines effective, in order for a professor to efficiently lead and follow up on a MMO production task.

1. Quantitative survey

For this reasearch, on which a larger scale survey will be led as of 2012, we investigated a sample of the global population.

Features :

✓ **Schools** :
  - Ingineering – Chemistry /Life science (Oenology)
  - Nursing

✓ **Number of students**:
  - 26 (Oenology)
  - 31 (Nursing)

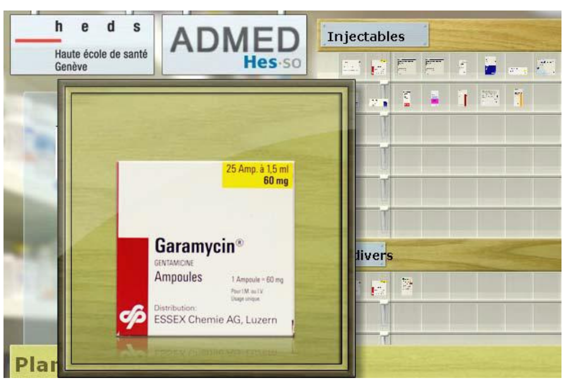
✓ **MMO type**:
  - Interactive

-**Œnology MMO** : Assembling/Dismantling wine cellar elements

The student drags and drops the items on the right hand side to assemble the device. A photo of each item was taken to correspond to a real world item. If the item is placed correctly, it will become stationary. If it is misplaced, the student can move it. The assembly task runs against the clock.

The pedagogical aim of this MMO consists in familiarizing the student with the machine and increasing his speed. Few such machines are available to students, so the MMO enables practicing the skills at home.

-**Nursing MMO**: Virtual medicine cabinet



Nursing students must calculate doses. These calculations, based on the rule of three, are simple to carry out. However, the students pout at them and when performed manually, they tend to make many errors, which can be potentially lethal for the patients. These errors are explained by the fact that, until today, these calculations were disconnected from real life and poles apart from students' gaming habits. This simulation enables them to accept or refuse a prescription, to choose the medicine, the injection method, to calculate the dose, to validate it, etc…

The survey comprised twelve questions aiming at obtaining the following information :

- The MMO usefulness;
- Use habits (home/class);
- Aims for its use (on a regular basis/before exams) ;
- MMO assessment (features pinpointed by the student);
- Favorite learning aids (paper, professor, exchanges among students etc.);
- Expected result of the transfer from the learning to the professional situation.

According to the majority of students, the tested MMO is;

- Useful
- Convenient
- A valuable course supplement
- Easy to use
- Enabling progress

We therefore deduced that the MMO reached its goal (supporting progress during the learning process), that it can truly be considered as a supplement to teaching material and methods (hybrid teaching).

A large number of students having replied to this survey, wish to use MMO more frequently, as they believe it can contribute in reinforcing their motivation and can help them be more efficient in their future professional practical tasks.

2. Grid

These small learning objects, easy to design, flexible, with a positive cognitive result and the outstanding acceptance by students, encouraged us in further developing such objects on an empirical basis.

However, we have noticed that if professors master the teaching material they decide to supplement with a multimedia item, and if they have a clear vision of the learning outcome they wish to reach, they rarely know how to transform knowledge into multimedia objects. They tend to focus on the technical aspects, dazzled by or reluctant to the possibilities offered, and often wish to design objects which are tremendously costly, lacking recognized pedagogical contribution; or on the contrary, they will get stuck when designing the scenario. Due to lack of technical knowhow or didactic imagination, they may experience difficulties at concretely adjusting the orientation of their projects.

Therefore, we decided to develop an operational grid aimed at helping them with asking the right questions for setting up the project, as well as to communicate with the technical team in charge of developing their creation.

This grid was designed based on empirically acquired experience. Its theoretical fundaments are as follows:

Authors	Theoretical concept	Items
Paivio	Double encoding sound, image, animated image Collision encoding representations/MMO	- Sound - Image - Animated image
Chomienne [2]	Intervention levels	**Levels** : - perceptive - transactional - cognitive - pedagogical - evaluative
Marton [9]	Semiotic communication	- Feedback Interface-Learner - Audio (sound, music) - Visual (images, still or animated) - Linguistic (oral or written words)
Rézeau[11]	Nodes	- Link with prior knowledge
Trocmé-Fabre [12]	Triple anchorage	- In the present - During the experiment - During a project

The grid is based around these notions and is completed by more and broader technical or pedagogical elements, namely when follow up and learning assessment are concerned.
Every theoretical notion was transformed into question items in order to enable assessment.

First iteration

The grid integrates the retained theoretical elements and transforms them into question items to make them operational.
We tested the theoretical grid for guidelines by assessing one of the MMOs : AD-MED the medicine cabinet described above. (cf Annexe III). We noticed that this grid is relatively operational to assess an existing MMO. However, it is not practical or concrete enough for non-specialists to design their MMO, let alone appraise their ideas when developing an MMO.
Moreover, some aspects necessary for preparing the MMO (narrative aspects, for instance) are not well integrated in this version of the grid for guidelines.

Second iteration

We adjusted the grid in the second iteration, based on the design of an interactive MMO. We imagined a new MMO about body language in communication. This MMO will have to deal with both knowledge acquisition and practical exercises.
It will be completed by an entrance quiz and a final quiz.

We polished the grid for guidelines in order to make this tool more accessible. Indeed, we feel that the first version of the grid better suits specialists in the educational field, and is difficult to implement for technical staff as well as for professors specialized in other fields, who might wish to design MMOs, via the e-creation call channel, for instance.

Adjustments
Based on the body language MMO example, we felt that the grid should be remodeled by integrated the following points:

a) Intentions
This section concerns the designer's first intentions. It will enable him to outline his project.

b) Didactic aspects
This section covers the relation between knowledge and MMO.

c) Pedagogical aspects
This section deals with how knowledge progress is conducted and measured.

d) Technical aspects
This section is concerned with the MMO's technical and ergonomic aspects. Students are accustomed (daily exposure to video games, web interface, mobiles, television, cinema, etc.) to using high quality graphic and ergonomic multimedia objects. Therefore, the MMOs, although of smaller technical scale, must nevertheless be designed very carefully graphically and ergonomically.

Third iteration

The second version of the grid was confronted to students' replies to the questionnaire and some items were integrated.
Two important items, highlighted by students, were integrated into the grid for guidelines.

- The playful aspect : students wish to be motivated by the proposed MMO. Their motivation depends on various factors (interest, ease of use, knowledge achievement, reward (grades), etc.). The playful aspect contributes in maintaining motivation. Several items are combined to provide the amusement and gaming approach: playing against the clock, scoring points, including funny and amusing feedback, challenging other users or comparing scores;
- The link with professional practice : students clearly highlighted the importance of personalization and contextualization of knowledge. HES studies aim at training students to become active professionals, it is, therefore, legitimate and useful to present the students with knowledge in a form which they know is useful in practice, by ensuring delivery of concrete, realistic and practical MMOs.

Ajustements

We have created a new category for the "narrative aspect " and added two questions to cover the fun, playful feature. With the help the questionnaire, we also verified whether the link with professional practice was outstanding enough.

Access to the grid : http://blog.cyberlearn.ch/

CONCLUSION

We now have an operational grid for guidelines. This grid, where a number of theoretical notions related to the educational multimedia issue are intertwined, offers a validated aid, which is not only based on theory, but is very operational, as we tested it on an existing MMO, as well as on a future MMO.

The effort put together so far unfolds in the form of a cascade sequence: from researcher to teacher to student.

However, the current grid version will have to be used by professors developing their own MMO, in order to check its usability. Indeed, we could not detach ourselves completely from actual years of experience in e-learning and multimedia. Neither were we able to neutralize our theoretical knowledge in educational sciences, nor our practical teaching experience on the field.

We, therefore, wish to have the grid tested by professors beginning in the creation of MMO, to verify if our position and realizations are coherent, not only from an intellectual point of view, but also to ensure that they are a truly useful aid.

At a time when new mobile devices are appearing on the educational market (Kindle, iPAD, etc.), allowing storage of thousands of books, articles, interconnected via the Web, playing animations, videos and easily and quickly sharing them, these become part of a societal movement that slowly affects the world of education.

We hope these observations will motivate education specialists and epistemologists to return to the work initiated in the 90s and think, analyze and verify the characteristics of new multimedia objects resulting from the emergence of new educational modalities.

This virtuous circle will generate new teaching and learning objects that will fit new students' expectations, needs and learning habits and sustain their appetence for interaction with knowledge.

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[i] Referred to in this document asMMO

[ii] In this text the masculine is used as a generic term

Individualising Media Practice Education Using a Feedback Loop and Instructional Videos Within an eLearning Environment.

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ABSTRACT

This paper explores the development and impact of the author's TELE (Technology Enhanced Learning Environment) action research project for individualising media practice education. The latest iteration of different classroom methodologies being employed to develop high-level skills in media production, the author has combined an interactive eLearning approach with instructional videos and, crucially, an individual feedback loop in order to widen access to the curriculum and create a more efficient teaching and learning environment. The focus therefore is on student engagement and organisational efficiencies as a result of the research.

It should be noted that there has been no funding attached to this work, nor are there any institutional imperatives or other stakeholder involvement in this research. This project has been undertaken by the author as an evolutionary development of the various methodologies, cognisant of the increased technology literacy of the student cohort. The educational benefit of bringing video instruction into the curriculum as part of the project is examined as a creative pedagogy of direct benefit to students rather than as a subliminal marketing tool that other systems are often used for.

The over 16K words of written data collected during the project is analysed both quantitatively and qualitatively with reference to the initial objectives of the research

Keywords: action research, feedback, eLearning, instructional video, creative pedagogy, technology enhanced learning, and student-centred teaching and learning

1. INTRODUCTION

Using material gathered from student feedback comments as well as empirical evidence from classroom support teachers and support tutors, the paper explore two aspects of the TELE concept. The primary focus is on the innovative use of feedback to individualise teaching and learning; the second aspect is to reinforce the use of video as an inclusive experience for a wide range of students and assess how it contributed to the individualisation of classroom teaching. Finally, the paper looks at how these innovations might have empowered students to become self-sufficient and reflective learners.

During the course of this research a range of manual and, more recently, digital technologies have been used in an attempt to generate interaction, deeper engagement and feedback from students. This paper concentrates primarily on the latest work using an eLearning system.

It is the use of the Moodle eLearning environment that has enabled the innovative use of an individual and inclusive feedback loop, which has in turn enabled evaluation of the impact of the technology implemented in workshops to be assessed and refined for the cohort of students engaged in the course. Instead of an end of course questionnaire evaluation, which has little if any relevance for students that have completed the course in question, the submission of feedback for every learning opportunity makes the process meaningful and relevant for the student actively participating in that learning. The standard summative questionnaire involves tick boxes and perhaps one sentence of comment, whereas the TELE methodology has elicited up to 1.5K of free text narrative per student, collected over 11 weeks, establishing a student-tutor discussion that can direct that student's learning, whilst the tutor has in depth comments that can be used for evaluating the effectiveness of the teaching and perhaps for wider quality assurance purposes.

2. OBJECTIVES

The research was motivated by a number of factors and objectives set by the author, influenced by and having reflected on the unsatisfactory nature of the standard end of module questionnaire. Without any detailed comments the plethora of tick boxes were of limited or no help in assessing the 'performance' of the teacher, the usefulness of the teaching materials, and the development of the student as a critically reflective learner. How could the gap between the teacher as a lecturer and the class as passive recipients of teaching be bridged? A number of observations defined the approach taken.

Within traditional curriculum design there is acknowledgement of the power of assessment in defining the outcomes of a learning opportunity. This *constructive alignment* [2] is effective as far as it goes. It does not, however, realistically allow full and inclusive assessment of all aspects of a course or module to be assessed, due to the range, number and amount of assessments having to be limited due to obvious logistical considerations.

There is no measure or recognition of prior or experiential learning by the student. How do we know how much our teaching has actively contributed to the learning outcome?

How also can we gain an understanding of what the student is seeking to learn from a course. It may simply be "enough to be able to pass" but there may be a less jaundiced view. How can we find out if students have more altruistic motivations?

Finally how can we as teachers engage students in deeper learning, encouraging them in critically reflecting on their learning? Is it possible to give them individual attention, to *individualise* their education.

Initially, therefore, the research sought to address the following broad objectives

1. How effective was the author as a teacher?
2. How effective were the materials that were being used?
3. How did the students respond and reflect on their learning?

These were tested using a number of interventions.

3. INTERVENTIONS

Intervention 1: Manual use of post-it notes.
The initial method for an intervention used anonymous post-it notes. These were used in order to gain an understanding of a student's existing knowledge and their expectation of a course. These were colour coded; RED to indicate existing knowledge of, for example, their use of Photoshop for image manipulation; and GREEN for what the student expected to learn from the course. YELLOW was also used at times during the course to get feedback on a process such as handing in work on a disc (at the time a surprisingly fraught issue for first year students in an unfamiliar IT setup) or to ask what the most difficult aspect of a class had been. The post-it notes were handed out in class, filled in at the appropriate time and then collected up in a ballot box as students left the class. The author could then read and reflect on the contents and report back to the class any points of interest or changes made as a result of those comments.

The author found this to be a successful and personally empowering process. It was extremely gratifying to know that the students did not know very much about the subject, were wanting to learn what you are planning to teach them, and that unbeknowns to you, they were not all struggling with difficult concepts.

This manual process was used effectively in gaining insight and feedback from students up until the university made the Moodle VLE available in October 2008. The introduction of this service opened up the possibility of a new digital approach, albeit without the anonymity offered by post-it notes.

Intervention 2: Introduction of the Moodle VLE.

The advent of an eLearning system was immediately recognised as having the potential to be a powerful alternative to post-it notes. The Moodle system offered an enticing range of features for engaging students in dialogue, such as Blogs, Forums, and Assignments.

The author's previous experience trialling a course message-board had not been successful, with little or no unprompted input from students. Thus an alternative approach was needed. The author found that Moodle's online assignment tool had the most potential due to its free-text format option. Therefore, within the course structure in Moodle, each week's workshop activities were uploaded, followed by a short 'assignment' soliciting feedback to the questions shown in figure 1 below.

Please comment briefly on the following:
1. What did you learn from this workshop?
2. What was the trickiest aspect of the workshop?
3. How could the workshop be improved?

Figure 1 Stage one feedback questions

This relatively simple and unsophisticated method of gaining feedback was then 'marked' by suitable comments from the author; it was not formally included as part of the assessment for the course. It did, however, serve the purpose of prompting the student to reflect on the workshops as a learning experience, establishing whether the materials and arrangements for the workshops were satisfactory, and allowing students to make suggestions for improving a course *whilst it was being taught to them*. There were, however, no significant changes suggested and so consequently none were made as a direct result of this feedback.

The author reflected on the first year course in particular and wanted to find a more effective way to empower students and make more efficient use of resources. Having gone digital in terms of the mode of delivering content, the approach to teaching and learning had to be also be moved out of an analogue mode of thinking.

Intervention 3: All change in 2010-11.

Having successfully introduced the Moodle VLE into teaching and learning in 2008-09 and bedded it down in 2009-10, the author decided to take it a step further in 2010-11. The first year class were chosen to be the guinea pigs for a deeper digital approach, reducing the amount of paper distributed and making greater use of online technologies.

For example, paper copies of workshop notes were to be reduced to one per workshop seat and therefore shared (workshops were repeated four or more times a week), whilst, controversially in the mind of the author, lecture notes and other handouts were to only be available online.

After the first week it was immediately made known that the new cohort of students had different expectations to their predecessors, particularly in terms of the type of materials used in workshops. Communicated using question 3 of the feedback mechanism, the message came through that learning from paper copies was not a suitable method for digital natives weaned on YouTube and online tutorials. The movement of materials onto Moodle had not gone far enough!

The most anguished comment, which was not expressed either in class or in any other environment, was that "Some people learn differently, when I was given the book to look through and follow, I wanted to cry. If I was given the option of watching a online tutorial (YouTube), this would be much better".

Another student commented "I think that if there was a demonstration it would have helped me learn this a lot faster", whilst a third observed that "I think the workshop could be improved by not only just giving us a handbook to work through but a practical demonstration at the beginning of the session".

Taking these and many other comments on board, the author set about creating weekly videos as support material for the weekly workshops. After implementing the video channel in week four, the feedback was questions were subsequently expanded from three to five as shown in figure 2, adding in an opportunity to comment on the lecture as well as that relating to the additional weekly video material.

Please comment briefly on the following:
1. How useful was this week's lecture?
2. Did you find the video helpful?
3. What did you learn from this workshop?
4. What was the trickiest aspect of the workshop?
5. How could the workshop be improved?

Figure 2 Stage two feedback questions

There was immediate and positive comment from individual students, such as "I was told there was a online tutorial, which helped a lot." Another commented, "It was easily understood thanks to the video", whilst a third remarked on their use of both the printed and video material, "I'm using the video as well as the booklet now, because I find it easier to understand". The empowering aspect of having a video to help reflect on the success of the workshop was another important factor, as noted in this feedback comment, "The video was useful, and gave a clearer outline of the end result instead of potentially making our way through the workshop, making a big mistake on it and being none the wiser".

The university's Student Support Service also found that the implementation of the video lessons was impacting positively on their students. A deaf student reported that, "The video is very, very helpful. It has a voice-over, which is not much use for me, but I can use the handbook with it as subtitles. The handbook on its own is very difficult to learn from, it is not clear enough", whilst the impact on a Dyslexic student was noted, "Working from the handbook was overwhelming her and sapping her confidence as there were 'too many words and it does it in a complicated way'. With the video she has regained her confidence finding 'learning the software this way is much easier'." The member of staff concerned also made the following unsolicited remark in an email "From the point of view of a support tutor I wish more lecturers would present information in such an inclusive and creative way."

4. DATA ANALYSIS

With the availability of the detailed and extensive comments form the Moodle feedback the original objectives can be revisited and the data analysed using both quantitative and qualitative methods

Quantitative analysis.
We can extract some raw statistics from the feedback data in terms of the amount written by the students, and how many sessions were commented upon, as shown in figure 3.

Moodle Feedback

# of students in project = 34
Number of words in feedback comments
12% 0 words = 4 students
26% 0-249 words = 9 students
20% 250 - 499 words = 7 students
15% 500 - 749 words = 5 students
12% 750 - 999 words = 4 students
15% Over 1K words = 5 students
TOTAL number of words = 16,040
TOTAL number of students making comments = 30
TOTAL number of sessions commented on = 204

Figure 3 Moodle feedback data analysis

This can be compared to the standard end of course questionnaire feedback for the same course, as shown in figure 4.

End of course questionnaire feedback

forms distributed = 34
completed forms = 22
TOTAL number of words written = 108
TOTAL number of students making comments = 8

Figure 4 Questionnaire feedback data analysis

From the data analysis shown in figure 3 and figure 4 it is clear that the continuous feedback loop set up in Moodle has very successfully engaged students in written feedback comments, despite that effort not being formally assessed or subject to any formal reward or, conversely, subject to sanction if not completed. To make the point even more starkly, the most words on the questionnaire was 25 words compared to a 1,564 words by one student submitted on Moodle.

It is not all about quantity, as any teacher will testify. Although 30 out of 34 students completed some form of feedback, and nearly half of them wrote at least 500 words, some of the most telling feedback came from those that wrote under 250, words in terms of making a clear point about their needs, whether it be requesting online videos, requesting personal copies of notes, on specifically coloured paper, when and where the video should shown, or how they used the video.

Qualitative analysis.

In the initial stages of the research the students were asked to reflect on what they had learned during a workshop, conceptualised by the author as a mechanism for immediate recall that would help embed that learning. They were also asked to recall the trickiest part of the workshop, in order to highlight any general problems that the author could respond to, and finally, include any comments or suggestions on how to improve the workshops (see figure 1 above).

In the extended feedback, shown in figure 2 above, students were also asked to comment on the lecture as well as the introduction of the video exemplar of the workshop on YouTube. It is fair to say that both of these additions were approached with some trepidation by the author as they opened up the prospect of unfavourable or personal comments on his 'performance' as a lecturer and as a video editor and voice-over artist. It was an act of faith that the students would not be unkind or worse! The submitted comments have been analysed as shown in figure 5.

What did you learn from this workshop?
177 comments = Instant recall (91%)
18 comments = Reflective comment (9%)

What was the trickiest aspect of the workshop?
153 comments = Note on aspect of process (86%)
24 comments = Reflection on process (14%)

How could the workshop be improved?
132 comments = No improvement (70%)
58 comments = Suggestions for improvement (30%)

How useful was this week's lecture?
21 comments = Useful (54%)
18 comments = Useful with reflective comment (46%)

Did you find the video helpful?
20 comments = Helpful (44%)
23 comments = Helpful with reflective comment (50%)
3 comments = Not helpful (6%)

Figure 5 Analysis of feedback comments

Analysis of objectives

In terms of meeting the objectives of the research we can see from the quantitative analysis that the project managed to engage students in meaningful feedback and comment on their learning over a sustained period. This activity delivered far more useful and meaningful data than the end of module questionnaire. We will now discuss the three main objectives using the previous analysis

1. How effective was the author as a teacher?

The author's teaching was favourably reviewed as shown by the 70% that felt that no improvement or changes were needed to the classes. The introduction of the videos was also favourably received with only 6% not finding them helpful, whilst no one commented that the lecture was not useful.

2. How effective were the materials that were used?

The feedback mechanism allowed students to suggest changes to the way materials were being presented, whether it be the arrangements for colour copies of workshop notes, loan copies of notes, the production of videos and so on. The 30% of comments requesting changes or making changes were by and large satisfied by the changes made. Others that related to group activities are more problematic and will require further thought, For example, it is unclear how a group discussion be organised following a workshop when the participants are all completing the task at their own pace and therefore finishing at different times. The logical method would either be a later seminar (for what purpose?) or an online discussion that may not be effective.

3. How did students respond and reflect on their learning?

The qualitative analysis shows that when asked to comment on what they had learned that 9% of the students offered a reflective comment that went beyond a simple listing of the content of the class. That figure rose to 14% when they were asked to comment on what had been the trickiest aspect of the class (aka 'the muddiest point'[1]), rising again to 30% when asked how the workshop could be improved. An additional two questions were added in towards the end of the project and therefore had fewer responses. Nevertheless, when asked about usefulness of the weekly lecture almost half of the students reflected on why the lecture was useful, almost all of these exercising their critical faculties to contextualise the content into the broader course or their own learning objectives. Finally, the videos that had been introduced as part of the action research as a direct result of student demand, not surprisingly elicited the highest percentage of positive reflective comments at 50% of those submitted.

5. CONCLUSIONS

The TELE action research project has proven invaluable for the author in establishing a closer rapport with the student cohort. It has empowered the author in his teaching and confirmed his confidence with the materials being used. It has also empowered the students by introducing them to reflective practice early on in their higher education course. It has kick started the author into producing videos for use in the classroom having been prompted to work through the qualitative issues involved in instructional video production as well as overcoming the fear of being actively part of a video production.

It is suggested that there are the following lessons to be learned from the Technology Enhanced Learning Environment used in this research:

1. Feedback should be a continuous process, acting as a kind of 'pedagogic glue' that binds a course together
2. Formative feedback can enable students to direct their teaching and reflect on their learning
3. Video is a transformational and inclusive tool in education, freeing the classroom for individualised teaching. Students can use the video to troubleshoot problems for themselves, freeing the teacher to answer deeper questions in one to one encounters. This can also create organisational efficiencies, as less support time is needed in the classroom to respond to technology related issues.
4. Technology can enable education practice to be 'flipped' [3]. Instead of classroom time being used in a "one size fits all" lecture, the lecture videos can be watched at any time allowing classroom time to be used in a far more effective and efficient way.
5. The focused and appropriate use of technology empowers students by allowing them to experience learning at their own pace and in their own time.

6. FURTHER RESEARCH

This research could be taken further to establish whether the methodology used is scalable, taking into account that the time taken to answer individual online feedback comments is not inconsiderable, let alone the time taken in any response or an initiative taken. A second question is what would be the impact of the student input being marked. Would it still be as extensive or would it conform to marking guidelines. Thirdly, could there be any scope for online peer group activities in this model? Finally, the profiles of the students could analysed and be correlated with the feedback data, as could the attainment of the students, to see if there were any insights to be gained from that analysis.

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WHAT IS CAMPUS MARKETS AND HOW IS IT GOING TO HELP IN IMPLEMENTING THE NEW CURRICULUM AT HAAGA-HELIA PORVOO CAMPUS?

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Figure 1: The Porvoo Campus logo, which also functions as the entrance to the Campus Markets system.

The purpose of this paper is to present the main idea of Campus Markets (working title), a system which at this point is under construction. The aim of the presentation is to create discussion and to generate new ideas, points of view and suggestions on how to further develop the system and its implementation.

1. What is Haaga-Helia Porvoo Campus?

Until January 2011 Haaga-Helia University of Applied Sciences Porvoo unit had operated its six BBA degree programmes in three different locations in the city of Porvoo, some 50 km east of Helsinki, Finland. The students in Porvoo study either business or tourism in three languages: Finnish, Swedish and English. There are approximately 1000 students and slightly less than 100 staff members in the HH Porvoo unit. Another UAS, Laurea, has a medical nursing faculty with some 300 students in Porvoo. All of these programmes and faculties moved under the same roof in the beginning of 2011, when the brand new Porvoo Campus opened for business.

Not only is the building new, it is also a rather different one in design for a university of this scale. In comparison with the old premises, the number of traditional classrooms for lecturing purposes has been reduced significantly (I must mention that apart from the library there weren't any other types of rooms in the old premises). New types of rooms were adopted: conference rooms, small rooms for team working, a lot more new technology and even a room with only a screen and a floor full of "fatboy" bean bags. One major improvement upon moving to the new Campus was that all students received a personal laptop computer, which they get to keep after they graduate.

2. What is the New Curriculum?

As soon as there were plans of building the new Porvoo Campus, the plans for the new curriculum were also launched. The main idea was that it wouldn't serve any purpose for us to move to a new location in order to do things in the way we always had done. The working practices also had to change. Many a teacher – and student – had felt for a long time that the traditional way of studying through series of courses comprised of series of lectures, in which the students are to absorb the knowledge presented by The Oracle in front of the class, had come to an end.

The new curriculum emphasizes learning instead of teaching. The focus is on the competences of the individual student, rather than subjects. All studies are in conjunction in projects which are run with internal or, preferably, external partners. The students learn real things by working with real companies, dealing with real money, people, tasks and challenges. The job of the teacher is to guide the students' learning in the process and to help them put their experiences in a larger context. Most of the work is done in relatively small teams. The credits are earned in modules, under the five main competence areas: communication, production of sales and services, social and collaboration, business and entrepreneurial skills, as well as operational environment. In addition, the students' professional growth within meta-competences (project management, R&D, coaching, creative problem solving and innovation) is also evaluated. The implementation of the meta-competences is assessed under all the main competence areas.

Unsurprisingly, the new curriculum very much dictated the design of the Porvoo Campus interior, since a house full of classrooms just wouldn't suit the school's purposes anymore.

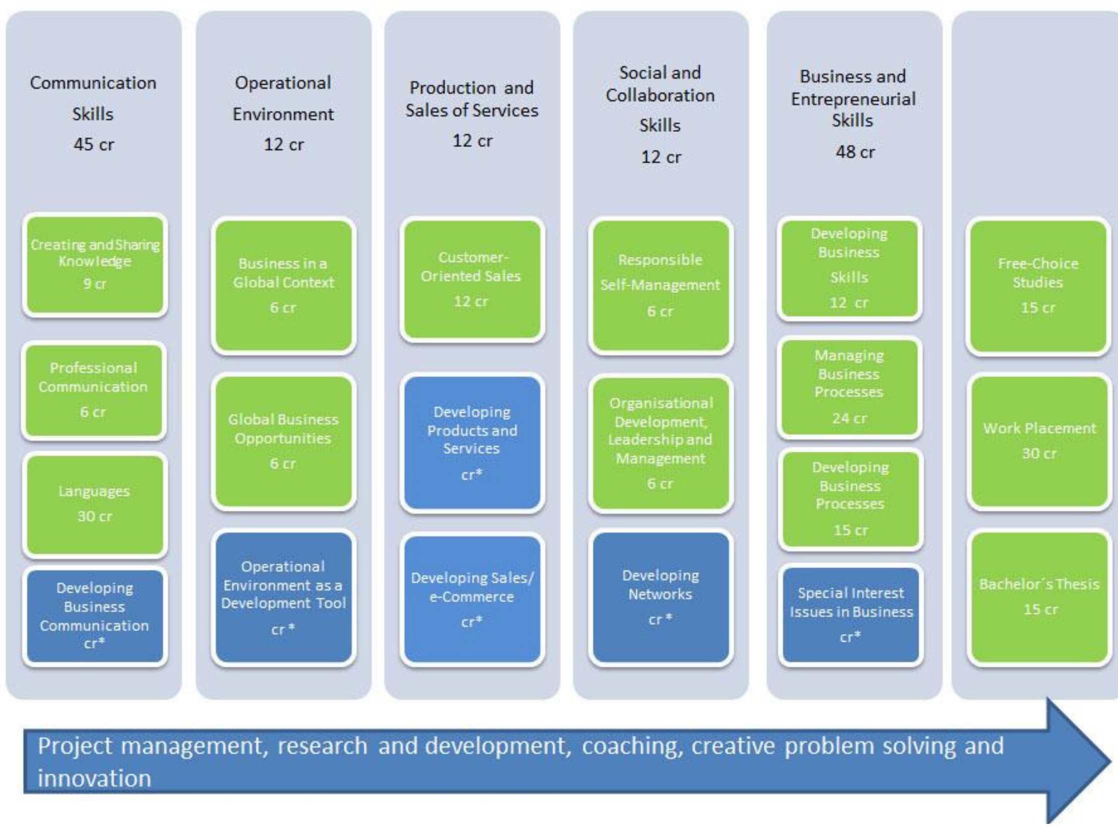

Figure 2: Study Modules in Degree Programme in International Business. (Blue stands for free-choice study modules)

The new curriculum has run for one academic year now. Although most degree programmes embraced it eventually, individual teachers and students have not been able to fully live up to the spirit of the curriculum. Among the issues causing trouble – apart from working in the new way in the old buildings for the first semester - were finding sufficiently large and suitably demanding projects for rather a large groups of first-year students. In many cases, probably out of fear of "things getting out of control" from a teacher's point of view, a group of some 30 students were given one – often internal event organizing – project to work on. This led to a lot of people not having much to do, which caused problems with student motivation. There were those who did a lot and those who didn't do anything, but all might have received good grades because of the good performance of the group as a whole.

It has been rather difficult for the students to create their own path and to really design their own competence portfolio, in which the development of the individual student is recorded by varied means. In the beginning everyone in a team may have received the same credits in the same modules, even if their tasks and actual development in the five competences were very different.

Students have often felt they were ordered to a project by the teachers, rather than actually applying for the ones they were most interested in – even if they were allowed the chance to give their opinion on occasions where emerging projects were presented.

Teachers have experienced difficulties in adjusting their work (lectures, reading circles, workshops, clinics, you name it) to the current needs of the students. It has also been hard, even impossible for many teachers to stand back from the project management role. Many have felt that in the end the external commissioners are holding the teachers responsible for the outcome of the project, which may have played a part in teachers taking a more active role in running the project. This is very much against the spirit of the curriculum, as we are supposed to guide the learning, not the work behind it. Also, if the teachers are the True Project Managers, it doesn't really give much ownership to the students nominally in charge of the case.

We also suffered many practical problems. How could the partners, students and teachers easily follow the progress of their project(s)? How could a student follow their development and visualize the competence portfolio, so that it all would actually make some sense? One of the biggest questions is where to announce new projects, how to inform about them to the students, and how to get a good team to work on the project? How could a student actually be able to choose or at least apply for a position in a project of their choice, instead of being placed into one by a teacher? Where to store all the data regarding the work in the projects, the learning outcomes, individual development, relationships with the external partners, etc., etc.? How to let the world – and ourselves – know, what kind of interesting projects we are engaged in with a wide variety of partners? How to best share and utilize the currently scattered knowledge, networks and information within the organization?

The answer is: Campus Markets.

3. What is Campus Markets?

Campus Markets is the working title of a web-based system, which is the place where partners can offer projects for the students to work with and allow everyone involved to follow the progress of their projects and their own profiles. Campus Markets is co-ordinated by Ms. Anu Sipilä and it is a part of VIDICO (Visible Digital Competence) Digital Campus project, which is an EU funded co-operation between a number of educational institutes and development companies. The project manager of VIDICO in Haaga-Helia is Ms. Kitte Marttinen.

Technically, Campus Markets is a database including information about available, running and completed projects, the students and their competence portfolios, the partner organizations, the Porvoo Campus staff and all the documentation regarding the projects. There will also be different communication tools, such as messages, e-mail and chat.

From a user perspective Campus Markets offers different doors for the students, staff, researchers, business partners to enter the database from a desired point of view. The doors are named Works (a list of projects), People (student and staff profiles), Partners (partner profiles), Stories (documentation) and possibly Communications.

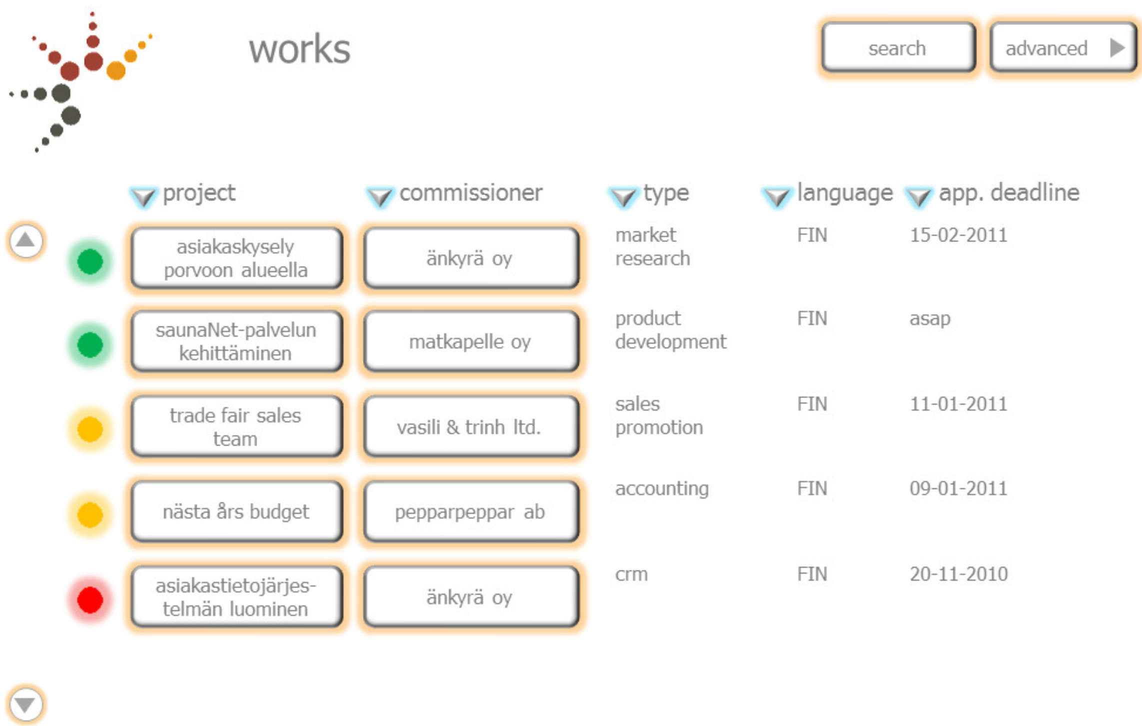

Figure 3: "Works" module: a list of available, running and closed projects.

At the time of writing this paper the system is on planning stage. The actual programming started in September 2011 and the pilot testing of the system will start in January 2012. A number of demos have been constructed so far, in order to give some idea, what Campus Markets is about. One main feature of the system is "facebook-y" links, which means that if, for instance, a student or a partner is mentioned on the front page of a project, there is also a link to their profiles. And vice versa, if a student's project is shown on her profile, the user can easily enter the project's front page from there.

3.1 What does Campus Markets mean to a student?

The students will be able to enter the Works module and apply for relevant positions in projects, which they find interesting. Once they are working on a project, they can access the project(s) in the same module, see whether there has happened anything new on it (such as new reports or other documents, new recruits, alarms for missing deadlines, etc.) and add new documents on it. The students can access their projects even after completion in the Works module. The opening list of projects is very simple, but it can be customized through filters and advanced functions. This principle applies to most parts of the system.

The students can follow their professional growth in their own profiles. The first view is the competence portfolio, which shows how much of each of the modules within the five competences are "filled". A more detailed list of how the competences have been acquired can be seen by clicking the modules. This should help the student to quickly see, what she needs to work on, where her main emphasis is and what kind of concrete actions lie behind her credits.

The communication tools give the opportunity to send messages to all parts involved in a project. The possibility to upload documents into the projects helps with sending reports, as a student only needs to put a file in one place, where all stakeholders can easily find it. No more e-mailing to a wide range of recipients with varied level of interest in the case.

3.2 What does Campus Markets mean to the staff?

The people working at Haaga-Helia should also have their own profiles. We teachers should also document our development. However, at this point the staff profile has not been given much attention, even if a well-tailored profile would help us a lot in organizing our work and keeping track of our haves and have-nots, let alone provide improved ways of keeping contact with the students and each other. Our current habit of running almost all (including group) discussions by e-mail has become outdated and unbearable.

Be there useful staff profiles or not, Campus Markets should help the staff to keep track of the projects, in which their students are involved. This is important because the number of projects will increase substantially. The system will make coaching and development discussions with the students easier, as teachers can view the profiles of their students.

Since teachers will very likely be heavily involved in finding new projects even in the future, the system will aid in finding out, which companies we have been dealing with before, what they and we have thought about the collaboration and whether we are currently working on something with them and whom we should contact, if we'd like to propose some sort of co-operation. This means that even Campus Markets will function as a type of CRM system for Porvoo Campus.

3.3 What does Campus Markets mean to partners?

Through their own profiles and access to their own projects the partner organizations can easily check the status of their projects by logging into the system. This should help with building trust between the companies and the school, as well as minimizing the amount of fruitless e-mailing and calling. The system will also provide a databank for the partners, so that they don't have to feel all the work and results vanish somewhere, without leading into any tangible results or analyses for long-term use.

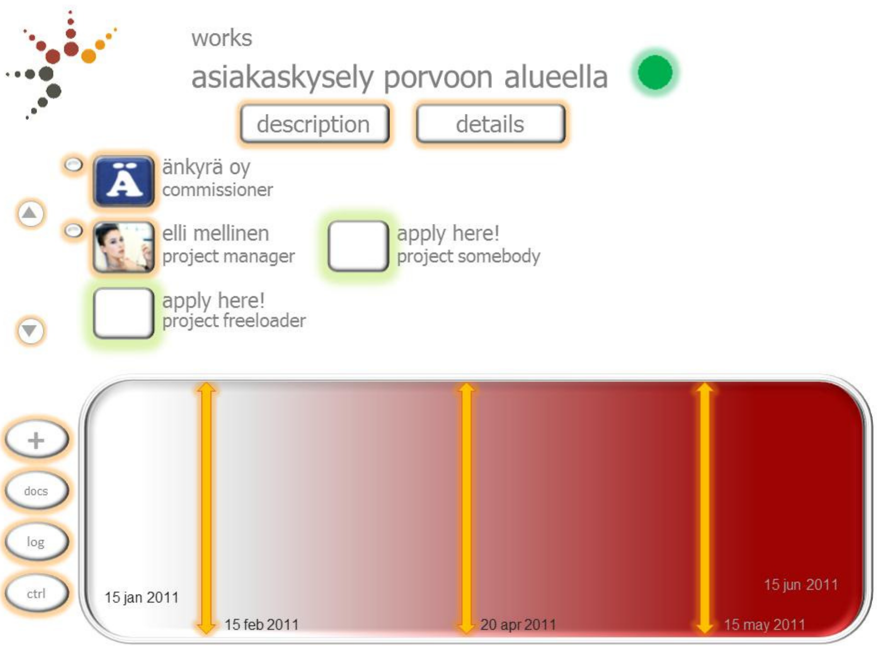

Figure 4: a project home page, this is where everything happens and where people can follow the development of the project.

As Campus Markets is designed to be a highly visual, easily accessed tool for implementing the Porvoo Campus curriculum, a written description of it can only go so far. I will prepare a demo version and/or a presentation, which will show in a very concrete manner, how the system is planned to work. If anyone attending the presentation has an idea for a better name for the system, I would be very pleased to hear it. As long as it is not some old Google-derivative.

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Knowledge Trading in Practice: Installing a Virtually Real Know-How Company

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ABSTRACT

Every person and almost every organization faces problems that cannot be solved by the know-how at hand. The traditional way of outsourcing these problems to a selected service provider risks a biased or just no solution, and comes with dependence on that particular provider. Hence, it is desirable to have a designated expert tackling the problem most effectively. We review the theoretical background of know-how trading via an online community. We present the implementation of such a platform based on the theoretical insights and show the impact on the performance of the platform of applying the various theoretical concepts. The reported implementation presents as a virtual company which aims at blurring the boundary between online and offline worlds by direct online user participation in the management of the corresponding offline company actually running the portal.

Keywords: Knowledge Application, Knowledge Management, Know-How Trading, Crowdsourcing, Knowledge Classification

1. INTRODUCTION

Outsourcing of problem solving is desirable in cases where the available expertise or resources are not sufficient to tackle the problem without help. With the global integration of more than one billion users by means of the internet, global aggregation of know-how becomes tractable so that expertise from every field can be made accessible to anyone through know-how trading portals. Since there are an overwhelming number of Internet forums where people offer their know-how voluntarily, and for free, gathering useful information for a specified problem is a tedious process and often requires understanding the respective language and methods in order to rate the available flood of information. From the viewpoint of a question poser, it is highly desirable to have some filtering mechanism that quickly creates a single, accurate and comprehensible answer [21]. Currently, such a filter can only be achieved by human resources, ideally orchestrated by a single point of contact. A global know-how trading portal not only offers a much wider search area for optimization, it also leads to much more satisfying solutions to choose from, compared to the problem-solving capability of a small group. Further, it can also provide interaction between different solvers to create solutions to much more complex problems than a single solver could answer [21].

The current contribution will consider the theoretical background and the implementation of a know-how trading platform. After a detailed presentation of the implementation, the efficiency of the core of the platform, the incentive mechanism, is investigated.

2. BASICS OF KNOW-HOW TRADING

The idea of designing a portal for know-how trading seems appealing and straightforward. People with a burning question but either limited time or limited expertise present their problem and several portal members offer their know-how to solve it. Interestingly, this simple situation brings about high complexity not apparent at first sight. Similar situations have been investigated in various fields such as sociology, business and technology under the rubrics crowdsourcing, user participation, open innovation and user-generated content.

Assessing Private Information

Besides the obvious benefits to pose problems to someone else with more time and/or a higher expertise, there is additional value in reaching out to a large group of humans to answer open questions: according to Von Hayek, every person possesses, due to his unique situation, particular knowledge, called private information, which might add value to the solution of a certain problem [24]. A know-how trading platform should make the relevant private information accessible to solution seekers. This implies either identifying the individual who has the appropriate private information, or gathering solutions from several solvers, offering private information. In the first case the search for the person might not be successful, leaving the seeker with no solution, or a sub-optimal solution, if the search for the person with relevant private information is not confined enough. In the latter case, either a fitering is necessary to review the different contributions to identify the relevant private information, or the seeker is presented with multiple solutions, perhaps too many to be useful, especially if he is under time pressure. The diversity of solutions is problematic for a seeker with low expertise who may not be able to differentiate between correct and false solutions. This issue can be solved by publishing all solution submissions to the entire solver group to enable a discussion among solvers combined with a ranking of solutions.

Prerequisites of Mass Innovation

The possibility that a large group of non-professionals can give better answers than a single expert or small group thereof is assumed to be dependent on several conditions. According to Howe, problems should be interesting and hard enough and solvers have to have some qualifications, including an understanding of the sometimes technical language used [8]. There must also be some method and habit of aggregating the diverse contributions, which may already be built into the process of problem solving, preserving the important parts of useful private information. Participants must be drawn from a pool large enough to guarantee a variety of approaches. In the best case, diversity and creativity are supported by the seeker or the environment. The community members must clearly understand the rules, including intellectual property considerations, when asking or answering questions. And there must be mechanisms in place to protect against gaming or sabotaging the system [18]. Strong feedback by other group members supports several of these prerequisites: it strengthens intrinsic motivations for content and contributions in general, lets members educate each other on rules and the culture of the platform, and controls the quality of contributions, similar to traditional peer review processes. Usually, only the quality of the contributed know-how is, and can be, judged. In general, both experimental and theoretical evidence indicates that mass innovation performs well on the basis of diversity of opinion, independence of opinion, an incentive for truthful reporting, and estimates of individuals being hampered only by imprecision and not by a systematic bias [10, 11, 15, 25].

Motivations and Incentives

Since users cannot be forced to contribute to a solution, as might be the case in a hierarchically structured organization, the operability and efficiency of a know-how trading platform is directly related to the motivation of its members to provide their know-how and time to solve problems. Thus a thorough consideration of possible incentives provides a view into the fundamental constituents of a portal. In the case of an internet portal, motivations to contribute to a larger project can be access to visibility, efficiency in use of time, efficiency of use of labor, to gain experience, to increase productivity, to multiply proficiencies, to overcome intellectual isolation, need for additional confirmation of evaluation of a problem or the need for stimulation or crossfertilization [16]. In a study of motives underlying contributions to Wikipedia, certain values were found to form the basis of the online encyclopedia: altruism, reciprocity, community, reputation and autonomy [12]. Each of those values is taken care of by the design of the Wiki system. Investigating a more related portal, the know-how trading platform Innocentive, the additional motivations to win money, and spare time were identified as having a positive effect on the quality of a solution in addition to intrinsic motivations [13].

Self-Organization of Communities

The often surprising emergent phenomena shown by self-organizing systems are subject to a large variety of frequently interdisciplinary scientific projects, ranging from pattern-forming chemical reactions to the collective behavior of life forms of all complexities. Interacting autonomous agents may add up to complex dynamics that are entirely unexpected. Owing to the fast development of communication technology, the Internet has introduced a radically broadened interaction network between humans as compared to the pre-Internet era, where interaction was mostly restricted to people knowing each other or being in geographical proximity. Peer-to-peer services like file sharing tools impressively demonstrate the impact the decentralized Internet has on private and public life as well as economy [23].

The form of collective action, and hence often the function, is usually encoded in generative behavioral rules. Such rules, being subject to natural selection, allow the generation of self-organized adaptive patterns at group level. As the costs and benefits to individuals may change dynamically, even as a function of the position of an individual relative to other group members, changes in single rules are likely to occur as group members attempt to maximize their individual fitness. This can result in groups adopting different shapes, or motions, as well as being a potential driving force for internal structuring within both human and animal groups according to studies from behavioral biology [3].

The goal in a distributed know-how trading platform is to maximize collective intelligence producing smart and useful answers to hard questions. Group intelligence characterizes the ability of a team to solve problems. Interestingly, investigations demonstrated recently, the ability of a group to solve a problem is not correlated with the individual IQs of the team members but mainly depends on average social sensitivity of group members, the equality in distribution of conversational turn-taking, and the proportion of females in the group [26].

Weaknesses of Large Groups

Care has to be taken that group discussions are not trapped in dead-ends such as ignoring new information for the sake of the established group opinion [9, 22], information cascades where group members perceive the group opinion as most rational [1], which are influenced by social considerations and not rational decisions [6]. Additionally, strategies of individuals differ dramatically from what would seem rational from the external view when group interactions are present to find a collective solution to a problem, which again will affect the individuals, e.g., by rewards [23]. As long as there is no trust in the entire community, each individual will only try to maximize his own benefit without aiming at a globally optimal solution, which is the goal of the solution seeker. But if the discussion members act in unbiased and cooperative ways, groups have shown to produce better solutions than individuals [2, 17].

In order to prevent these dead-ends, it is important to avoid group cohesion and group insulation or isolation, directive leadership, homogeneity of the social background and ideology of the members, high pressure, failures, communication difficulties and moral dilemmas. On the other hand, it is recommended to install norms requiring certain methodologies, have separate teams working on the same task, a culture to consider all available alternatives, a devil's advocate in every team, and active exchange with external experts. Additionally, each member should be encouraged to comment critically [9, 19].

Appraisal of the Community

As the members of a know-how trading portal are by no means legally bound to produce solutions, but often act purely voluntarily, great care has to be applied when designing such a community in order to provide a useful tool, especially for organizations outsourcing tasks. In particular, such tasks usually require a high level of quality and meeting a hard deadline. Therefore, organizations addressing such a portal have to change their way of thinking about service provision in contrast to traditional assignments. Members of successful crowds are deeply committed to their community, and will defend any attempt at exploitation [8]. The right social climate within the community is, therefore, an essential feature if a portal is to be productive and successful. Such a climate is very sensitive to many factors and thus difficult to achieve and maintain [20].

Intellectual Property

As the main purpose of a know-how trading platform is to transfer knowledge in the form of elaborate solutions to specific problems, a clear handling of intellectual property aspects of solutions is essential. Also, offering several degrees of disclosure best addresses the different types of problems that might reach the community. Issues could arise either directly between question poser and solver if, e.g., some solution is resold to a competitor of the seeker, or between the community members and the portal itself when it comes to the publication of contributions on the website. For the latter, a clear relationship of member to the portal is important.
In contrast to freely available know-how, scientific and technological knowledge is more and more restricted through the use of patents, copyrights, and other, more novel forms of intellectual property protection [4]. In the situation where an organization outsources problem solving to a know-how trading portal, the organization faces the risks that their knowledge will be published.

Sabotage

An interactive online portal always is at risk of sabotage by disappointed or snoopy users, e.g., Digg has been plagued by users trading their votes for money [8]. Malicious users may have a personal motivation, but also coordinated sabotaging in order to destroy the trust into the platform or the community, which may be driven by a competing business, is a severe danger for a know-how trading platform. In order to minimize the risk of sabotage, the community must not be able to act entirely freely, but, e.g., to be under the guidance of the portal owners [14].

3. KNOW-HOW TRADING PLATFORMS

There are a number of Internet portals that are dedicated to questions and solving them by its users. Some of the more important examples are listed in Fig. 1 classified according to the estimated financial outcome for question solvers and the amount of money a question poser has to offer.

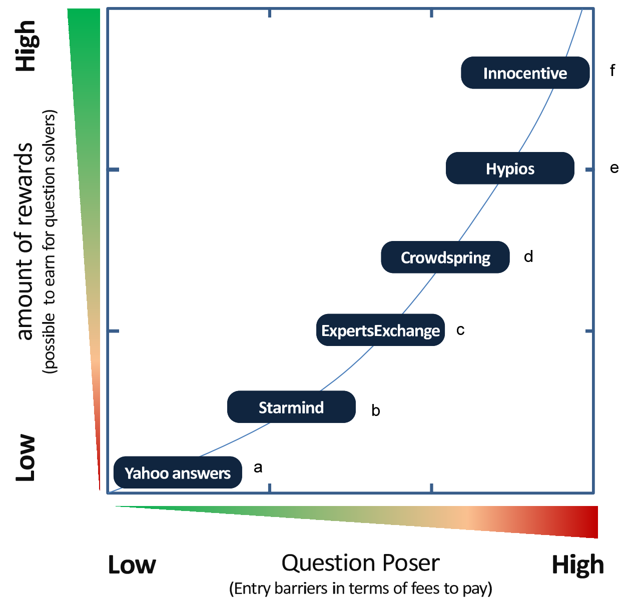

Figure 1: Comparison of different know-how exchange portals according to the amount of possible outcome for solvers in dependence of the necessary monetary input by question posers. Note the issue of high entry barriers and reward sums that question solvers could potentially earn. The lower the average reward is, the higher is the number of posted questions and hence solvers can also earn more money by answering more questions.

a Yahoo answers: is different from common know-how platforms. It is mainly a chat forum where questions are used as a starting point for discussion and socializing.

b Starmind: is currently working near the free and open model of Yahoo Answers, with the striking differences of a closed community with an influx of new members controlled by targeted invitation by members and the rather strict etiquette for answering questions mainly enforced by the solution mask. In the future, Starmind is not intended to rest at the level of low entrance barriers and low outcome. Rather, it is positioned in a region of low barriers according to free questions but high outcomes due to the possibility to add paid features to a question and to assign a certain reward for question solvers.

c ExpertsExchange: is a technology help website. Users are experienced technology experts from around the globe. It is mainly restricted to information technology questions. Members have to pay fees.

d Crowdspring: is one of the largest marketplaces in the world for crowdsourced creative services. Small businesses, start-ups or agencies can have their logo, website or graphics designed with Crowdspring. Revenues are generated by taking a 10-20% share, where minimum rewards start at US$ 200 per project.

e Hypios: is a French website operating since 2009. Revenue-sharing schemes as well as reward allocation schemes seem to be tested currently.

f Innocentive: is a pioneer in the field of *know-how on demand* and operating since 2001. Innocentive publishes problems associated with rewards from several thousands of dollars with a strong focus on research. Entry barriers for question posers are thus high, whereas the solution probability is about 50%, which might be good for hard scientific problems, but bad for quick everyday questions. Together with the complexity of their IP sharing schemes, taking part in the solver crowd requires expertise and time.

4. THE EXAMPLE OF STARMIND

We will now consider Starmind as an example of a know-how trading portal which implements many aspects reviewed in the theory section of our contribution. Starmind is constituted as an online platform and social web for trading know-how between individuals while actively locating talents around the globe to join the Starmind community. Starmind matches questions to qualified question solvers. Questions are posted combined with rewards. The Starmind Community transfers solutions and intellectual property to question posers. Question posers have several options to tune the appearance and visibility of their questions. In general, solutions are created for free, based on intrinsic motivation of community members. Often talents tackle posted problems since they are either highly familiar with the subject, have solved a similar question already or want to use Starmind as a platform to successfully present their individual know-how and therefore themselves. Both question posers and question solvers benefit while new solutions are created ceaselessly.

Starmind allows to outsource both challenging and also trivial problems to a community of question solvers located around the globe. The Starmind online portal unites graduates from the world's top universities, business professionals, talents and creative minds who are willing to share their know-how.

In order to become a member of the Starmind community, individuals have to receive an invitation key from a member, or be affiliated with one of the partners of Starmind, e.g., certain universities. The quality of solutions generated by Starmind is achieved by both selection and social control. Questions as well as solutions can only be posted by community members. There is no distinction between question posers and solvers, even though user activity shows that members usually show a tendency to either post questions or to solve questions of others.

To present the mechanisms incorporated in the design of Starmind, the following section will describe the particularities of question posing and solving, introduce the voting mechanism as well as the so called career model which defines the incentive system of Starmind that forms the basis for non-monetary reward within Starmind.

Posing a Question

For question posing, a user has to define a short title, which has to be a question and is displayed in the list view when browsing questions. The question body can be edited quite extensively. Finally, keywords have to be assigned to the question, which will ensure that the right experts will receive notification of the published question via email. Optionally, clear expectations for possible solutions can be given. The latter usually helps a lot to answer questions appropriately and eliminates misunderstandings and long clarifications in comments.

Generally, questions on Starmind can be classified as proper questions and task assignments. Starmind focuses on the former, which can easily be solved by an expert on that subject, while a small fraction of questions on Starmind are tasks. These tasks will require a significant amount of work even for experts, and are mostly posted as paid questions and in that context perceived as appropriate.

When the portal launched a new release in June 2010, each user was allowed to post three so-called *pioneer questions* for free. All other questions had to be assigned a certain financial reward the question poser will transfer to the authors of satisfying solutions. With the growth of Starmind which required a self-controlling mechanism within the Starmind community, the question mechanism was redesigned such that questions are free by default and solvers (as well as question posers) were rewarded with points for their internal career (see the section *Career Mode*) thereby providing several of the prerequisites of mass innovation as introduced above: a community culture based on certain common rules and the enforcement of quality by reciprocal rating.

Peer review

Questions of users below a defined experience level are first held in an *unverified* section and are only released into the expert pool of Starmind questions when three positive votes for that question have accumulated. In general, all questions and solutions are subject to an open peer review by other users. They have the opportunity to comment and/or to vote. This peer review helps to solve the information overload problem a question poser is faced when provided with multiple and differing solutions [21].

Solving a Question

Currently, each experienced user is able to post a solution to any question posed. Solutions can range from simple descriptions to illustrated and structured submissions with attachments. Some solutions are private, other solutions are publically visible and can be commented and voted upon by the community, thereby supporting the emergence of collective intelligence by self-organization. All solutions for one question are presented below the question body in the order of upvotes they received, except the particular solution that has been accepted as the final solution to the question by the solution seeker, which is always displayed immediately below the question body.

Voting Mechanism

Each user is able to express his favor or disfavor of a certain question or solution by assigning his up- or downvote for that particular item. Downvotes have proven to significantly improve quality [5, 7] and counteract sabotage. This process is essential for the evolution of the Starmind user base towards a crowd of very intelligent, versatile, precise people, who can express themselves clearly, which is essential for the success of such a know-how trading portal. The voting process is made as simple as possible. It is done via one mouse click. But not only the recipient gains (or loses) from being upvoted or downvoted; the person doing the peer review is affected as well. If he gives an upvote, he also gains career points. If he votes down, he loses career points. This mechanism is able to prevent abuse of the downvote functionality, e.g., for surpassing a competitor on the internal ranking or systematic maligning of another user. The sparse usage of downvotes proves the suitability of this method. Clearly, an important aspect when dealing with negative feedback is that even though it is a way to assure a high quality of contributions, it negatively affects intrinsic motivation. If the negative feedback becomes too frequent, users may be repelled.

Career System

Since the beginning of April 2011, Starmind has implemented a novel user classification system by assigning job statuses to the users that resemble jobs in a real-life company. With this approach, the Starmind portal, including all users, became a know-how company. The so called *career system* is based on the voting mechanisms above and the earning of career points by various activities, whereas upvotes, i.e., the positive reception to questions and solutions by the Starmind community have the greatest impact on the career of a user. By incorporating users directly into the physical company and thereby strengthening their commitment to the community, Starmind ranges between the online and offline world as a company offering both virtual and real-life affiliation for users.

Career points are assigned (in decreasing order) depending on received upvotes, acceptance of a solution, comments, upvoting of a solution, upvoting of questions. Points are subtracted for downvoting either a question or a solution and receiving a downvote, the latter being equivalent to loosing one upvote. This incentive model is able to introduce a very efficient self-organization process in the Starmind community, such that question posers as well as solvers are prudent and present original work of high quality and well written up, such that the community will like it. Additionally, the amount of work a user has to invest in his career ensures that every user who reaches higher levels has a good understanding of the functionality and the aims of Starmind and is able to produce high-quality solutions and questions. The latter makes these users eligible for very hard problems or challenging question posers. If a question is assigned a monetary reward, only users of high experience are allowed to post answers. Virtual jobs on Starmind range from a start as a *Trainee* via *Managers* who are involved in strategic decisions, to *Partners* who participate biannually in the revenues generated by a 10%-fee deduced from solved questions. Currently, a significant crowd of users is actively building their career towards higher managerial positions.

5. EFFICIENCY OF THE INCENTIVE MECHANISMS

The introduction of the career system into the Starmind community in April 2011 allows to assess its impact by direct comparison of global measures before and after the change in the incentive mechanism. Before April 2011, almost all questions on Starmind were paid questions. All questions were freely assigned a reward beginning from one, and later ten euros. The reward, together with the estimated effort influenced how many solutions were handed in, and how long their accomplishment took, with higher rewards producing more and faster responses. Only very large rewards in the range of several hundred euros received rather little and late responses, presumably because of the difficulty of the problem or the anticipated quality requirements of a solution.

In order to assure high-quality solutions, solvers were required to post a solution abstract based on which the question poser decides whether to open (and rate and pay) the solution or decline it immediately. In the event of a successful solution, the poser rated the solution in percent of satisfaction, which is directly used as the percentage of the assigned reward to be transferred to the solver.

Clearly, there was little interaction within the community, due to high degree of competition to post the best abstract and solution in order to be chosen versus other members. Such a lack of communication often led to poor quality responses, also because the question itself was not peer reviewed. Often misunderstandings became apparent only after a solution was posted. No self-organization among the community members took place, and therefore no mutual enhancement, in the sense of collective intelligence was possible to emerge.

After the introduction of the career mode, the number of (free) solutions shows the success of the new system. Not only is a poorly posed question rather quickly identified and edited by the question poser. The different solutions can be related to each other, potentially adding up to a better solution for the question poser compared to the former mechanism.

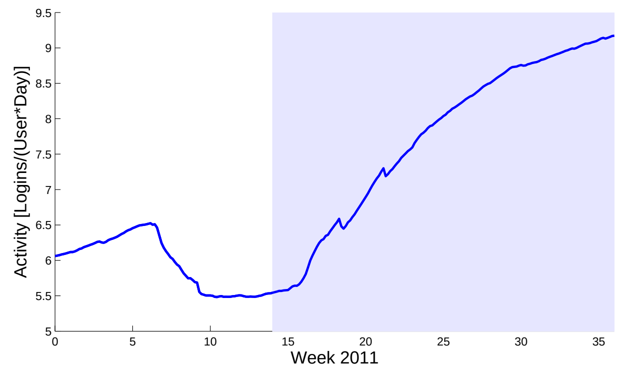

Figure 2: User activity, related to distinct logins per user per day before (white region) and after (shaded region) the introduction of the career system.

How the switch to the career system affects user activity is shown in Fig. 2. Since the introduction of job statuses and votes, activity is rising steadily. Several factors have contributed to the increased activation: the possibility to participate by voting, as well as curiosity about votes received but also the publication of solutions has made Starmind a portal to browse for interesting questions and related answers. In addition, the number of qualified comments to questions and solutions shows great interest in assuring quality within Starmind.

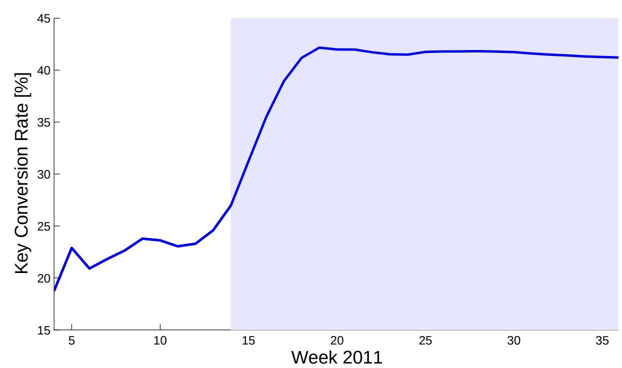

Figure 3: Conversion rate of invitation keys before (white region) and after (shaded region) the introduction of the career system in a sliding average of 5 weeks. Invitation keys can be generated by high-ranking users only while the conversion rate (=used keys) is an indicator of the perceived attractiveness of Starmind.

Another indication of the changes introduced by the career model, the conversion rate of invitation keys generated by Starmind users, over the critical period of introduction of the career system is shown in Fig. 3. The process of invitation and registration was left unchanged by the transition to career mode, thus the effect can be related directly to the impact of the new community mechanisms. Clearly, the career system, especially the start as Trainee is not perceived negatively, but rather a plus, as more people actively invited to Starmind register.

Considering the qualitative change within Starmind, discussions have grown and span from comments to multiple solutions, each adding value to the solution a question poser receives. The number of votes reflects active participation in quality control and community building by users, showing the positive impact of the incentive implementation chosen. The quantitative comparison of solution quality would be the ultimate measure to prove success, but designing such a measure is a very complex task and is beyond the scope of the present paper.

6. CONCLUSION

We have shown how to design a successful know-how trading platform taking into account a multitude of aspects that arise in a community aimed at producing value in the form of solutions to problems. We have reviewed findings from sociology, business and physics, i.e. self-organization, dynamics of groups and individual motivations to contribute to a community. We also pointed out common pitfalls of know-how trading communities. We then presented the approach used by Starmind as an example of a recent implementation of a virtual know-how company where all members are assigned job statuses together with concomitant privileges, in order to provide an ecosystem in which an agile and functional apparatus emerges. We showed the suitability of the career system reflected in the increase in user activity and attractiveness of joining the community.

Starmind is about to evolve into a community of experts with classification of their very diverse backgrounds and skills, so the right experts can be assigned to any problem posed to the portal. The high rewards, solvers can possibly gain, and the low barriers to question posing will attract more and more users to Starmind, differentiating Starmind from comparable platforms.

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Symbik - A New Medium for Collaborative Knowledge-Intensive Work

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ABSTRACT

Knowledge-intensive work in business practice is usually supported by rather static media where expressiveness and ease of content *consumption* are paid for by a high effort for content creation. In the area of highly interactive collaboration, however, physical media like whiteboards dominate because of the speed and ease of content *creation*. Regrettably, physical media come with a number of shortcomings, e.g., in terms of accommodating increases in complexity and scope.

Computer support can help to create a new medium that combines the directness and ease of use of physical media with the power of mass data processing. However, the current limitations of human computer interaction must be overcome in order to make such a medium viable.

The paper outlines a new interaction metaphor and its embodiment in a prototype, called Symbik, which represents a significant step towards a powerful medium for knowledge representation and creation.

INTRODUCTION

Knowledge creation and communication are vital for creative business work, like decision making, problem solving or planning. These activities often involve an interdependent process of switching between problem analysis (defining which items should be created or gathered from other sources) and solution synthesis (how these items ought to be linked, combined and prioritized). This process has been coined reflection-in-action [1].

External representations are crucial components for many of this kind of tasks – they are more than just memory aids or permanent archives [2].

The media that are used for these external representations highly depend on the granularity of information to be represented and the interactivity of communication. In highly interactive settings designers mentioned to struggle with current collaborative tools such as wikis or video conferencing [3].

Figure 1 gives an overview over the established media – and corresponding tools as they have been reflected in creative business work over the last fifteen years or so.

Elaborated content for remote consumption is usually stored in documents, wiki pages, spreadsheets. Illustrations are often created with high effort, using dedicated tools, and then embedded into the documents.

In presentations, such visual representations play an overwhelmingly important role in the form of slides. They allow us to grasp complex content quickly because our brains are able to translate spatial arrangements into meaning in a particularly efficient way. Hasher and Zacks demonstrated that spatial locations of objects are processed automatically [4]. Further experimental results demonstrate that a great deal of spatial information is available for retrieval without attention having been directed to it [5].

Still, the place of slide presentations in our media ecosystem is mostly unidirectional communication, where the time invested in the preparation of a visual presentation is a multiple of the audience´s consumption time. In Nonaka's SECI model [6], this is the *Externalization* interaction.

The most frequent and important interaction in knowledge-intensive work, however, is the direct discussion among people, contributing with their specific knowledge towards a combined view (the *Combination* interaction in the SECI model).

A typical example is collaborative problem solving, where physical presence and direct interaction are vital. Herring et al. observed that designers struggled to communicate design ideas when working together with team members in different locations. Collaborative tools such as wikis and video conferencing were immediately dismissed because designers' needs were ignored [3].

For this kind of communication, the usage of presentation software is much too cumbersome. The use of technology in group sessions is often considered harmful since using

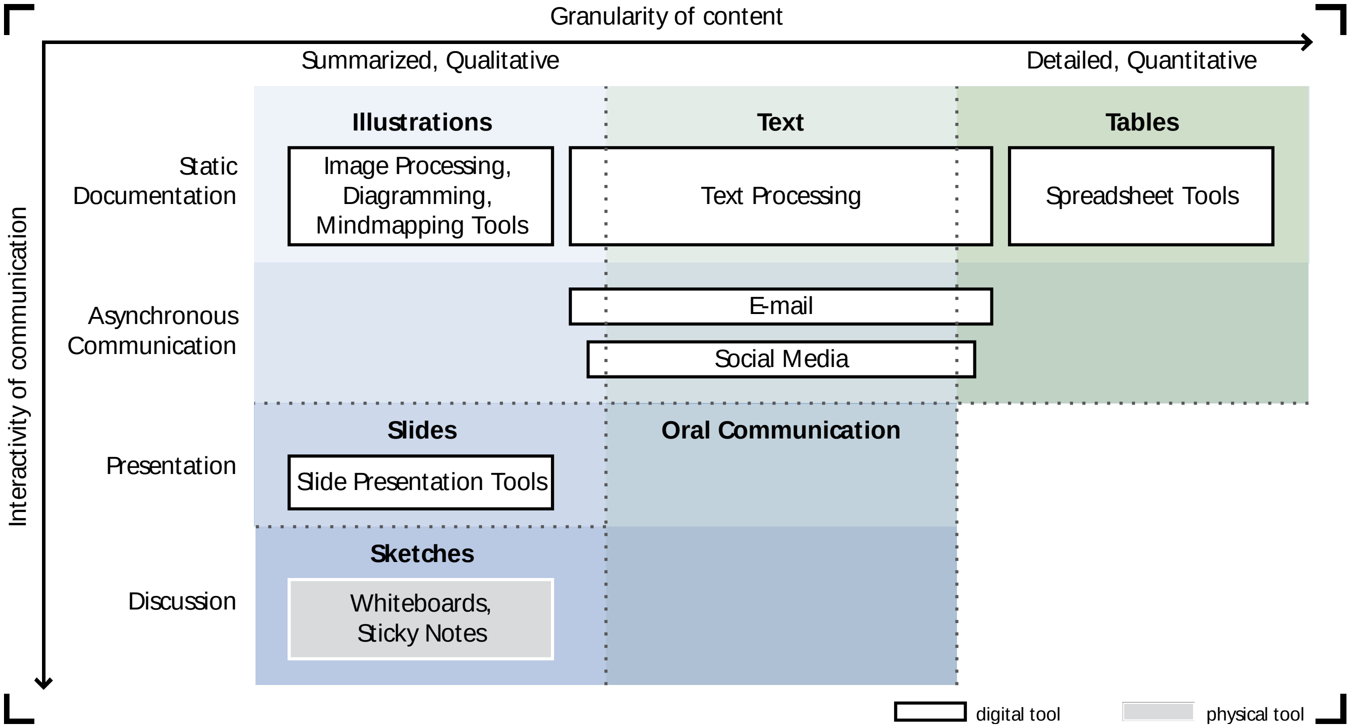

Figure 1: Commonly used media and associated tools by granularity of content and degree of interactivity of the communication

desktop-based digital tools tends to isolate participants, leading to a breakdown of communication that is vital for a shared understanding of discussed work in the group [7].

In rare cases, mind mapping software is used, but this niche is almost exclusively occupied by physical tools like whiteboards or flipcharts and sticky notes. Due to limitations of time and drawing space, the content produced in these media is rather qualitative and simplified.

ASSESSMENT OF THE STATUS QUO

A glance at Figure 1 should make us aware of the following:

1. The domain of knowledge representations used in practice is rather strictly segmented into different media and corresponding tools. Although some of the media can be embedded into others, the media breaks are a major source of concern in collaborative knowledge-intensive work. Bergman et al. studied the problem that users lost track of their project documents and relations across the various tools and called this “project fragmentation” [8].
2. For the whole area of highly interactive collaboration, no suitable digital media exist for business practice.
3. The triangular structure of this chart hints at a trade-off situation between the level of detail that can be handled and the interactivity of the communication.

These points partly result from hardware limitations of the past – with keyboard and mouse as the predominant input devices – and partly from the mental concept of unidirectional communication that shaped the design of tools, with a clear separation between content creation and consumption.

But in the highly interactive scenarios of discussion and problem solving, every participant is a *prosumer*, i.e., at the same time a producer and a consumer. Content is created, discussed, modified, and erased within minutes or even seconds.

The white space in the lower right corner of Figure 1 indicates the lack of a suitable medium for the immediate and natural interaction with large amounts of fine-grained information that supports the prosumer role. Since visualization space and time are scarce in these highly interactive situations, such a medium cannot statically expose the full complexity to the humans. The most efficient way of conveying complex information is to use tangible models and real-time simulations: Instead of just pushing information to the consumer, they rather answer questions by their dynamic behavior.

Thus the missing medium needs to be interactive like a tangible model and at the same time moldable like clay. If the user is able to create interactive models with the speed and ease of drawing sketches on a whiteboard, the separation between creation and consumption can be left behind. Thus the medium rather augments the human capability to directly communicate instead of being just a static means for information representation.

Only computer support can enable us to interact with large amounts of fine-grained information in real-time. While the creation of such a medium has become possible with today’s hardware, the big obstacle here is the lack of suitable human-computer-interaction.

QUALITIES OF THE SYMBIOSIS INTERACTION METAPHOR

The ideal situation for working on creative tasks would be a symbiosis between computer and human, where the specific strengths of both perfectly blend together. The fundamental difference between computers and humans was pointed out by Frieder Naake: "Humans Create, Occasionally. Computers Operate, Always." [9]. In industrial practice, human-computer interaction is still dominated by the machine's limitations.

Several issues in user experience can be solved by adhering to the large number of different design principles and usability heuristics from the HCI literature [10], [11], [12], [13]: Affordance, reducing cognitive overload, low physical effort, learnability, user satisfaction, flexibility in use, responsiveness and feedback, and error tolerance.

However, creating an entirely new medium with the characteristics outlined above requires a distinctly different user experience: If the tool itself is disembodied as much as possible, the user only perceives, and interacts with, the content. We found that this kind of experience can be achieved with the following qualities:

Immediateness of Interaction

Using a combination of touch screens with gesture recognition and handwriting and/or voice recognition instead of keyboard and mouse, a much more natural interaction style can be achieved. Compared to clicking through menus with tiny control areas, gesture input is much faster and requires less precision. Some approaches are using data mining to distinguish between text and shapes in hand-drawn diagrams [14] as well as for recognizing strokes [15]. An immediate and fluid response of the system to any input creates a closed "tangible" feedback loop that allows users to interact as naturally as with physical objects.

Freedom and Open-endedness

A characteristic of human thinking is that it can start out in a rather hazy way and crystallize into a more structured form later. The structure of the result or solution, and often even the structure of the problem itself emerge only in the course of detailing, structuring and evaluating the initially vague concepts.

Therefore, the medium should allow the user to capture, visualize and manipulate content without restrictions in layout, format or data model. Insights regarding how the spatial layout of information supports visual information gathering tasks were gained testing the prototype BrainDump. The results show that users especially like the fast way to visually change relations and associations between information [16].

Continuity

The medium allows a smooth flow of creation, arrangement, navigation, and exploration, without technically imposed media breaks and interruptions. This implies a seamless integration and transition of information at various levels of structure, including heterogeneous information types, such as free text and sketches or web and database contents. Also, the user can deliberately combine contents of different types. A stable work environment across multiple sessions facilitates the re-immersion into the work context.

Immersive Work Environment

The boundary between user and system should be as seamless as possible to give users the feeling of being the active part in a powerful environment that is tailored to their needs. Such a work environment needs to have an intuitive visual appeal and make all needed functionality available in a natural and consistent way.

Support for Multiple Angles of View

Allowing subjectivity and considering the same content from a multitude of different viewpoints is an essential part of creative work. Involved people need to be enabled to concurrently inspect the current state of their work from individual perspectives. This includes the ability to create multiple context-specific variations of the visualization and data representation of a common concept and to keep track of these contextual changes.

SYMBIK – A PROTOTYPE OF A NEW INTERACTION MEDIUM

The key principles listed above were implemented in a prototype code-named "Mother of All Whiteboards" [17]. The refined prototype is now called *Symbik* as a reference to the symbiosis metaphor according to the qualities and requirements as described above; it will be formatively evaluated during a consulting project. Symbik is meant to be used for creating and maintaining highly expressive models of project-relevant knowledge, both during customer workshops and in the subsequent project execution phase.

Although technically a tool, the Symbik is rather an interactive medium since it has no permanent controls or menus. It presents itself as a plain interactive surface, realizing the symbiotic qualities by means of the following concrete capabilities:

Immediate Feedback

The Symbik has been designed for extreme performance, so that any user interaction results in immediate and smooth reaction. This allows all transitions to be performed in a continuous, animated manner, even if it is the zooming into, or the rearrangement of, sets of several thousand objects. For example, the following frame rates for zooming have been measured on a business notebook: 20 FPS with 8800 objects on the screen, 13 FPS with 17600 objects and 9 FPS with 26400 objects. This smoothness is an essential factor for achieving the quality of *continuity* as mentioned above.

Gesture Control

Gestures can be executed very fast and at the same time have a high expressiveness. This makes them ideal for performing frequent tasks in a way that is natural to a human. In the Symbik , lines and shapes are drawn directly on the screen and then interpreted as new objects, associations or commands depending on their geometry.

Deep Zooming and Free Spatial Positioning

Two-dimensional positioning of objects is an effective approach for reflection in the early phases of a design task. It helps the user to keep track of the task status without detracting from the task itself [18].

Creative freedom and continuity are provided by the ability to use an infinite layout area combined with a zoomable user interface (ZUI) technique. ZUIs aim at solving the problem of more information existing in a system than fits on the screen by enabling panning and zooming operations. Pad was the first system to explore this idea [19].

Bederson defines ZUIs as "systems that support the spatial organization of and navigation among multiple documents or visual objects [20]." The abundance of space allows the human to jot down thoughts as they come: preliminary, unfinished, from multiple angles of view. Not only can the user use this unlimited work area as a canvas to lay out content, he or she can even mix content and tools deliberately in an arrangement that perfectly matches the needs of his or her current activity and work style.

Semi-structured Information Representation and Processing

A key requirement as mentioned above is the transition from a hazy collection of thoughts to structured information that is used as input for subsequent tangible actions. Therefore, the Symbik maintains both a visual and a semantic model of the content and ensures that both are consistent. Every closed shape that is generated corresponds to a meaningful object that can have associations and attributes. The spatial arrangement of objects is automatically translated into meaning in the data model. New types of objects, associations and attributes can be created on the fly by just defining them ad hoc. What feels like tagging to the user in fact generates a data structure that can be leveraged for powerful mass operations on objects such as grouping and filtering.

Lightweight Semantics

When subsequently making concepts more concrete, human and computer "speak the same language", i.e., the computer is able to adopt the human's terminology instead of imposing a predefined set of terms and concepts on the user. The use of taxonomies gives the software a grasp of the meaning of content, thus enabling powerful processing mechanisms. E.g., a box drawn on the screen represents a generic *topic* at the beginning. Later, the meaning of the box can be concretized by tagging it with a more specific type, e.g., *decision* or *issue*. Technically, this content is represented in the Active Information Store data model which is similar to RDF [17].

Content Integration

In order to connect user-created content with existing content from arbitrary sources, the impact of system boundaries is removed by a content integration layer so that all content may be exposed if needed and can be processed in a uniform way. This refers both to the technical integration which enables the access to content across system boundaries and to the semantic integration which allows to use a unified set of terms to describe similar content and attribute types.

Particle Dynamics

An efficient way to visualize the properties of large amounts of concepts or entities is by spatially arranging them in a meaningful way, e.g., on a geographic map, on charts or even in a tag cloud. Thousands of entities can be visualized at once if they are scaled down to the size of particles. So a set of entities becomes a particle cloud that can be reshaped according to user-defined structuring criteria in fractions of seconds. By zooming in, the individual properties of the objects can be inspected at any time. This functionality is key to enabling the real-time communication of very detailed and complex data.

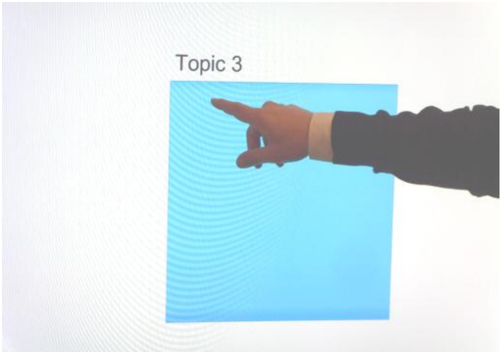

Figure 2: Drawing shapes with the Symbik (left), results in visual representation of the drawn outline connected to a respective data model (right).

WORKING WITH THE SYMBIK

In a hypothetical example, a company producing high-end kitchen equipment, which has invested massively in the development of nanoparticle-based coatings for their products, becomes aware of government plans to regulate the usage of nanoparticles.

In a small group brainstorming session the impact and possible reactions are discussed. At first, points of concern are collected and drawn on the Symbik as freehand rectangles (Figure 2). Each rectangle gets a heading, e.g., Impact on Products, Impact on Production, Task Force, PR Campaign, or Alternative Materials.

In the following discussion it becomes clear that most of the topics obtain the character of a task. So an ellipse is drawn and annotated with “Type: Task”. The topics that are consequently dragged into the ellipse are changed into tasks and immediately change shape and color accordingly. *Task Force* is changed from *topic* to *team* by editing the *type* annotation in its property sheet.

To carry out these tasks, different subject matter experts should get involved. By annotating a circle with “Type: Employee” and performing a query gesture, icons for all employees are rendered in the circle. A context menu allows dynamically arranging these five hundred icons in subsets according to different criteria, like location or department in a pie chart layout (Figure 3).

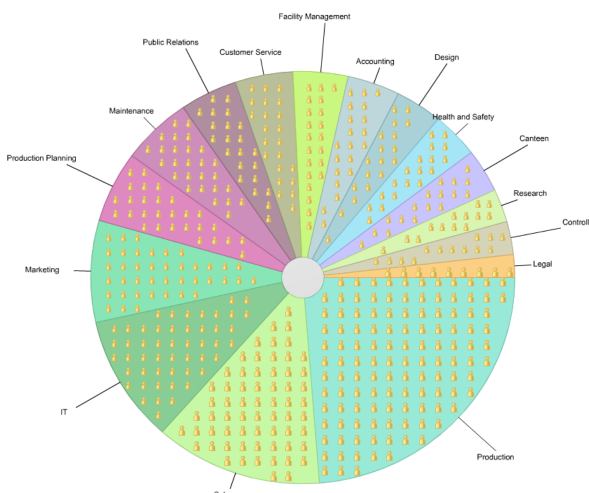

Figure 3: Arrangement in Subsets Mimicking a Pie Chart

Employees who qualify as task force members are picked from these subsets and are either dragged into the *Task Force* rectangle or associated with it by drawing a freehand line. In either case, the association of the person with the team is also maintained correspondingly in the underlying data model.

In the same way, the tasks are assigned to employees. Associating multiple tasks to the same person is facilitated by drawing first an ellipse around them and then a line between the ellipse and the employee (Figure 4). Annotations of ellipses are also used to maintain attributes like priority or effort for multiple tasks.

In the course of the discussion, the content on the Symbik is further structured: An action plan with several steps is drawn and copies of the different tasks are dragged into the corresponding steps. Cloning visual objects in order to create different views on the same content is a particularly important feature.

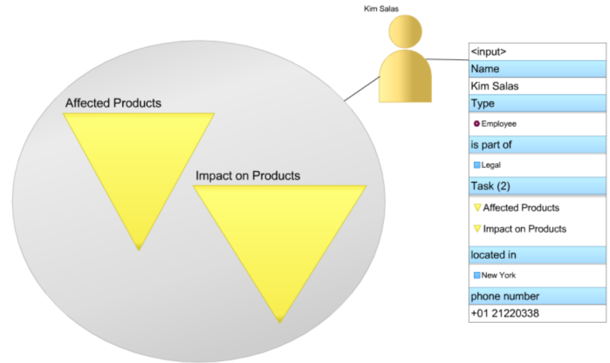

Figure 4: Set of items associated to a person and reflection of the associations in the person’s property sheet.

The infinite zooming and automatic downscaling of objects when dragged into each other allows creating very detailed hierarchical views. The gesture-controlled mass operations for creating, copying and rearranging visual content make it viable that every participant can create his/her own view on the topics in the course of the meeting, e.g., organizational, technical, or financial.

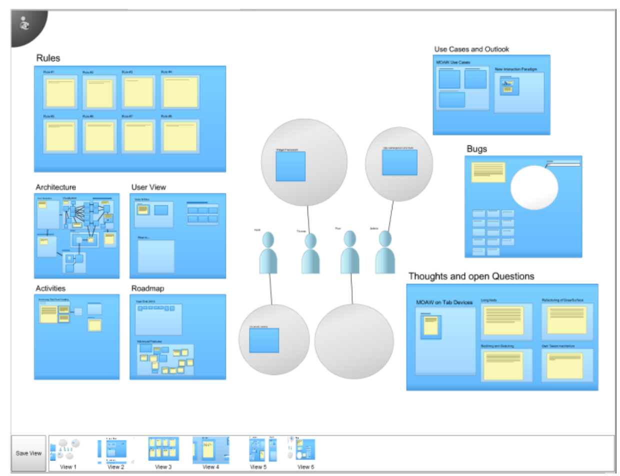

Figure 5: A large-screen capture of the content of a Symbik after several weeks of work.

All these views share one consistent data model. So it is possible to look from the different participants’ perspectives at a specific object by having the camera travel along the corresponding visual occurrences.

At the end of the meeting, specific views can be exported as an HTML document or spreadsheet table and attached to the meeting minutes. It is also possible to continue maintaining the content throughout the whole project or activity in order to keep track of the many different aspects. As an example, Figure 5 depicts a high-level view of a project documentation after several weeks.

USER FEEDBACK AND OUTLOOK

Informal feedback sessions revealed that users immediately liked the interactivity and versatility of the Symbik. Still, the strong focus on gesture control initially imposed some hurdles: People needed to learn how to interact with this genuinely novel kind of an interactive medium. Therefore it is planned to offer more common interaction techniques and controls, e.g., the embedding of widgets like tables or specific forms, which underscore the aspired symbiotic interaction qualities.

Another consideration relates to accommodating the diverse constellations in which users find themselves, with respect to situational task characteristics and equipment, e.g., the use of tablets or large touchscreens. Therefore, dedicated versions of Symbik which entail suitable HCI techniques may be needed.

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Development of computer software simulation for training CT technologists in the performance of CT Colonography (CTC)

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Abstract

A software tool was developed to train technologists on how to perform CT colonography (CTC) procedures. A prototype was developed and tested to obtain feedback via a formative evaluation process. Initial assessment and required data for designing the software were gathered through multiple sources (questionnaire, literature, interviews and observation). A simulator that emulates the CT scanner control console, table and CO_2 insufflator was developed using Adobe Captivate©. The simulator was evaluated by 2 technologists experienced in the performance of CTC who completed all scenarios of the simulation via navigating through the software and provided detailed direct verbal feedback and then completed feedback questionnaire asking about the "ease of use" of the software as well as the "content". The results of formative evaluation showed that the simulator software was promising and efficient as a training tool. Based on this experience, a more detailed interactive CT console and CO_2 insufflator user interface was developed using National Instruments LAbVIEW® programming language. **Conclusion:** Training of CT technologists in the performance of CTC currently done by cumbersome and time-consuming radiologist-technologist interaction with a large number of patients over a prolonged period of time can be supplanted by a computer software simulation training program.

Keywords: Colorectal cancer (CRC), CT Colonography (CTC), Virtual colonoscopy, Technologists, Simulation, Training

Introduction

Colorectal cancer (CRC) is the third most commonly diagnosed cancer in males and the second in females. Over 1.2 million new cancer cases and 608,700 deaths are estimated to have occurred in 2008[1]**.** In terms of geographic distribution, Australia and New Zealand, Europe, and North America have the highest incidence, whereas the lowest rates are reported in Africa and south-Central Asia [1]. If CRC is diagnosed at early stage (confined to the wall of the bowel) five-year survival is 90%. The survival decreases to 68% for regional disease (lymph node involvement) and reaches to 10% if distant metastases are present[2] There are several screening test including: 1-stool blood tests,2-sDNA, 3-Flexible Sigmoidoscopy 4- Colonoscopy 5- Double contrast barium enema (DCBE) and 6- Computed tomographic colonography (CTC). The recommended repetition intervals for average risk individuals aged between 50 and 80 years are: 10 years for colonoscopy, 5 years for sigmoidoscopy, CTC and DCBE, and 1 year for stool blood tests.

Computed tomographic colonography (known also as virtual colonoscopy), has been rapidly developed since its introduction in mid-1990s as a minimally invasive imaging modality for evaluation of entire colon and rectum. Helical CT images are used to create standard axial and reformatted 2-dimensional (2D) and 3-dimensional (3D) images of the colon. It provides visualization of 3D endoscopic flight paths through the inside of the colon accompanied with simultaneous interactive 2D images which allows polyp detection and characterization of lesion density and location. Bowel preparation and gaseous distention of the colon through a CO_2 insufflator is required for a successful examination. The residual stool and fluid are tagged with barium and/or iodine oral contrast agents. The advantages of CTC are to be time efficient, minimally invasive, and no sedation is utilized, so the patient can return to work on the same day(Figure1) [2].

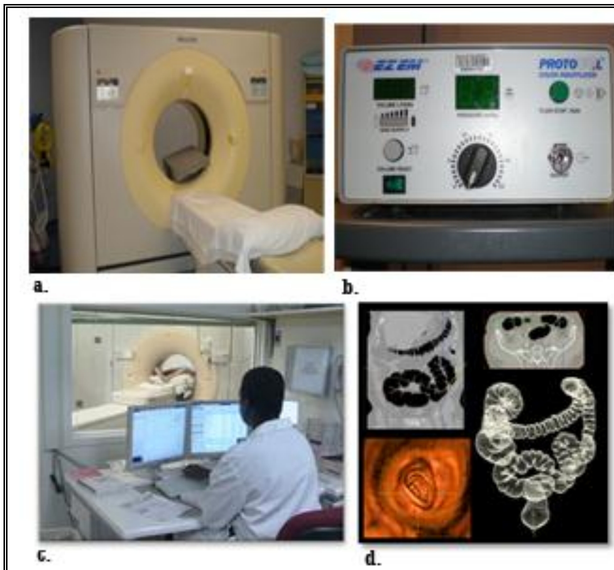


Figure1. Images of CT scanner (a), CO_2 insufflator(b), CT console (c), and different 2D and 3D views of exams(d).

Colonic insufflation and scanning are performed by trained technologists working under the supervision of radiologists. To be cost-effective and adapted to general practice, a technologist must be sufficiently trained to function independently. Two of the most important elements for successful CTC performance are: 1- optimal colonic insufflation/distension, and 2- the use of proper scanning parameters [3, 4].

Technologists must learn unique skills that are not normally part of their training. Currently, there are courses that equip radiologists with the necessary skills and knowledge required to interpret and read CTC cases. However, there are no training programs specifically designed for technologists. There are few expensive 1-3 day training programs designed for radiologists that focus on exam interpretation. They may incorporate a lecture on exam performance, but the details relevant to optimizing colon insufflation and other details normally in the domain of technologists are left out. These programs do not offer the option of continuous practice which is time consuming, and requires several months for a technologist to acquire and retain the complex information.

Simulation can provide an interactive training environment that replicates real experiences in an efficient and engaging manner. In medical field it is defined as “a person, device, or set of conditions which attempts to present [education and] evaluation problems authentically”[5, 6]. Simulators have been mostly used for training in aviation and medicine, but for limited particular skills [7]. The first medical simulator was introduced by peter Safar in late 1950s who was an anesthesiologist working on cardiopulmonary resuscitation [8]. Since then, simulation-based healthcare education has a considerable growth with creation of society for simulation and related journal [9]. Surgery and anesthesiology are two fields which have used simulators most extensively compared to other specialties. Simulator base training has been developed for ophthalmology and gastroenterology [7]. Nowadays simulation has to be noticed as an effective method and efforts are needed to facilitate practical use of this powerful education tool.

In this paper, we present a software simulation training tool developed by using Adobe Captivate to simulate the decision points encountered by the technologist when performing CTC. We also performed a formative evaluation of the tool through getting feedback from two radiology technicians who navigated through the software. Also, separately, we experienced creating the user interface of CT console and CO_2 insufflator using industrial programming software (LabVIEW) to demonstrate the feasibility of creating real environments for the purpose of training.

Methods and Materials

Resources and software development: Initial assessments to determine data required for simulation software were performed through 4 sources including:

1. Questionnaire: questionnaire included a mixture of qualitative open-ended questions and quantitative (ordinal) Likert scale questions. Twelve radiology technologists in the radiology department of the University of Chicago Medical Center (UCMC) participated to share their self-experience, familiarity, training, expertise, and difficulties they encountered in various aspects of CTC performance.
2. In-depth interviews of a knowledgeable informant and two key informants. The knowledgeable informant was one of the most experienced technologists in the performance of CTC at UCMC while the key informants were two experienced radiologists.
3. Literature review: Several articles[3,10,11] and books [12,13] were reviewed in order to gather and analyze existing validated protocols on the process of performing CTC.
4. Naturalistic observation (observation in the real-world setting) of several CTC procedures with construction of extensive field notes

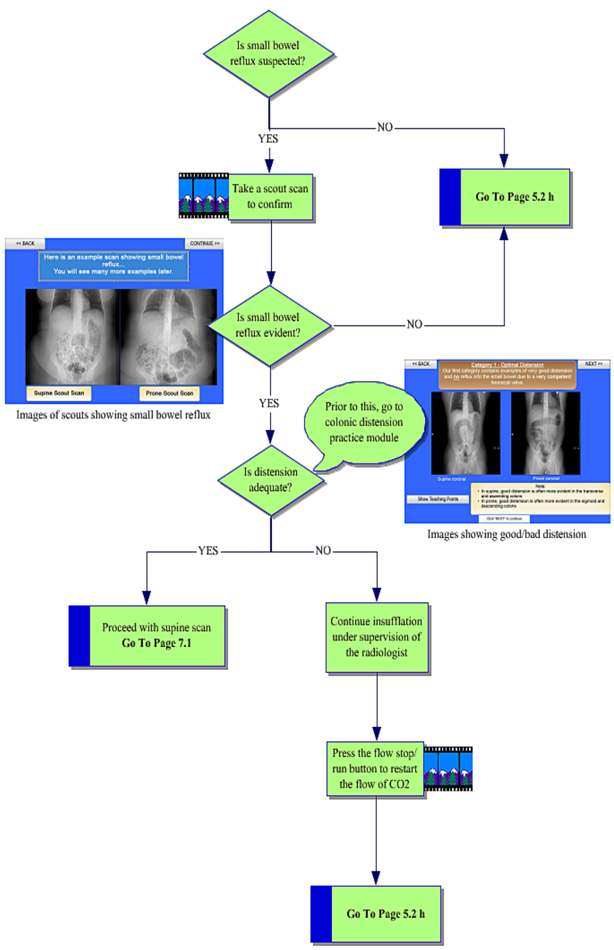
Data types included documents, questionnaires, graphic images, step-by-step professional videos (scripted, recorded and edited specifically for this project) of various tasks involved in the performance of CTC (technologist interactions with both the patient and the equipment), algorithms representing the flowchart of decisions, and CT scan images.

An extensive, detailed algorithm was developed using Inspiration© software, to capture the decision points and possible scenarios involved in the performance of virtual colonoscopy (Figure 2). A list of the steps involved in the performance of CTC was made and each step was professionally videotaped (employing the audiovisual department of the University of Chicago Medical Center). The video clips included patients (with informed consent), mock patients, a technologist and usage of the equipment. Screen capture images of the steps involved in positioning and scanning patients were made at the computer console using SnagIt© screen capture software. All videos were then edited using Apple Final Cut Pro 6© video editing software. Table1 summarizes tasks and tools for developing the simulation software. Using the algorithm, images, videos and text information the software simulation tool was created using Adobe Captivate© software, which is a software basically used for creating software demonstrations, simulations, branched scenarios, and randomized quizzes in flash(SWF) format. Adobe Captivate has a safe and simplified environment for learning where corrective feedback is provided. It is possible to add interactivity with branching to create realistic practice scenarios. It supports many different interaction types with no coding or scripting skills required [14].

Table 1 Summary of Software Simulation Tasks

Process/Task	Tools and Methods
Creation of video library (50 video clips)	Video clips recorded with the help of the AV department of University of Chicago Medical Center. Videos edited by author using Apple Final Cut Pro 6© software
Creation of image library (35 images)	Digital camera
Creation of Virtual Colonoscopy algorithm (25 pages)	Inspiration Software©
Screen captures of scanning process (78 images)	SnagIt© software
CT scout scan image library (179 images)	Created by a radiologist/research assistant, includes teaching points
Creation of Software Simulation (185 slides)	Adobe Captivate©

Figure2). Sample flowchart page for the training tool. (There are 25 pages of flowcharts in all).



Software formative evaluation*:* Simulator software performance was assessed through direct verbal and questionnaire feedback. Two radiology technologists who had more than 3 years' work experience and more than 3 years of work experience in CT gave their feedback after 3.5 hours navigating through the software (Table2). In addition to verbal feedback, a questionnaire was used to obtain feedback about the "ease of use" of the software simulation as well as the "content". The "content" section of the questionnaire focused on evaluating the effectiveness of the simulation in teaching specific skills and decision points identified in the algorithm

User interface development: Other than development and formative evaluation of a training tool for CTC, we decided to try creating CT console and CO_2 user interfaces looking more real and interactive by using National Instruments' LAbVIEW® (Laboratory Virtual Instrument Engineering Workbench) which is a graphical user interface (GUI) and visual programming language (VPL). Labview is a general-purpose programming tool which was introduced in 1986 and provided a powerful object-oriented programming environment with a wide variety of applications including simulation, instrumentation, process control, automation and etc. The software is basically an industry-standard programming language. LabVIEW is ideal for developing software-based versions of real-world instruments. Programming is done through block diagrams that consist of icons and wires which can be directly compiled into executable codes. It provides graphical user interface (GUI) in which the program environment can be designed. LabVIEW programs are called "virtual instruments" (VIs). Each VI consist of three parts: 1) the **front panel,** in which the real environment is designed and simulated by using a variety of controls (specifies inputs) and indicators (specifies outputs), such as buttons, switches, knobs, graphs and etc. ; 2) the **block diagram,** where the icon-shaped codes (rather than text-based codes) are placed, and 3) the **icon~connector,** which are "wires" connecting code icons together. Each front panel has a corresponding block diagram, which defines the actual data flow between the inputs and outputs. The code icons then are wired together by using programming concepts like other programming languages[15–17].We used Labview version 10.0 (2010) for creating CT console and CO_2 insufflator user interface.

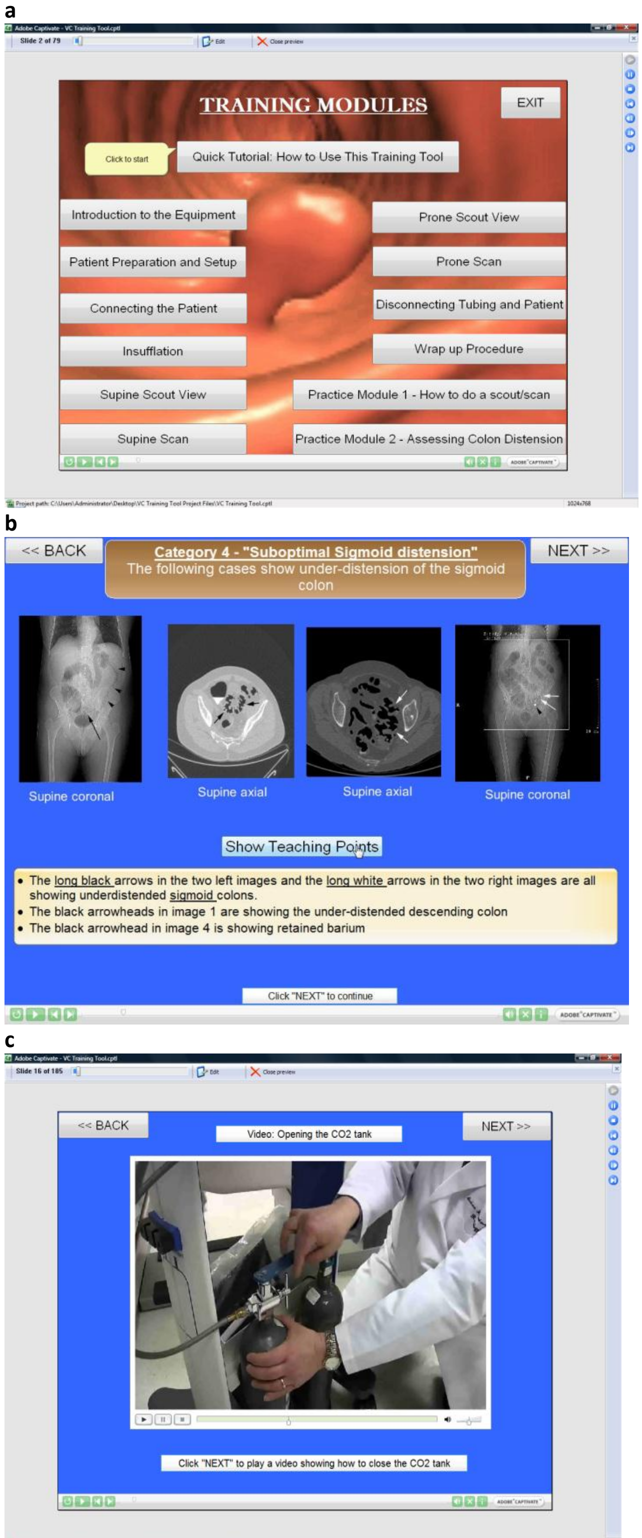
To create a user interface that accurately resembled the Philips software and instrument, The Philips CT console software was divided (and screen captured) into different user interfaces which the trainees have to go through step by step from the beginning (entering patient information) to the end of process. The active fields of each interface that the trainee has to follow were created by using LabVIEW elements in the front panel, and relations among controls, indicators and VIs were programmed by using graphical codes and wires in the block diagram. To create the user interface of the CO_2 insufflator, a captured image of the instrument was imported into the front panel. Then buttons, switches, indicators, LEDs and etc. were designed in the imported image exactly at the same place with the same shape. Some elements' functionality on the instrument were given through codes written in the block diagram.

Table2 Technologists' experience backgrounds	
Self-reported level of expertise in the performance of virtual colonoscopy (1= Beginner, 5 = Expert)	Both technologists = 4
Number of virtual colonoscopy procedures performed in the last 12 months	Technologist A= 4 Technologist B = 10
Familiarity with the front panel and controls of the mechanical CO_2 insufflator (1 = Unfamiliar, 5 = Very familiar)	Technologist A = 5 Technologist B = 3
Familiarity with scanning parameters (1 = Unfamiliar, 5 = Very familiar)	Both technologists = 5
Self-reported level of expertise in the use of the mechanical CO_2 insufflator (1=Beginner, 5=Expert)	Technologist A = 5 Technologist B = 3
Self-reported level of expertise in the use of manual room air insufflation (1=Beginner, 5=Expert)	Technologist A = 4 Technologist B = 1

Results

Using Adobe captivate, we developed the CTC training tool by using prepared materials including detailed 25 pages algorithms, videos, images, transcripts, and screen captured of scanning process. The total numbers of slides created were 185. Figure3 shows screenshots of the designed tool. After 3.5 hours navigating through each slide of the training tool by two technologists, they provided direct verbal feedback to the author/interviewer. Their feedback was categorized and the following general themes were deduced:

Figure 3. Screenshots from modules in the software simulation. a) Screenshot of Simulator Menu. b) Screenshot of an interactive screen from the "Assessing colonic Distension" practice module.c) Screenshot of sample video screen.



- Design and "Ease of Use" issues: e.g. the position of some buttons, navigational challenges, and the need for better display techniques such as videos and interactive animations instead of static images on some screens.
- Sequence of tasks: The order of some tasks in the simulation needs revising.
- Practice pattern issues: Some of the items reflect ideal situations not actual practice patterns.
- Omissions and additions: e.g. the need for visual aids for some processes. No glaring omissions.

Both technologists also completed the feedback questionnaire which is summarized in table3.

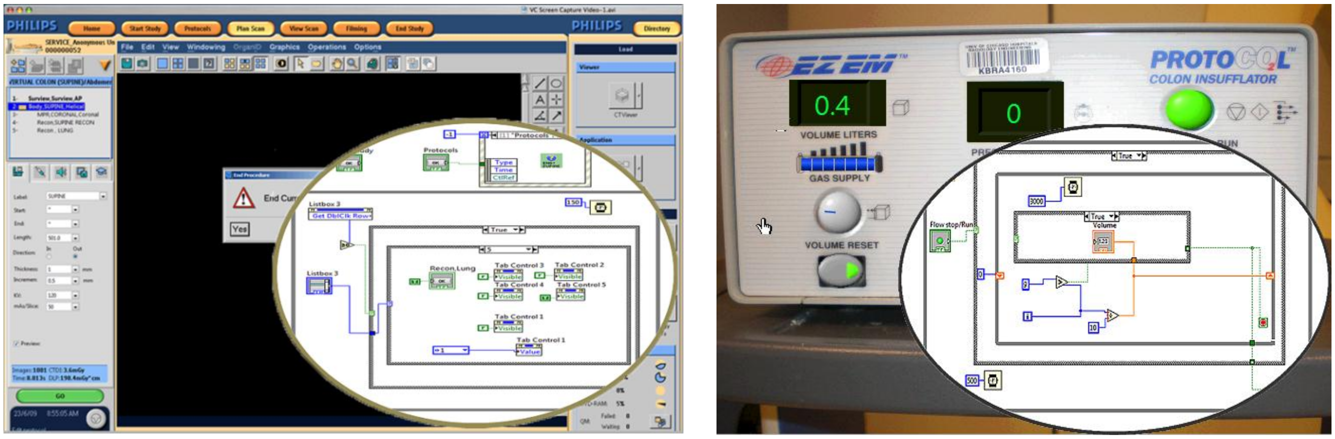
A primitive program was separately developed for making user interfaces of CT console look like real and to be interactive. It was designed by using LabView programming elements and codes to create subVIs of working and pop-up windows and their connections. The user interface for CO_2 insufflator was also designed using buttons and knobs and other LabView controls. Figure4 demonstrates screenshots of the front panels and block diagrams of designed CT console and also CO_2 Insufflator.

Table3	Pilot Feedback Questionnaire
Ease of understanding the instructions and navigation	Technologist A = "Easy" Technologist B= "Very Easy"
Color scheme	Technologist A = "Very good" Technologist B = "Good"
Proportion of headings and buttons clearly labeled	Technologist A="Most" Technologist B = "All"
Effectiveness in teaching the skills required for a "routine" or "difficult" virtual colonoscopy procedure	Both technologists = "Effective"
Effectiveness in teaching 13 specific CTC skills	Both technologists rated all items as either "Effective" or "Very Effective"

Discussion

The diagnostic accuracy of virtual colonoscopy is highly dependent on factors such as good colonic distension and the use of optimal scanning parameters. These factors are in turn largely dependent on the training, experience and skill level of the technologist performing the procedure. At the writing of this paper, to the best of our knowledge, there are no training tools specifically designed for training technologists to perform virtual colonoscopy procedures although there are a few studies offering suggested protocols in text format [3,11]

Figure4. a) Screenshots of the CT scanner user interface in the background and a component of the virtual instrument programming codes shown in the circle. **b.)** Screenshots of the Co_2 insufflator user interface in the background and programing codes shown in the circle.



a b

There are reports of the application of simulators to improve techniques in performing ultrasound and vascular interventions [19–21]. The Radiological Society of North America (RSNA), the Cardiovascular and Interventional Radiological Society of Europe, and the Society of Interventional Radiology have emphasized the need for many factors to be taken into account for simulation to form a part of training and assessment. They established individual medical simulation task forces and have set out joined strategies and proposed recommendations [22].

Our challenge was to create a simulation software that would capture the knowledge, information, decision points and branching logic that goes into the performance of virtual colonoscopy resulting in good image sets for 3D reconstruction/flythrough and problem solving. The needs assessment for our software was performed thorough a questionnaire and information which were gathered from viewpoints of technologists who were from both ends of expertise (60% rated themselves as average or experts in CTC versus 40% rated themselves as beginners).

To create an effective simulation-based training program, we had to consider some main characteristics. The Best Evidence Medical Education (BEME) collaboration suggested 10 features leading to effective learning, among which "Feedback" was described as the most important feature to promote efficient learning. The rest of the nine features include: Repetitive practice, Range of difficulty level, Multiple learning strategies, Clinical variation, Controlled environment, Individualized learning, Defined outcomes/benchmarks, Simulator validity/realism and Curricular integration [23]. In terms of feedback, the formative evaluations of our simulator software demonstrated very satisfactory results. However, we are aware of the limitations of our training tool evaluation. Compared to the respondents, non-respondents to our needs assessment questionnaire may have had different opinions and contributions that we were not able to capture. Secondly, since the questionnaires were based on self-reported practice and respondents' recollections, the responses are subject to recall bias. Thirdly, since our study focused mostly on virtual colonoscopy performance at UCMC and our respondents are all technologists at UCMC, our sample size was small and we could not ensure the generalizability and external validity of our tool. However, we reduced this limitation by ensuring that our data collection towards building the simulation included several studies done outside UCMC. Lastly, in designing our questionnaires, we were not able to use objective metrics of technologist expertise, since there are currently none, so we used self-reported metrics.

Moreover, we were able to create some primitive, interactive, real looking user interfaces for the CT console and the CO_2 insufflator using an industrial programming language (LabVIEW). Although they were created separate from the training tool, the user interfaces can be used as a template for professional Labview programmers to implement our training materials into this framework and develop the program to a more interactive environment by making the interfaces look like the real CT console and insufflator. Besides the industrial use of Labview in the field of engineering and medicine, this potent software has been implemented in education for more than a decade in the engineering field. Many lecture –based engineering courses and conventional experiments which were dependent on specialized instruments have been delivered in the shape of computer-based applications [24]. However, medicine has been far behind in using labview as an educational tool. In a recent project, Altrabsheh developed an application using labview software which automatically classifies normal and abnormal heart sounds, murmurs and lung sounds recorded directly through a microphone. This program has been proposed as a detection aid tool as well as a potential tool for educational purposes at medical and nursing schools[25]. This powerful program should be encouraged to be used in radiology education by creating real-time interactive tools.

In conclusion, this training tool has implications for the way in which technologists are trained to perform CTC. If CTC is to fulfill its promise of becoming a primary screening tool for CRC, one piece of the puzzle that must fall into place is the establishment of standardized training of technologists. Compared to the current methods, our software simulation offers a method of training technologists that is more efficient, saves time and involves less practice on patients. A refined and validated version of this simulation can also be used to certify/recertify technologists thus providing a mechanism for quality assurance in CTC performance. It would also be easy for manufacturers of different CT equipment to make limited substitutions of components of the simulator such that all vendors would be able to make use of the training tool.

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A HANDS-ON APPROACH TO TEACHING MICROCONTROLLER

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Abstract –*Practice and application-oriented approach in education is important, and some research on active learning and cooperative problem-solving have shown that a student will learn faster and develop communication skill, leadership and team work through these methods. This paper presents a study of student preference and performance while learning the microcontroller subject with a 2-day curriculum that emphasized on hands-on approach. The curriculum uses the PIC16F877A microcontroller and participants learned to develop basic circuits and several other applications. Programming was completed on the MPLAB platform. Results show that participants had better understanding in this subject after attending the hands-on course.*

1. INTRODUCTION

Microcontroller subject is one of the compulsory subjects for Electronic Engineering undergraduate program [1]. Traditionally, this course was taught focusing primary on computer software and hardware architecture [2]. However, the advancement in semiconductor electronics nowadays changed the way industry solves manufacturing and process control problems. Many control problems can now be solved more effectively and reliably using microcontroller rather than using mechanical or electrical switching systems. The increased used of microcontroller in industries led to new trends in microcontroller education [2].

There are two teaching methods in teaching this subject which are traditional approach and alternative approach [3]. The traditional teaching method emphasizes direct instruction and lecture, seatwork and the student learn through listening and observation. In the Faculty of Electrical Engineering in Universiti Teknologi Malaysia, microcontroller subject is taught as a lecture in a classroom or lecture hall, for a period of three to four months. During the semester, students were taught theories about the internal architecture of microcontroller and how to use the microcontroller through programming with a simulator. At the end of the course, students may be given assignments to design or develop an embedded system using the knowledge they have acquired throughout the semester. However, due to time constraint and the lack of hands-on practice in class, students had difficulty in completing their tasks.

Fig. 1: The 2-Day PIC Microcontroller: Hands-on course

The alternative teaching methods emphasize on group activities, students-led discovery and hands-on activities. Learning microcontroller courses with real-world applications provides the opportunity of tackling problems which would not be normally encountered in traditional learning [2]. The hands-on approach of teaching in engineering curriculum must be exposed to undergraduate students since first year for them to retain in the coming year [4]. Several academicians also have proposed new method to teach microcontroller subject [5,2].

In Universiti Teknologi Malaysia, a 2-day "PIC Microcontroller: Hands-On" course was designed to complement the classic form of lecturing. Fig. 1 shows the facilitator discussing with two participants. Students have the option to attend this course if they needed to. During this course, the students have to construct and program a microcontroller based on tasks given. The level of difficulty ranges from elementary to intermediate tasks such as LED blinking to motor control.

The course had been conducted many times and had been improved over the time, but only recently a formal survey in the form of questionnaire was conducted to gauge the response of participants and investigate the effectiveness of the course. This paper describes and discusses the results of this survey.

II. METHOD

A total of 18 participants were involved in this case study. The participants attended a 2-day short course on microcontroller, where 15 hands-on kit were handed to the students. Twelve participants were given individual kit to work on, while the remaining six shared the kit in pairs. All participants, either individuals or in pairs, were given the same tasks and each task had to be completed within 10-30 minutes.

All participants were between 18-32 years' old, with 12 male and 6 female participants. Their background included Medical Electronics, Mechatronics, Mechanical, Electrical and Computer Science. At the point of data collection, most of the participants had recently completed their undergraduate programs and currently working as research assistants in the university.

The course lasted 9 hours, starting from 8 am till 5 pm each day, with half hour break for tea in the morning and evening, and an hour break for lunch. During this microcontroller short course, the participant learned by actively completing allocated tasks rather than by passively absorbing information. Explanation of technical concepts preceded each task. Tasks were designed such that the students progressively applied what they had just learnt, and increased in difficulty from easy, medium to hard.

Delivering the microcontroller subject through a 2-day short course, with practical sessions, have its challenges:

1. The participants come from various backgrounds.
2. Most of the participant does not have much experience working with a microcontroller and had varying levels of competency in programming.
3. Time is too limited to cover an entire one semester subject syllabus.

Taking into consideration the factors above, we selected several major concepts to be discussed, that will help the participants to grasp smaller technical details while working on a solution to their tasks. The focus was on learning through practice.

Course outline

Day 1
Introduction to microcontroller
Assemble microcontroller basic circuit and use starter kit SK40C
Programming in assembly and C-language
Basic I/O: output (LEDs, 7segments, LCD)
Day 2
Basic I/O: input (switch)
Advance I/O: controlling motor (servo motor, DC motor and Stepper motor)
Demonstration

On day 1, we started the course by providing the student with MPLAB software from Microchip Technology Inc [6]. This was the platform on which source code for the tasks would be written. During the installation process, we showed some video clips of robotic competitions where participating robots were controlled using the microcontroller. The objective of showing the videos was to expose the participants to the variety of designs and applications that can be achieved with a microcontroller, e.g. how the robot can move with intelligence. Following the clips, participants were given short lectures on the basics of microcontroller and the supporting elements required to construct a basic working circuit. The supporting elements such as voltage regulator, oscillator and capacitors were provided for the participants to start building their own circuitry.

Simple programming using the assembly language was also taught. Participants were then given simple task such as making an LED (light emitting diode) blink at specified intervals, and progresses to multiple LEDs blinking with several blinking patterns. In the afternoon, participants were taught basic C language to replace the assembly language that was used in the morning session. SK40C PIC starter kit from Cytron Technologies [7] was introduced to the participants. This SK40C starter kit has built-in microcontroller, voltage regulator, oscillator and input-output connectors. This starter kit reduces the hardware configuration time for participants when trying to complete a task.

We started the 2nd day with short video clips of robots and automatic systems, ranging from straight-forward designs to sophisticated devices. From the earlier task of LED blinking, the participants progressed to more challenging tasks such as detecting inputs, directions of a servo motor, DC motor and stepper motor.

At the end of the course, all participants completed a set of questionnaire to state their level of expertise in microcontroller upon entry to the course, preferences and feedbacks. Participants were not required to state their names and details on the form. Responses from the participants were then analysed and presented in the results section.

IV. RESULT

Participants were categorized into four skill levels:

(1) **no experience**,
(2) **novice**, who has learnt simple theory in class and has previously completed LED blinking projects using microcontroller,
(3) **intermediate**, who has experience in developing simple embedded system, and
(4) **advanced**, who has experience in developing complicated embedded system.

From the 18 participants, 9 had no experience, 7 were novice and the remaining was intermediate. There was no advanced participant in the course.

i. Teaching platform

Participants were asked to state if they prefer to be taught using (a) Only basic circuit, which they assembled on their own; (b) the SK40C starter kit or (c) combination of both platforms. As shown in Fig. 2a, 78% of participants preferred to be taught on both platforms, where

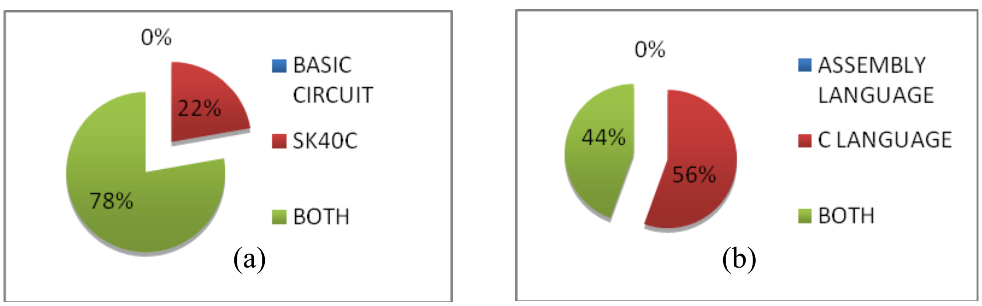


Fig. 2: (a) Percentage of participants with their preferred type of teaching platform
(b) Percentage of participants with their preferred programming language

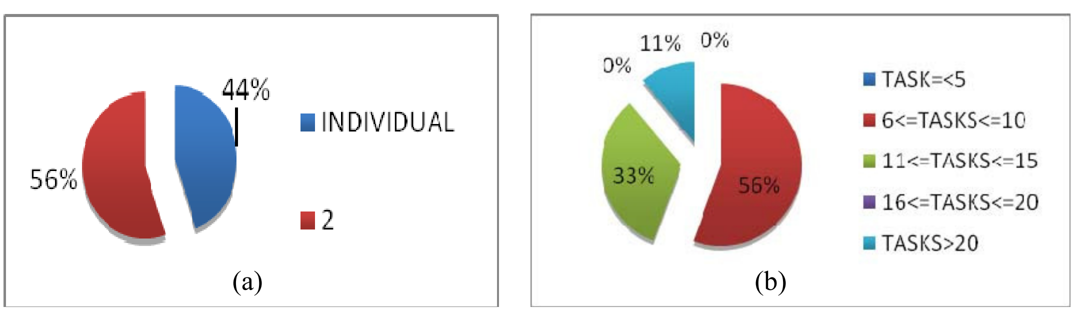


Fig. 3: (a) Percentage of participants with their preferred number of members in a group
(b) Percentage of participants with their preferred total number of tasks

they get to learn how to construct a basic microcontroller circuit from scratch, and then switched to simpler method of using pre-fabricated starter kit. 22% chose to be taught using only the SK40C starter kit, without having to construct their own circuit. No participants wanted to be taught using only the basic circuit. All the participants with no prior experience chose to be taught on both platforms. Four participants chose to learn only using the starter kit, two of whom were novice and the other two were intermediate.

ii. Programming language

56% of the participants chose to learn programming in only C-language while the remaining 44% preferred to learn both assembly and C-language to program the microcontroller (Fig. 2b). From the analysis of the survey, we found that 50% of the participants who chose to learn only C-language were novice, 20% of them were intermediate and 30% were inexperienced participants.

ii. Number of members in a group

As shown on the Fig. 3a, 56% of all participants preferred to work in pairs to complete their tasks. From the individual category, 60% preferred to have been assigned a partner, while 40% from the paired category hoped they had worked individually. All inexperienced participants preferred to work in pairs regardless of whether they had been assigned to the individual or paired categories during the course.

iii. Number of tasks

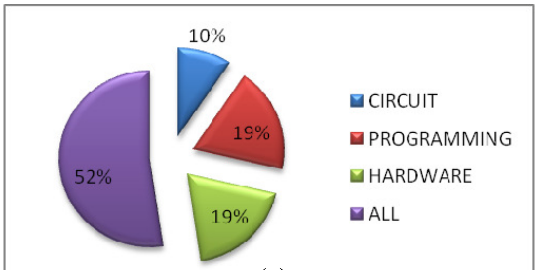
The number of tasks assigned during the course was 15. Participants attempted all tasks, although most of them managed to successfully complete only the first 10 tasks. Fig. 3b shows the preferred number of tasks according to the participants. Ten participants (56%) wanted the number of tasks to range between 6 to 10. Out of these ten participants, 40% were novice while 60% had no experience with microcontroller. Only 2 participants wanted more than 20 tasks. The two who wanted additional and more challenging tasks were experienced in embedded systems, and were ranked in the intermediate level.

iv. Skills

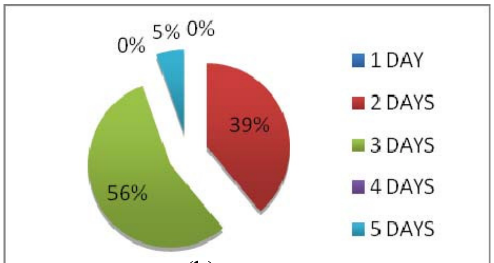
Participants were asked to choose the skills they considered most valuable to them, which they want to focus on. Four options were given: circuit construction, programming, hardware (motor, 7-segment display) or all options. They were allowed to choose more than one. The most selected option was ‘all’ skills. The skills jointly ranked second were programming and hardware skills. Participants with no experience mostly chose to focus on ‘all’ skills. Fig. 4a shows percentage of participants with their preferred skill to focus on.

v. Video clips and other presentations

During the short course, a combined total of about one hour was allocated for showing video clips and additional presentations. The video and short presentations were about international robotic events, student projects and some simulated product designs. These video and presentations were meant to provide participants with an overview of microcontroller applications and its performance. All participants liked the video clips and other short presentations in the course. Participants agreed that the duration for these additional elements were just right with 6% wanted longer duration for these elements.



(a)



(b)

Fig. 4: (a) Percentage of participants with their preferred skill to focus on.
(b) Percentage of participants with their preferred duration of the course.

vi. Duration of course

As shown in Fig. 4b, 56% preferred that the course to be held for 3 days while 39% agree with the current duration of 2 days. 5% wanted the course to be 5 days' long.

V. DISCUSSION

The feedbacks obtained from participants of the short course have been favorable and encouraging. Many claimed that they have better understanding of the microcontroller after the two days hands-on course.

From the survey, it was found that pairing the students had a positive impact in the learning. Most participants preferred to work in pairs and from observation during the course, participants who were allocated individual kits also chose to discuss with friends and work together to complete their tasks. This scenario applied mostly to participants who had no experience and novice. For expert participants, they enjoyed working individually as they were able to work faster, and could attempt more complicated tasks based on their interest, with help from the instructor. To make the course effective for all participants, the instructor has to be aware of participants' skills and prepare additional tasks with a higher difficulty level for skilled participants who completed their tasks early.

From earlier experience in separate courses, three or more participants per group were found to be unsuitable as discussion would be longer, and often, one or two participants would be left out during the hands-on. Two participants in a group was ideal for this type of short course as both could work together to complement each other in understanding and applying theoretical knowledge to applications. They also managed to complete the tasks faster.

Constructing a basic circuit from scratch helped the participants to understand the fundamental requirements of a microcontroller circuitry. While using the starter kit eased their work, it was still important for students to know how the starter kit was constructed, which was achieved by having students construct their own basic circuit using proto-board and wires. With this lesson, the participant then moved on to use starter kit that allowed them to focus on programming their applications rather than being hindered by errors in wiring or hardware faults.

While the knowledge imparted by hands on approach should be comparable to that of the conventional lecture-based curriculum, the hands-on approach differed from the latter in two important ways:

1. Students must actively participate in their own education, with the emphasis being on learning.
2. Participant's immediate hands-on practice that follows a theoretical lecture will provide realistic representation to that new knowledge and encourage them to become self-directed learners.

One improvement as suggested by the participants was the extension of the course duration from two to three days. This was to give time for participants to digest their knowledge and to ensure participants would be able to complete all the tasks assigned. A thorough review of the course with the extended duration needs to be done to ensure optimal delivery of this microcontroller subject.

VI. CONCLUSION

From the survey, the hands-on microcontroller short course was found to help in better understanding of the microcontroller. The practical sessions were fun for the students as they could explore their ideas through programming, and each participant came up with variety of solutions for the same task. Students learnt from each other and improved their performance. A 2-day hands-on would not be able to replace theoretical lectures, but will serve as a helpful addition to enhance student's learning.

ACKNOWLEDGMENT

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Relationships Between Teaching and Practice How Can Teachers be Effective Without the Knowledge and Application of Teaching Models?

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ABSTRACT

You have heard your colleagues say many times, *"my students have no idea what I presented in class today"* or *"they did not understand the concepts that I demonstrated",* and/or *"they just can't read".* These comments are heard over and over nation-wide, causing concern for educators at all levels and in many disciplines. Additionally, you have heard your students comment, *"I can't understand what Dr. X is saying",* or *"she may know what she is presenting, but I don't understand a thing she is saying",* and/or *"she just doesn't know how to get the material across to us so that we somewhat understand".* Is education in many schools failing? Is there cause for alarm in the statements, "If the child hasn't learned, the teacher hasn't taught?" All of the aforementioned comments have some legitimacy. However, with effective teaching models, methods, strategies, and tactics through collaboration with disciplines across the curriculum, the statements can be "stamped" out.

Keywords: Teaching Models, Teacher-Centered, Student-Centered and Lesson Plans.

1. INTRODUCTION

What factors affect the way teachers teach? How can models of teaching be utilized to effect positive changes in the classroom? These are just a few of the questions that are concerns from outside entities, about student performances in the classroom. Studies have shown that attitudes and beliefs about teaching have been a long driving force behind the success and/or failure of student learning. Therefore, the focus of teaching should entail one or a combination of the six models of teaching, which include (1) Presenting and Explaining, (2) Direct Instruction, (3) Concept and Inquiry-Based Teaching, (4) Cooperative Learning, (5) Problem-Based Learning, and (6) Classroom Discussion. Additionally, application of teaching models is essential and what better way to demonstrate these teaching models, than through best practice lesson plans that illustrate students' understanding of the models of teaching with public school students in K-6 grades and with their peers in a university class setting.

The object of this paper is to present models of teaching that are used to impact a positive change in the learning experience for students. The paper begins providing a theoretical framework on which the work is based. The next section introduces the teaching methods used in the course. The paper concludes with summary points.

2. THEORETICAL FRAMEWORK

In an effort to prepare future teachers, during the fall 2010 and 2011 semesters, 13 and 6 students respectively, enrolled in a curriculum and teaching *Methods of Teaching* course. Generally, the course content focuses on (1) developing a repertoire of teaching models and strategies, (2) understanding the theoretical foundations behind teaching and learning, (3) understanding the dynamics, both inside and outside of the classroom, (4) developing an awareness of current teaching practices, (5) appreciating the challenges of teaching in diverse classroom settings, (6) developing the skills for assessing and evaluating student learning, and (7) becoming knowledgeable on how to adapt instruction to meet the needs of all learners.

Regardless of the discipline or profession, everyone needs a "good" teacher, that is both "*good* and *effective"* and everyone should aspire to be a "*good"* and "*effective"* teacher to help all students' survive in this competitive world. Therefore, it is essential to be knowledgeable about models of teaching as depicted in figure 1. Research shows that there are six models of teaching, characterized as either *teacher-centered* or *student-centered*: (1) Presenting and Explaining, (2) Direct Instruction, (3) Concept and Inquiry-Based Teaching, (4) Cooperative Learning, (5) Problem-Based Learning, and (6) Classroom Discussion.

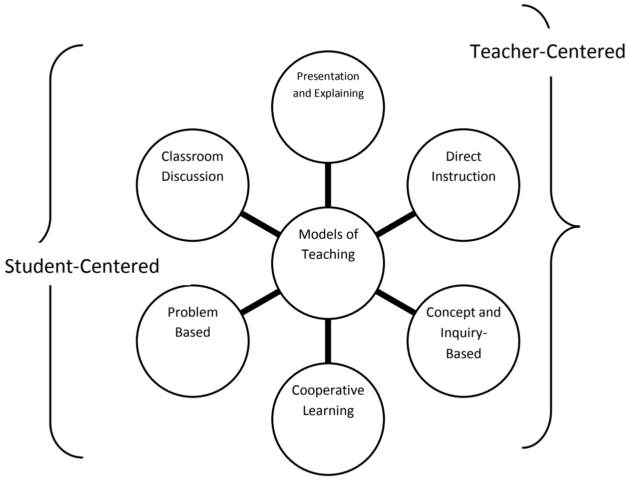

Figure 1. Models of Teaching

A teaching model is a broad, overall approach to instruction with a coherent theoretical perceptive about what students should learn and how they learn; albeit through behaviorism (Skinner), Social Cognitive (Bandura), Cognitive and Information Processing (Bruner, Gagne, Anderson), and Social cultural and constructivist (Dewey, Piaget, Vygotsky). [1].

Teaching models prescribe tested steps and procedures to effectively generate desired outcomes [8]. The *presentation* model is a teacher-directed and systematically way of delivering information, Figure 2.

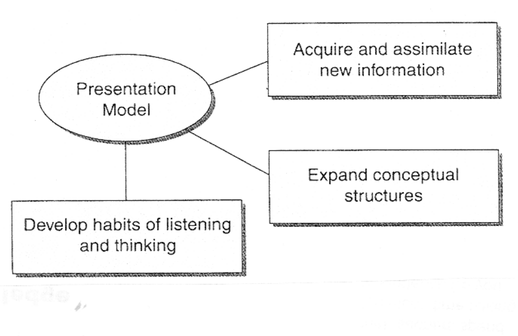

Figure 2. Presentation Model

The students are to acquire, assimilate, and retain information, expand their conceptual structures, and develop habits of thinking and learning [1]. The term *direct* instruction, which is teacher-centered [3] refers to a highly structured and fast-paced teaching method with constant interaction between the teacher and the student, accomplishing knowledge and skill mastery. Figure 3 provides an example of direct instruction.

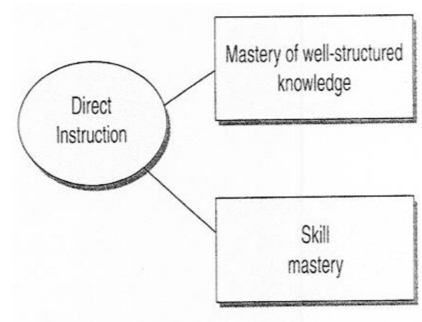

Figure 3. Direct Instruction

A *concept* model of teaching can be described as teacher-centered and moderately structured to effect students' higher-level thinking. Figure 4 provides a graphical representation of the concept model of teaching.

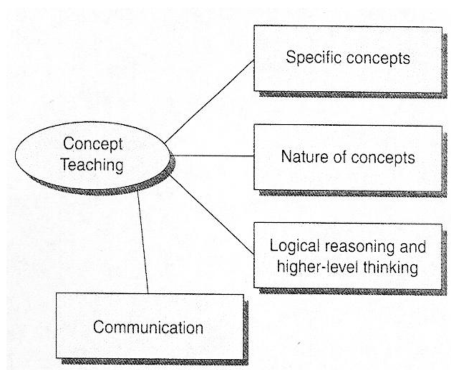

Figure 4. Concept Model

The aforementioned modalities of teaching stemmed from the areas of behavioral, cognitive and information processing theories of learning; and were all teacher-centered. The teaching models of cooperative, problem-based, and classroom discussion are all student-centered. *"Helping each other"* describes the cooperative teaching model. Figure 5 shows the cooperative teaching model.

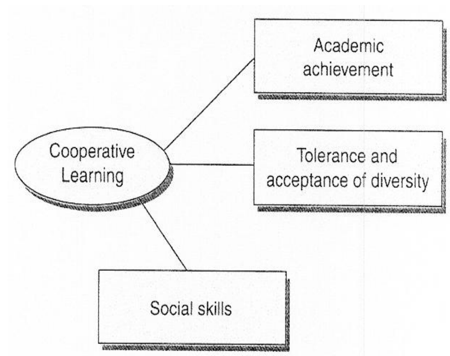

Figure 5. Cooperative Teaching Model

Students by nature are inquisitive-minded. Hence, the *problem-based* teaching model gives the students an opportunity to investigate a *"real"* problem and present solutions. Figure 6 shows the problem-based teaching model.

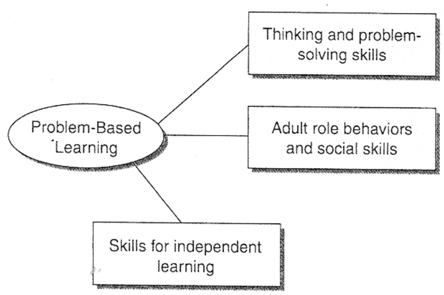

Figure 6. Problem-based Teaching Model

Perhaps, *classroom discussions* as depicted in figure 7 are utilized across most of the other five models described and is one of the most important distinctions of constructivist teaching. It is through discussions which is a student-centered model that verbal-illicit ideas are exchanged to posit student learning.

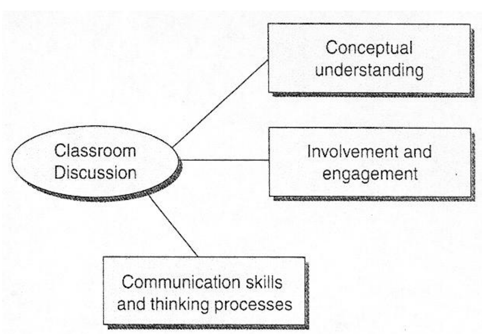

Figure 7. Classroom Discussions

3. COURSE DESIGN

3.1. Course Description

A brief description of *EDCU 309 – Curriculum Principles for Elementary Education* is to introduce basic considerations in curriculum development for Early Childhood and Elementary Education, including Factors Affecting Curriculum, Curriculum Goals and Objectives, Organizing for Teaching and Learning and Classroom Management. The prerequisites for the course include acceptance in the teacher education program and a seminar in teaching.

The curriculum and teaching class is a junior level undergraduate course for students with a major in elementary education. The teaching methods in this course include: lectures, readings, observation of practicing teachers in their classrooms; lessons and activities with elementary children; videography (including microteaching); cooperative learning activities; and games and simulation. Although all models are taught, the Curriculum and Instruction Department has adopted a constructivist perspective approach which under-grid all methods used in teaching this course. The **Constructivist teacher**:

1. Encourages and accept student autonomy and initiative.
2. Uses raw data and primary sources, along with manipulative, interactive, and physical materials.
3. When framing tasks, use cognitive terminology such as "classify," "analyze," "predict," and "create."
4. Allows student responses to drive lessons, shift instructional strategies, and alter content.
5. Inquires about students' understandings of concepts before sharing their own understandings of those concepts.
6. Encourages students to engage in dialogue, both with the teacher and with one another.
7. Encourages student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other.
8. Seeks elaboration of students' initial responses.
9. Engages students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.
10. Allows wait time after posing questions.
11. Provides time for students to construct relationships and create metaphors.
12. Nurtures students' natural curiosity through frequent use of the learning cycle ("discovery") model.

Students are also encouraged to use reflection to monitor their growth as a teacher, and to understand themselves and the children and teachers with whom they work. In this instance, reflection means to think deeply about a teaching or related experience and their relationship to it.

After being introduced to the models of teaching, the students were expected to show their competency and understanding of the models by teaching at least three of the six models to public school children in k-6 grades. The students were expected to use various techniques and to maximize their understanding of the six structures of the models to facilitate student learning in the classroom.

3.2. Learning Outcomes

Learning outcomes are extremely important when developing a course. The learning outcomes describe the specific knowledge and skills that students are expected to acquire. Learning outcomes were accomplished by way of written examinations, lesson plans, and clinical laboratory requirements. The learning outcomes for the

EDCU 309 course include the following: at the end of the course, a student should be able to apply:

1. Knowledge of the importance of developing learning objectives based on the Alabama course of study and the needs, interests, and abilities of students.
2. Knowledge of a wide range of research-based instructional strategies and the advantages and disadvantages associated with each.
3. Knowledge of the relationship between assessment and learning and of how to integrate appropriate assessments into all stages of the learning process.
4. Knowledge of current Alabama assessment requirements and procedures.
5. Knowledge of current trends, issues, and problems related to elementary education; knowledge of typical and alternative patterns of elementary school organization.
6. Knowledge of how to plan instruction based on curriculum goals/objectives and students' experiences, and how and when to adjust plans based on student responses and other contingencies.
7. Knowledge of various techniques, strategies, curriculum and literacy models, and programs for promoting maximum development of children, including interdisciplinary instruction, flexible grouping patterns, and strategies for facilitating cooperative and independent learning and decision-making skills. Advantages and limitations association with various instructional strategies
8. Knowledge of the state course(s) of study applicable to elementary education and how elementary education relates to other teaching fields.
9. Knowledge of approaches to knowledge construction and application in all disciplines.
10. Knowledge of techniques for using manipulative materials and play as instruments for enhancing development and learning.
11. Knowledge of criteria to be used in selecting, organizing, and evaluating available space resources, experiences, and equipment appropriate to the divergent components of the elementary education curriculum.
12. Knowledge of effective classroom and behavior management techniques and how to discipline students.
13. Knowledge of a variety of strategies for evaluating and reflecting on one's own performance as a teacher.
14. Knowledge of techniques for adapting the school program for children from diverse cultural backgrounds and exceptionalities.
15. Knowledge of appropriate strategies for working with parents and other guardians.
16. Knowledge of community agency materials and/or personnel which impact on the elementary school program.
17. Knowledge of collaborating with other professionals.

Hence, learning outcomes create a positive attitude towards learning and an increased commitment and responsibility for teaching and learning utilizing a plan of action and lesson plans.

For many in the classroom, teaching poses a challenge for lack of methodology and well-thought-out lesson plans. This was not the case for the students enrolled in a Curriculum and Teaching methods class in 2010 and 2011 fall semesters! They were required to develop, demonstrate their skills and understanding, and teach at least three of the six models of teaching in a public elementary school and a four-year university. Specific guidelines regarding the lesson plans and the teaching models were utilized and hence, are the focus of the student presentation through the actual lesson plans developed and taught. Table 1 is an example of the lesson plan presented in class.

Table 1. Lesson Plan

Lesson Plan Format – Internship
Curriculum & Instruction
Tuskegee University
Name ______________
Date of Observation _______
Primary Teaching/ Learning Strategies__________________
A. Title/Content of Lesson
1. You may give your lesson any title you choose. Be Creative!
2. Provide an overview of the content and concepts included in this lesson.
B. Purpose/Learning Outcomes
1. Write objectives with active verbs describing what you expect students to do or accomplish during the lesson.
2. Write objectives concerning the type of thinking you hope to promote the concepts students are developing..…
3. Write any other important objectives you have that may not be directly each other in positive ways during their small group discussions".
C. Before the Lesson Assessment of Students' Learning Needs
1. Describe students' prior experiences with the skill(s), knowledge and concepts involved in this lesson.
2. Describe how your lesson addresses students' learning needs.

	3. Describe how you will provide for students' individual differences.
D.	Procedures
	1. Describe what the students will be doing during the lesson.
	2. Include directions you will give the students.
	3. Include questions you want to ask during the lesson.
	4. Include questions that go beyond factual recall of information.
	5. Describe resources/materials you plan to use.
	6. Include the use of technology for planning, implementation and assessment.
E.	Plan for Assessment
	1. Explain the method(s) you will use for determining if all students have made progress towards the learning outcomes.

As a result of the learning experiences of creating lesson plans and utilizing methods of teaching, the students are better equipped to manage the classroom setting.

4. Conclusion/Statement of the Problem

Learning to teach is a complex journey. It cannot be learned over night. It continues for a lifetime, if teachers are serious about being effective in the classroom. Consequently, if we as teachers are to chart the way for a new direction and to assure more meaningful learning in the classroom, it is imperative for us to teach our students through models of teaching that are problem-based. We must instill in them the ability to think and read:

- Critically
- Creatively
- Environmentally
- Historically
- Psychologically
- Multi-culturally
- Technologically
- Sociologically
- Philosophically
- Economically
- Geographically
- Mathematically
- Morally
- Scientifically
- Aesthetically
- Politically
- Legally
- And to use other modalities that affect this global society

There are several goals of the paper. One specific goal was to study and learn how to use models of teaching to effect positive change in the classroom. Another goal was to have university students demonstrate their understanding of the teaching models by teaching a lesson utilizing several of the models with k-6 grade students and their peers as well. Through these efforts, it was our aim to further the understanding of models of teaching and application of skills through lesson plans to answer the initial questions, what factors affect the way teachers teach? How can models of teaching be utilized to effect positive changes in the classroom?

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Interdisciplinary Professional Development Program for Teachers

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ABSTRACT

This professional development program has been designed to increase the integrated science content, pedagogical, and technological knowledge of teams of middle and high school teachers in Ohio. The selected schools are high need areas with an overall average from these school districts serving a population of 63% students who are economically disadvantaged. The 24 teachers participating in this program each year serve as catalysts and mentors to other teachers, and has driven curriculum change in these districts. This professional development program has effected these changes by using a three-phase research based approach to classroom educator training with hands-on experiences. Phase I is composed of a one week field experience followed by a week long laboratory experience. The field trip involves participants to the Atlantic Ocean to study the physical and biological processes that interact to form the modern ocean environment compared to the ancient ocean sediments preserved in the Atlantic Coastal Plain around the Duke University Marine Laboratory and research institute. The field experiences are founded in guided and constructivist based questioning content and pedagogical understandings.

Following the inquiry based field trip, participants gathered for a week of laboratory work, participating in inquiry based learning with samples collected from the field, and developing ideas to integrate inquiry with science activities into their own classrooms. Phase II involves a four-week long internet course designed to assist participants in developing classroom applications. The teams of classroom educators have developed, implemented and assessed inquiry based integrated science activities in their own classrooms. Phase III has an on-line course that incorporates Earth System Science with real world topics and scenarios. Support and contact with participants and project personnel is maintained during phase III of the project through frequent interactive web-conferences during the K-12 school year. Teachers participating in this program have been agents of change and have been assisting their districts with leading students to be more versed in the skills that are stressed by the National Science Education Standards and current efforts to improve STEM education.

Keywords: Hands-on /Inquiry-based learning, Professional development, Science education, Interdisciplinary program.

We developed an outreach program at Wright State University designed to provide a set of learning experiences that connect chemistry, geology, biology and mathematics for K-12 teachers throughout the state of Ohio. This outreach program is sponsored by the Ohio Department of Education to provide K-12 in-service teachers with inquiry-based experiences (AAAS, 1994; NRC, 2000). This article reports on the impact of the program on the teachers' content knowledge and self-efficacy in teaching science. Based on the analysis of pre- and post-tests and feedback questionnaire, this program successfully has assisted the teachers with augmenting their science content knowledge and confidence to teach science and math.

There were three phases of the outreach program. In Phase I, teachers visited the oceanic environmental laboratory in Beaufort, North Carolina during the summer, followed by a trip to an ancient ocean environments preserved in marine sediments of the Appalachian Mountains of West Virginia and Virginia. The teachers worked in pairs during the field trips and preformed the following assays: pH, dissolved oxygen, turbidity, salinity, alkalinity, temperature, and the concentration of phosphates, and nitrates in ocean, rivers, lakes and streams. In the field students also collected samples of rocks, soil, and fossils (sharks teeth).

Phase I:

The Investigations at the Atlantic Ocean in Beaufort, North Carolina focused on the interplay between the physical and biological factors of the seashore environments. The teachers profiled a section of the beach located along Shackelford Island (dunes, backshore, foreshore, and near shore); collected samples of shells, sand, soil, sharks teeth, and soil; calculated the speed of the shore current; and collected ocean water samples for analysis in the field. These data were then used in the lab experience portion of Phase II. The teachers investigated the sedimentary layers of sand on the beach and took digital photographs so they could compare the sediment found in the modern ocean with the sedimentary rocks found in West Virginia, and Virginia (ancient ocean). Students went out on an ocean research vessel to collect water samples at different depths of the ocean, estuary, and river. A trawl was utilized at different depths of the ocean to expose the students to various animals living in each zone. Table 1 illustrated data collected at Atlantic Ocean (estuary water).

The Appalachian field experiences included igneous, metamorphic, and sedimentary rocks which make up the Blue Ridge and Valley and Ridge regions of the Appalachian Mountains. Samples of the metamorphic and sedimentary rocks were once part of the Iapetus Ocean (father of Atlantis) were studied and compared to the modern Atlantic Ocean samples collected. Table 2 exemplified the data collected from the rocks the ancient oceans and their impact on water chemistry of the streams and rivers. The teachers were required to explain why there are differences in the pH and how the differences are related to the depositional environmental of both ancient and modern oceans (explain the significance of changes in pH near coal mines and the relationship between chemical composition of the sediments and water near the coal mines in Virginia and West Virginia.)

Phase II:

A five-day lab exercise compared the modern ocean to the ancient ocean during the summer. These inquiry-based experiences during the field trips and lab allowed the teachers to discover the nature of science and how scientific evidence is based observations. Students were engaged in experimentation and Inquiry-based investigations with all of the data and scientific observations that were collected in the field experiences. The lab experiences integrated the different sciences to analyze the various samples collected. The teachers were required to investigate the similarities and the differences among the water, sediment, rock and fossil samples collected. For example one group of teachers did an analysis of phosphate (modern versus ancient) and asked the questions: "Is phosphate present in the ancient and the modern ocean? " Fossils such as shark's teeth were analyzed at the modern ocean versus the ancient ocean to compare the phosphate concentration present. Table 3 illustrates the data that was collected and analyzed to study phosphate concentrations at different sites visited.

In addition, analysis of anion and cation concentrations in water samples led to discussions regarding changes in dissolved oxygen and other parameters in collected water samples through time, chemical weathering, the water cycle, and ocean salinity. Students compared the composition of sands versus the composition of the source rocks and predator-prey relationships among modern and ancient mollusks.

PHASE III: (FOLLOW-UP)

The Phase III is an asynchronous experience for the teachers during the fall had weekly assignments/ deadlines for interaction. Phase III, enhanced the teachers understanding of content and pedagogy by providing them with an online cooperative learning experience. This experience was inserted to assist with the development of classroom applications through utilizing peer interactions to enhance the hands-on activities in their own classrooms. Inquiry-based labs were developed such as: "What is the ideal pH for your garden soil?" "What is beach profiling- how to make a Pie chart to analyze grain size of sand?" These lessons incorporated math, graphing, geology, beach profiling, biology (plant life, turtles, clams, snails), and chemistry of water and soil.

Pre-test and Post-test were given to assess the content knowledge gained by the participating teachers. The average pre-test score was 51.3% and the average post-test score was 85.7%, resulting in a normalized gain of 0.71 for 141 teachers served with this hands-on experience course over a seven-year period of implementation. In addition participating teachers were served a questionnaire about their own science instruction as shown below, Table 4.

This professional development program has been found to be effective in developing appreciation for science process skills and inquiry-based learning. These three phases of the course build content knowledge in the various sciences and address the pedagogical understanding needed to meet the National Science Education Standards and current efforts to improve STEM education.

Table 1. Data for Estuary Water at Shackelford Island (Atlantic Ocean)

Depth/meters	**0.70**	**4.0**	**7.0**	**10.0**	**13.0**	**19.0**
Temperature/^{0}C	**23.0**	**22.6**	**22.4**	**22.2**	**22.0**	**21.0**
pH	**7.8**	**7.6**	**7.6**	**7.6**	**7.6**	**7.6**
Dissolved Oxygen (mg/L)	**7.13**	**5.93**	**4.12**	**4.07**	**4.12**	**4.57**
Salinity (ppt)	**26.4**	**26.7**	**26.9**	**22.0**	**22.0**	**27.1**
Turbidity (nephelometric turbidity units, NTU)	**63**	**64**	**68**	**69**	**69**	**69**
Nitrates (ppm)	**1**	**1**	**1**	**1**	**1**	**1**
Phosphates (ppm)	**2**	**2**	**2**	**2**	**1**	**1**
Alkalinity (ppm)	**80**	**85**	**90**	**90**	**100**	**120**
Hardness (ppm)	**425**	**425**	**425**	**425**	**425**	**425**

Table 2. River Water in West Virginia

Depth /m	**0.2**
Temperature /^{0}C	**25**
pH	**2.3**
Dissolved Oxygen (mg/L)	**4.0**
Salinity (ppt)	**6.0**
Turbidity (NTU)	**16.0**
Nitrates (ppm)	**0**
Phosphates (ppm)	**1**
Alkalinity (ppm)	**40**
Hardness (ppm)	**200**

Table 3. Phosphate Data of Field Sites Visited

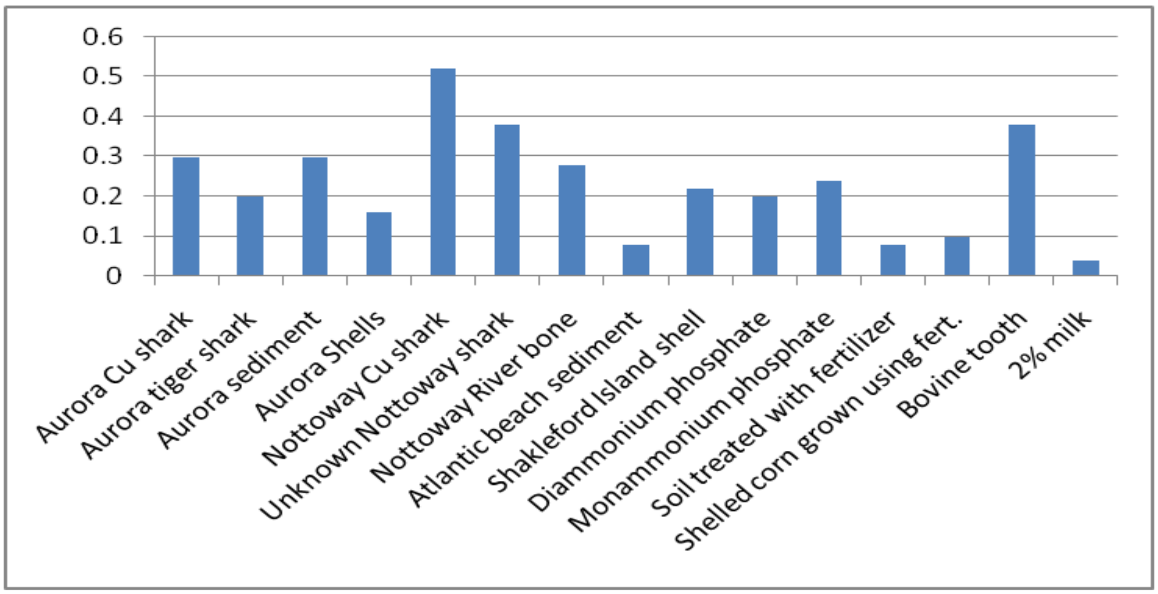

Table 4. Questionnaire About Teaching Science

1. Students learn science best in classes with students of similar abilities.

	Agree	No Opinion	Disagree
Pre-survey	29%	13%	58%
Post-survey	20%	0%	80%

2. I enjoy teaching science.

	Agree	No Opinion	Disagree
Pre-survey	60%	0%	40%
Post-survey	100%	0%	0%

3. I organize the curriculum around the textbook.

	Agree	No Opinion	Disagree
Pre-survey	20%	20%	60%
Post-survey	28%	0%	72%

4. The teacher should consistently use activities that require students to do original thinking.

	Agree	No Opinion	Disagree
Pre-survey	93%	0%	7%
Post-survey	100%	0%	0%

References:

1. American Association for the Advancement of Science. *Benchmark for Science Literacy*; Oxford University Press: New York, 1994.

2. National Research Council. *Inquiry and the National Science Education Standards, A Guide for Teaching and Learning*; National Academy Press: Washington, DC, 2000.

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An Application of Nonlinear Regression Analysis to Residential Construction Loans Default and Recovery Risk in Mexico

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***Abstract*—Residential construction loans are short term in nature and can involve large amounts of capital. Default risk could be very costly and also hazardous to the overall market stability, especially in emerging markets. This study analyzes the overall behavior from 2005 to 2011 of residential construction projects and loans funded by Sociedad Hipotecaria Federal S. N. C. (Mexican Development Bank), and develop models for default and recovery risk by means of nonlinear regression analysis. These models are the two key cornerstones for reserves calculations. The aim is to identify key factors that influence default and recovery rates. We found that a small set of behavioral characteristics can satisfactory describe the prospective behavior of a construction loan, making the proposed models easy to interpret and implement.**

***Index Terms*—Housing market, default, loss given default, residential construction loan, Mexico, nonlinear regression.**

I. INTRODUCTION

A Typical residential mortgage agreement require the borrower (*mortgagors*) to repay loan principal and interest on a monthly basis, and when the borrower misses a established number of consecutive payments, she is considered to have *defaulted* on the mortgage.[1] Once a loan is declared in default, the lender (*mortgagee*) could claim ownership of the property *(repossession*) and sell it in the open market (*foreclosure*) to compensate for financial losses. When assessing the severity of the loss given default from the lender perspective, not only financial losses from foreclosure must be considered, but also that the disposition of the property is difficult at its full market value under such circumstances; apart from the extra costs incurred such as legal expenses, property agent's commissions, property management fees and maintainance costs before disposal.

Commercial mortgage markets differ from their residential counterparts in several significant respects. Commercial loans finance investment opportunities and are typically used by sophisticated investors and real estate developers. The latter kind specialized in developing for residential purposes is what we call Residential Construction Loans (RCL).

Residential Construction Loans may be fixed or floating rate, interest-only, legally binding of a short-term bullet payment at the end of the amortization term, but with the optionality of amortizing at any time, in contrast to other commercial loans that are usually with balloon payments. Explicitly in the agreement or by operative practice, the distribution of the amortization payments corresponds to the selling of property, usually through a new typical residential loan (this is why this type of loans are also called bridging loans in Mexico).

In times of increased focus on risk management, risk control mechanisms that enable to make quick a clear judgment has become an attractive and necessary line of applied research. In particular, under Basel II and III, the proper quantification of risk tends to help the release of own capital, and precisely mortgage portfolios are those where the relative benefits of internal ratings-based approaches compared with the standardized approach are greatest.

A Credit Score is a number summarizing an individual's credit profile that indicates the likelihood that a borrower will repay future obligations. Credit scoring models are developed by analyzing statistics and picking out characteristics that are believed to relate to creditworthiness. These models have been used for decades and usually by potential lenders to rank consumers and determine whether a consumer qualifies for a loan, how much the consumer will be loaned and at what rate (i.e., at origination). Despite the fact that credit score-type models have been widely criticized [1] [11], their usage and range of applications has increased dramatically in the recent years. In 2001, The AARP Public Policy Institute estimated in one of its reports [10] that more than 10 billion credit scores (using credit-scoring model) have been sold, representing around 90 percent of all consumer credit decisions in the United States. In particular, in the home mortgage sector, it is estimated that 75 percent of loan decisions have been taken directly or indirectly using credit scores.

This paper intents to identify the dominant factors in Residential Construction Loans (RCL) default and severity of Loss Given Default (LGD) in Mexico using credit-score type models, specifically using Nonlinear Multivariable Regression. The remainder of the article is segmented into three additional sections. In the next section we discuss about the data available and the construction of the sample database for estimating the models. In the section that follows we detail on the two models: for probability of defauls and severity of loss given default. We describe the research methodology used and the estimation of parameters in the models. We close the article with conclusions.

The views expressed in this article are those of the authors and do not necessarily represent the views of, and should not be attributed to Sociedad Hipotecaria Federal S. N. C. This is a short version paper for presentation in IREPS2011.

[1]It is very common to take three to six payment overdue as the threshold to define *default*.

II. Data Collection

Sociedad Hipotecaria Federal S.N.C. (SHF) as a second floor bank monitors its granting Residential Construction Loans and their collateral . The database available for this study consists of six and a half years of loan behavioral data from beginning of 2005 to may of 2011 of 2778 projects, corresponding to 86, 042 registries from six different products,[2] from which the 93.82% are either current or overdue accounts, and 80.60% correspond to construction projects. The intersection of the two previous criteria form our population for study. The variety of loans and construction projects will assure the broad application we were looking for in the models.

In order to guarantee robustness in the estimation of the model parameters, invalid information and outliers were filtered from the population. Thus, obtaining a sample with 44,503 registries from 1475 projects. In terms of loan and project behavioral characteristics, the sample database consists of 159 variables from which the 34.36% are attributes at origination, 30.06% of behavioural characteristics and 35.58% corresponding to other variables not relevant to our purposes. Due to the broad range of construction project types and loan characteristics at origination, it was necessary to create 39 new composite variables to make the information comparable.

III. Research Methodology and Data Analysis

While lenders usually assess borrower credit history and asset quality (in the RCL case, of the construction project and developer), the riskiness of general commercial mortgages is primarily based on the ability of the asset to generate sufficient cash flow to make periodic mortgage payments (return on investment) and the expected asset value at loan maturity to repay principal (return of investment). Being the intention of our research to identify the dominant factors in Residential Construction Loans (RCL) default and severity of Loss Given Default (LGD) in Mexico, in the next two sections we detail on the methodology used and explain the selection of Nonlinear Multivariable Regression models.

A. A model for the probability of default

Usual residential loans amortize and pay interest in a monthly basis, and default is characterized by setting a threshold in the number of missed payments (*delinquency*). As discussed in the introduction, a Residential Construction Loan (RCL) is characterized by its monthly interest payments, the need of fully amortization at maturity and cash-flows coming from the the selling of the residences. By the structure of RCL, the definition of delinquency (resp. default) is more complex and need to involve not only the number of months of missed interest payments, but also a measure of the ability of fully amortize the loan at maturity or near it, and the departure of loan amortization from the income cash-flows from liberalization of residences,[3] as we discuss as follows.

Interest arrears in RCL are similar to treat as in usual residential loans. Although they have very different behavioral aspects, RCL by their shorter term and more money intensive nature, usually few interest payments overdue are already a sign of financial difficulties leading to default. From all registries in our sample database, the 51.47% correspond to project-registries with no missing interest payments, the 17.57% for one payment overdue, 7.57% correspond to two interest arrears, 5.09% to three and 18.26% to more than three payments overdue. This is, less than a quarter of the sample database have missed three or more interest payments.

In regard to return on investment prior to maturity, an easy measure of funds deviation can be constructed subtracting the monetary amount of residences sold corresponding to the loan, from the total amortization amount.[4] On one hand, fund deviation are more than a behavioral attribute. Similar to interest arrears and mainly because of the short term maturities of RCL contracts, it can serve as an early sign of financial distress, either because funds might have been used for other purposes (working capital, wages, etc.) or as evidence of poor planning or administrative procedures. In our sample database, the 4.5% of entries correspond to deviation of less than -20%. This represents the loans with undesirable behavior. Deviation in the range between -20% and -10% represents a 5.49% of the sample. A separating threshold in this interval might be a good alternative considering that some natural operative deviation may occur, e.g. transferring of funds might take time. The 89.98% of the remaining data represent loans with deviations of more than -10%. This are the loans with good behavior. A deviation on the positive side means that a prepayment have occurred.

On the other hand, fund deviation is a key component to computing the severity of loss given default, as we discuss in next section.

In a different context buy related, a recent study [2] recognizes that commercial mortgage default is not a one-step process and examines a previously under explored aspect in the whole default process, that is the stage between the initial delinquency and default, distinguishing servicers' behavior from the borrowers' behavior. They find that cash-flows condition is the most significant factor in the servicers' decision making process. They also find that borrowers make default decisions based upon both the equity position in the loan and the cash flow condition in the space market, which is related to our usage of funds deviation.

In regard to the condition of fully amortize at maturity, usual studies focus on the risk that the borrower may default before the loan matures but generally pay little attention to the possibility that a borrower may have difficulty paying off the loan at maturity (some sort of basis risk) even though the loan is not in default [7]. There are several recent studies on commercial mortgages that describe this situations. In Tu et al. [7] analyze commercial mortgages that are not fully amortizing, thus requiring a baloon payment that arises from the borrower's inability to refinance at mortgage maturity. Borrowers with a mortgage at maturity that is not in default

[2] By different products we mean granting credit lines with different funding objectives and requirements for the collateral involved.

[3] In general terms, liberalization of residences include cash payment or the selling through a usual residential loan.

[4] This measure of deviation in monetary terms need to be scaled to make it more comparable among loans. A natural way is to divide by the loan principal.

but does not meet contemporaneous underwriting standards will often request to extend the loan with the lender. The inability of a borrower to refinance a mortgage can lead to extension and ultimately default. This situation usually occurs during periods of increasing interest rates and/or slow property appreciation rates, when weaker projects may not qualify for a new loan at maturity.

In the day to day operation of RCL in Mexico, it is very common for a loan to go through a restructure in maturity. It is even sometimes part of the original agreement and used as a measure of control. If the construction project advances as expected, a loan term extension is almost automatically approved. In our sample, more than 50% of the database are loans with terms between 1 and 1.5 times the original maturity, and as the proportion of original loan term increases, the percentage of registries decreaces rapidly.

After numerous discussions with a group of experts on RCL in SHF, several analysis,[5] taking into account previous discussion on commercial loan default factors, and an in order to incorporate as much describing features as possible in our model for the probability of default for RCLs, we consider that at each observing time a "good" loan-project is described by satisfying jointly the following three aspects:

1) The number of interest payments overdue are less or equal two,
2) $Dev \geq -20\%$, defining Dev as the percentage fund deviation as follows,

$$\text{Dev} = \frac{\begin{pmatrix}\text{accumulated}\\ \text{amortization}\\ \text{amount}\end{pmatrix} - \begin{pmatrix}\text{accumulated amount}\\ \text{by selling}\\ \text{of residences}\end{pmatrix} \times (\text{LTV})}{(\text{loan principal})}. \tag{1}$$

3) Current age of loan is less or equal to 1.5 times the original term.

And by simplicity, a "bad" loan-project is one that satisfy the complementary conditions.

As usual in multivariate regression models for probability of default, we choose a time horizon H. The random variable Y_H representing the state of a loan in the future time H, follows a binomial distribution on the total number of entries in the sample database with the success probability (the event that the loan becomes bad), the probability of default (PD) for the loan. Thus, one estimates statistically on the sample database, the parameters (coefficients) in the logistic function for PD in Eqn. () and on a combinations of predefined functional forms of the potential explicative variables. We elaborate further on this in the coming sections.

For determining the functional relationships of the dominant factors in RCL default, we used a combination of operational knowledge, data exploration and fitting procedures. We found that for some variables, a non linear function fitted better than a linear relationship traditionally used in multivariable regression models. We applied a backward elimination procedure in the regression analysis via the maximum likelihood method.[6] And in order to assure robustness in the selection of the describing variables, we choose them only if their Chi-square probability were small (usually less or equal to five percent) for all analysis horizons H (from 1 to 12 months). Table I presents the Chi-square probability for each of the five variables selected and three of the horizons H.[7]

1) Independent variables and regression coefficients: The four variables (five with the intercept) that describe the probability of default are:

1) **DevE**. This variable is the deviation of funds (Dev in Eqn. (1)) times the scaled age, computed as the current age of the loan divided by the original maturity. By its composition, it is a nonlinear variable that differentiates the effect of funds deviation in relation with the closeness to maturity (or origination, respectively). It is somehow natural to be one of the describing variables as the definition of a good loan depended on it.
2) **MinProjE** Measures the difference between the percentage disposed and construction progress, escaled by the age of the loan and maturity. The nonlinearity guarantees that a project with much progress in relation with the amount disposed in early months will have less probability of default than one closer to maturity.
3) **Mora.** This is the number of interest delinquencies at the observing time. This is the usual way probability of default is defined in mortgages.
4) **Mora6.** In order to incorporate the most recent history in terms of interest delinquency, the variable Mora6 is computed as the number of months among the last seven of behavior that the loan worsened from one period to the next one, i.e., if the loan incremented twice its delinquency in the last seven months, then Mora6=2.

As we worked with twelve horizons (H), we really estimated coefficients for the twelve models. The models for PD_H therefore have the following form:

$$ln\left(\frac{PD_H}{1 - PD_H}\right) = \beta_0 + \sum_{i=1}^{4} \beta_i f_i(x_i) = f(\bar{x}), \tag{2}$$

where the values of the coefficients β_i and the functions $f_i(x_i)$, for $i = 1, ..., 4$ are the pre established relations and those in Table II.

The discriminatory power of a scoring model denotes its ability to discriminate ex ante between defaulting and non-defaulting loans. The validation process assesses the discriminatory power of scoring model, and it is usually via the ROC curve.[8] A score-type model performance is the better the stepper the ROC curve is at the left end and the closer the ROC curve' position is to the point (0,1). Similarly, for the model, the better the larger the area under the ROC curve is. Fig. 2(a) shows the ROC curve for $H = 12$ months probability of default model tested with our population database. For comparison purposes, we also have plotted a ROC corresponding to the estimation of parameters under the assumption that all variables follow linear relationships.

[5]Decision tree, clustering analysis and transitions matrices were some of the analysis performed and used to set thresholds to define what a good RCL is.

[6]For the regression analysis, we used the statistical software SAS and the GENMODE procedure.

[7]The Chi-square statistic and probability is used to statistically test whether including a variable reduces badness-of-fit measure in a model. This is analogous to producing an increment in R-square in hierarchical regression. If Chi-square is significant, the variable is considered to be a significant predictor in model.

[8]Fore more on ROC curves and its usage in validating score-type models see [14], [13], [12], [11].

One can notice that the nonlinear model fits much better than a pure linear. The slope -1 curve included in Fig. 2(a) will represent a model with no discrimination power at all (random model).[9]

B. A model for the severity of the loss given default

Understanding the tradeoff between receiving income streams from postponing foreclosure and acting it, is an important precursor to assessing the potential severity of loan defaults.

In a RCL, the severity of the loss given default is the unitary complement of the recovery rate. Once the loan is in default, the only means for recovering any cash-flows is by continuing with the development of the construction project, if necessary, and foreclosure of all remaining residences in the open market. Thus, severity of loss in a RCL is more associated to the project than the loan.

In Sociedad Hipotecaria Federal or anywhere else in Mexico, there is no large and robust database with information about foreclosure of construction loans. In order to come up with a model, we created a synthetic database by fictitious calculation of recovery given default (the present value of future cash-flows after default and foreclosure and including all costs involved), and comparing it with the outstanding amount (including interests) at default time. This was performed for each of the construction projects in our sample database. Once with the severity of loss given default figures for each project and each of the twelve analysis horizons, we constructed a score-type model to identify the key project and loan characteristics that describes it. It is worth noting that although we used a multivariate regression model, it is not based on a Binomial distribution or any other distribution. We estimate coefficient in the model directly from the synthetic estimates.

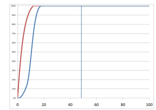
1) Severity of LGD synthetic database construction: For each of the RCL in the sample database, and assuming default has been declared, cash-flows were estimated based on ten pairs of theoretical curves (construction progress and residence selling) shown in Fig. 2. These theoretical curves represents the full range of possible combinations of construction progress and residential sale schedules (in terms of age of the loan).[10] Every curve reaches 100%, meaning that cash-flow recovery last until the last residence is sold.

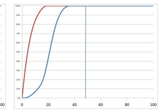
2) Curve occurrence probability: In order to assign a probability (likelihood) of occurrence to each of the pair of theoretical curves and to each of the RCL in the sample database, we used the following methodology.

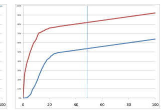
1) Each RCL in the sample has monthly information about construction and selling progress since its origination, denoted by $Month = 0$. We denote by

[9]Another measure of goodness-to-fit is the Kolmogorov-Smirnov(KS) test. For our nonlinar model KS=82.49% and for the linear KS=69.82%. There are opposite opponions about how good models are given by their KS statistics, but in general terms, a model with a KS larger than 60% has a good fitting. Both of our choices (linear and nonlinear) pass this criterion.

[10]These theoretical curves are the result of several historical analysis of residential construction loans behavior and the construction sector in Mexico, together with a series of meetings with experts in these topics.


(a) C-1.


(b) C-2.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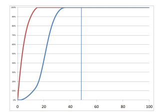
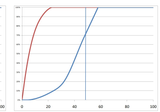
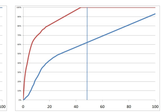
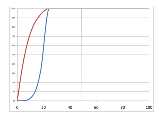
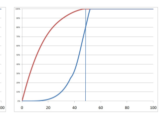
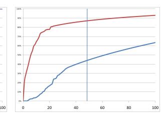

(d) C-4.


(e) C-5.


(f) C-6.


(g) C-7.


(h) C-8.


(i) C-9.

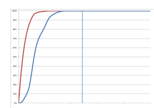

(j) C-10.

Fig. 1. Theoretical curves for cash-flow calculations. The x-axis represents the loan ages in months and the y-axis the progress in percentage (construction and selling of property). In each figure, every top curve corresponds to construction and the down one to the selling of property. This is because construction precedes to retail. The vertical line appearing in the plots is set at 48 months for visual comparison among curves.

$Month = K$ the month of the more recent observation.

2) Compute the distance between real data and theoretical curve points (measured as the absolute value of the difference) as follows:[11]

$$d^{\text{Const}}(\text{Real curve}, \text{Theoretical curve}^{\text{i}}) = \frac{1}{K} \sum_{j=Month=0}^{j=Month=K} \left| C_{real}^{Const}(j) - C_{i}^{Const}(j) \right|,$$

$$d^{\text{Sell}}(\text{Real curve}, \text{Theoretical curve}^{\text{i}}) = \frac{1}{K} \sum_{j=Month=0}^{j=Month=K} \left| C_{real}^{Sell}(j) - C_{i}^{Sell}(j) \right|,$$

[11]By our definition of distance $d(\text{Real curve}, \text{Theoretical curve}^{\text{i}})$, it represents the mean distance among the months of history for the loan. Note that $0 \leq d(\text{Real curve}, \text{Theoretical curve}^{\text{i}}) \leq 1$. The lesser the mean distance, the closer the real data to the theoretical curve.

		Horizon H		
variable	functional form	3	6	12
Probability of default model				
Intercept	none	0%	0%	0%
DevE	[composite]	0%	0%	0%
MinProyE	[composite]	0%	0%	0%
Mora	L	0%	0%	0%
Mora6	L	0%	0%	0%
Loss given default model				
Intercept	none	0%	0%	0%
AvMin	L	0.03%	0%	0%
AvProj	[cubic]	3.47%	5.22%	1.26%
DifMinAmort	[ln(ln(x+1.5))]	0%	0%	0%
AvAmort	L	0%	0%	0%
MAmort	[cuadratic]	0%	0.5%	2.09%
ResLib	L	29.49%	0.09%	0%

L: Linear, and [composite]: linear in the composite variable, but nonlinear in the input.

TABLE I
DESCRIPTIVE VARIABLES, FUNCTIONAL FORM AND CHI-SQUARE PROBABILITIES OF PROBABILITY OF DEFAULT AND LOSS GIVEN DEFAULT MODELS.

and then

$$d(\text{Real curve}, \text{Theoretical curve}^{\text{i}}) = \tag{3}$$

$$\frac{\left(\begin{array}{c} d^{\text{Const}}(\text{Real curve}, \text{Theoretical curve}^{\text{i}}) \\ + \\ d^{\text{Sell}}(\text{Real curve}, \text{Theoretical curve}^{\text{i}}) \end{array} \right)}{2}. \tag{4}$$

3) Define occurrence probability as the inverse of the total distance, i.e.,
   a) For each curve i, compute
   $$a_i = \frac{1}{d(\text{Real curve}, \text{Theoretical curve}^{\text{i}})}.$$
   b) Assign a probability of occurrence as
   $$p^i_{occurrence} = \frac{a_i}{\sum_{i=1}^{i=10} a_i}.$$

Once probability of occurrence for each curve and each RCL in the sample are assigned, cash-flows are computed under the following assumptions: (1) History is reconstructed based on the theoretical curves and projected a further H months to cover the analysis period, (2) Cash-flows start after twenty four months from default time, (3) Foreclosure costs are considered (legal expenses, building costs, property agent's commissions, property management fees and maintenance costs before disposal, etc.), and (4) Cash-flows are projected until last residence is sold.

Having all projected cash-flows, a Net Present Value is computed at default time. Recovery percentage is then computed as

$$\%\text{rec(proj)}$$
$$= \sum_{i=1}^{i=10} \frac{VPN_{\text{proj}}(\text{age} + H) \times \text{occ. prob.}_{\text{proj}}(\text{curve } i)}{\text{Outst. amount}_{\text{loan}}(\text{age} + H, \text{curve } i)}.$$

and finally, the severity of loss given default is calculated with $\%\text{LGD(project)} = 1 - \%\text{rec(project)}$.

Similar as in the model for probability of default, firstly we found the functional relationship of the dominant factors in the severity of LGD as a combination of operational knowledge and statistical analysis. We found several non linearities, as described in Table I. Using again a backward elimination procedure in the regression analysis via the maximum likelihood method, we ended up with a set of five describing variables satisfy too the robustness criteria over the twelve horizon of analysis H (see Table I for details on the Chi-square probabilities).

3) Independent variables and regression coefficients: The seven variables (six with the intercept) that describe the severity of loss given default are:

1) **AvMin**. This variable measures, as percentage, how much the developer has disposed of the original principal. It is very intuitive to be part of the set of variables describing the loss given default.
2) **AvAmort.** Similar to previous variable, it measures the total amount amortized as percentage of the principal. The larger the amortization the lesser the probability of default.
3) **DifMinAmort.** Disposition and amortization separately play an important role in determining default, but the model also incorporates too the relevance of the differential among them in a given valuation period. This spread is represented by the variable DifMinAmort. The shorter the spread, the healthier the behavior of the loan.
4) **AvProj.** One of the more natural variables to appear in the loss given default model is the project progress. It includes the progress on the part of the project currently under construction, but also the proportion that has been completed and even sold.
5) **MAmort.** This variable is computed as the number of months since origination, that the loan has amortizing any amount, scaled by the loan age. It can be interpreted as how often there has been financial activity in terms of amortization in the loan. A loan that has not been forgotten, has less probability of default.
6) **ResLib.** It is the percentage of the total residences sold. It is a very natural variable for describing loss given default of a construction project.

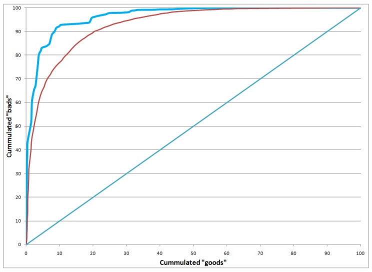
The models for the severity of LGD_H has the following form:

$$ln\left(\frac{LGD_H}{1 - LGD_H}\right) = \gamma_0 + \sum_{i=1}^{6} \gamma_i g_i(x_i) = g(\bar{x}), \tag{5}$$

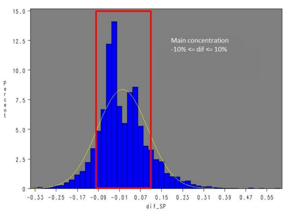
where the values of the coefficients γ_i and the functions $g_i(x_i)$, for $i = 1, ..., 6$ are in Table II.

In this case, the parameter estimation did not involved the assumption of an underlying probability distribution, as our synthetic values of severity of LGD were already figures between zero and one. Fig. 2(b) shows the distribution of the differences between the synthetic values and those estimated by the model. We appreciate how the 77.8% of the sample has differences in absolute values of less than 10%, and 95.6% of the data an absolute difference of 20%.

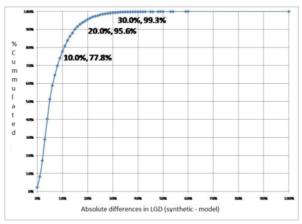
For validation purposes, we adapted the concept of ROC curves to test the closeness in estimation (instead of measuring its separating power as in usual ROC curves), by computing cumulative frequencies for each fix value of absolute differences. Fig. 2(c) shows the goodness of fit in the severity of LGD model. Interpretation of the adjusted ROC curve is similar as in PD. The closer to the left up corner, the better the fit.



(a) ROC for the PD model with the sample database.



(b) Distribution of the differences between synthetic severity and with the model.



(c) Goodness-to-fit curve for the loss given default model and the sample database.

Fig. 2. Validation for the loss given default model.

Probability of default model parameters			
	H=3 mes	H=6 mes	H=12 mes
β_0	-2.0449	-1.7471	-1.4717
β_1	-2.2745	-1.3604	-1.0788
β_2	0.7619	0.8388	0.6091
β_3	0.4198	0.2559	0.1367
β_4	0.3164	0.2569	0.1985
Loss given default model parameters			
γ_0	-0.6434	-0.454	-0.2651
γ_1	-0.1232	-0.2146	-0.3089
γ_2	0.7215	0.4286	0.1688
γ_3	-0.4334	-0.0583	0.2909
γ_4	-0.1472	-0.2522	-0.3702
γ_5	0.5964	0.5538	0.5413
γ_6	0.6128	0.5513	0.5012
γ_7	0.1396	0.0591	0.0132
γ_8	-0.6869	-0.523	-0.4089
γ_9	0.0001	-0.0522	-0.1052

TABLE II
PARAMETERS IN THE PROBABILITY OF DEFAULT AND LOSS GIVEN DEFAULT MODELS.

IV. CONCLUSIONS

The objectives of this research were to look for behavioral characteristics that determine the probability of default and severity of loss given default in Residential Construction Loans in Mexico, and to examine their significance using a mathematical and statistical approach.

This study contributes to the understanding of construction loans behavior in Mexico and its credit risk in general.

On one hand, we find a model for the probability of default of RCLs in Mexico that can be described by five variables, which happen to be very intuitive and with a direct financial interpretation. On the other hand, although there is no in Mexico a database for severity of loss given default of construction loans, we were able to built a synthetic sample and find seven behavioral characteristics that describe it. These two models are the key cornerstones for computing capital reserves for RCLs. These two models might serve as a first step toward analyzing systemic credit risk in the mortgage sector.

Future studies of credit risk for RCLs might include the analysis of macroeconomic factors.

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Cognition of Information System Control as Metalanguage (COINS)

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ABSTRACT

Information systems are treated as socio-technical systems for achieving some context relevant and consensual impact or effect through exchange of messages in the global marketplace. Hence, the systems have to be developed and implemented with respect to the spiritual system parts', perception of cultural disparate or contextual content realities. The complex meta-system; i.e., the Internet providers have to know and cognize how to transparently satisfy cultural disparities for what realities are requested by the parts in the virtual market. Internet, as enabling system dependability, is supposed to be the driving factor for global prosperity development. So, the prosperity sustainability complexity language can relay on the language for management of a complex, but not necessarily complicated system; e.g., Internet control as meta-language.

Keywords: Cognition, Information, System, Control, Language, Dependability.

PRESUPPOSITIONS

The Figure 1 socio-technological (SOT) system model is aimed to message an experienced general view on a system of entropy reducing [1]: (Miller, 1978; p. 16) processes being impacted of its environmental events. In particular, the model can represent realizations of "Technology and Industrial Innovation Management" [2]: (TIIM, 2011) proceedings as textbook objectives for sustainability efforts' dependability with respect to [3]: (UN, 1948) Human Rights declaration meaning.

The abbreviations —listed in the final paragraph— are for exemplifying how introduction of a meta-language and generic use of it for strategic 'can be', tactic 'shall be' and operation 'is' challenges questions of real effect of message exchange.

The requisite variety width (RQW) idea is based on the meaning of requisite variety in [4]: (Ashby, 1999). The RQW cognition is achieved per entity (ETY) identity (IDY) function through Bloom's taxonomy application [5]: (IEEE, 2004), [6]:

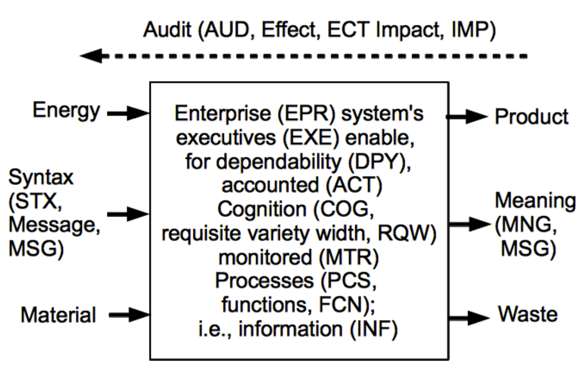

Figure 1. The contextual (CXT) system model concept

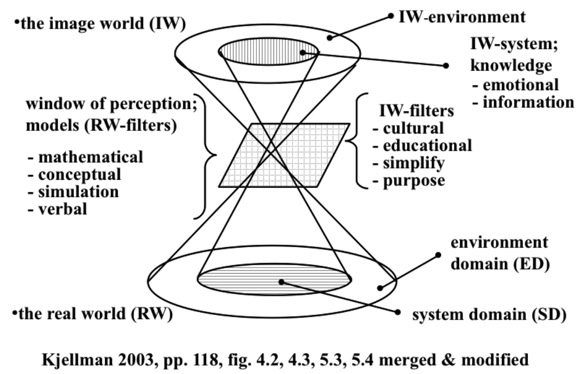

Fig. 2. Cognition (COG) filters [7, pp. 117-124, adapted]

(IOWA, 2009).

Realizations depend on an enterprise (EPR) executive entity's contextual perception of realities according to Figure 2 [7]: (Kjellman, 2003; pp. 117-124, adapted). Each spiritual, as well as technological (TEL), authentic ETY_IDY has to be authorized with respect to cognized RQW concerning the real world [8]: (IEA, 2007) events and access to dependent abilities as assets.

The authorization process is de facto accreditation relatively to a, in policy, stated evaluation level. For feedback, each ETY_IDY behavior has to be monitored (MTR) and taken in account (ACT) when auditing (AUD) of the environmental events:
"If a system's negative feed-back discontinues and it is not restored by that system or by another on which it becomes parasitic or symbiotic, it decomposes into multiple components and its supra-system assumes control of them." [1]: (Miller, 1978; p. 110, hypothesis 5.6-1)

Trust as a dependability feature
Dependability (DPY) is a basic for sustainability. It is about reliability in trust as a confidence asset:
"Mutual understanding as 'Trust' between the Agents of Change [communicating parts]:
1. The two parties have faith in each other's recommendations.
2. Each party is sensitive to the motivation, aspirations, and values of the other party.
3. Each party understands its own decision-making process as well as of the opposite side.
4. The "implementer" [imperative implementer as provider, P] is involved in the formulation of [policy, PCY] goals in order that his recommendations and programs bear relationships to the [quality of service, QOS] needs of the recipients [customer as questioner, Q].
5. The recipients [Q] are involved in the preparation of plans and programs so that they bear relation to their own perception

of [RQW cognition] needs and [evaluation level] scale of values.
6. The agent promoting [P] change is capable of placing himself in the position of the recipients [Q] and of "thinking" like them." [9]: (Van Gigch, 1978; p. 401)

Security through certified dependability
A de facto expression for information security is: ISC {confidentiality, integrity and availability}. For the conceptual Figure 1 context, that expression is not enough because any operator entity as authorized dependability has to be protected against not authorized impact and is, according to the strategic policy, certified and accredited with respect to class of: ISC {confidence or secrecy, integrity, dependability including availability, and feedback: (monitored performance, accounted behavior, and audits of environmental effects)}

ARISTOCRACY

In the current context, an Aristocratic [10]: (Adizes, 2006) decision state associates with imperative [11] laissez-faire behavior; i.e., escape from difficulties motivating that some other executive entity than I will do what ought to be done. Perhaps it is because of RQW or access right is not in parity with the actual ETY_IDY's authority: "The effects of steady decline in flexibility, which began in Prime [state], start to become more obvious in Aristocracy. Because it has neglected to pursue long-term opportunities, the company's [enterprise, entity's] focus becomes increasingly short-term. For the most part, its goals are financially oriented and low-risk. With less of the long-term view, the [cultural, ergonomic] climate in an Aristocratic organization is relatively stale." [10]: (Adizes, 2006), [11]

Not authorized (¬ATH), certified and 'robot' or 'chat-bot' like imperative mechanistic meta-language behavior need to be avoided. In general, any application implementation shall be SWOT {Strength, Weakness, Opportunity, and Threat} analyzed in an appropriate evaluation process for authorized adaptation of it with respect to a strategic risk policy.

SWOT RISK

A risk reason may be routines, leading to antibiosis characteristic like behavior, if not reasonably programmed algorithms or rules as mandatory operational action duties. A 'not adapted SWOT analyzed routines' attitude can be interpreted as Adizes' [10] "aristocracy" through delegating technical or bureaucratic functions the role attitude that associates with some of the characteristics:
"As organizations enter Aristocracy they characteristically:
- Are cash rich and have very strong financial statements.
- Have reduced expectations for growth.
- Demonstrate little interest in conquering new markets, technologies, and frontiers.
- Focus on past achievements rather than future visions.
- Are suspicious of change.
- Reward those who do what they are told to do and punish those who do not.
- Are interested in reducing their risks.
- Invest much more on control systems, benefits, and facilities than they do on R & D.
- Form dominates function in the organizational [cultural, CLT] climate.
- More emphasis is placed on how things are done, than what was done.
- Value uniformity, consistency and formality in dress, decorum, and behavior.
- Employ individuals who are concerned about the company's vitality, but are willing to abide by a "don't make waves" operating motto.
- Engender only negligible innovation with internal efforts.
- Acquire other products or companies for new products, markets, and entrepreneurship to feed into their distribution channels and operating systems.
- May be takeover targets themselves." [10]: (Adizes, 2006)

LIVING SYSTEMS

The Figure 1 system model is supposed to inhere with living systems characteristics.

Structure
"H1-1: In general, the more components a system has, the more echelons it has. [1]: (Miller, 1978; p. 92)
H1-2: In general, the more structurally different types of members or components a system has, the more segregation of functions there is." [1]: (Miller, 1978; p. 92),

Process
"H2-1: System components incapable of associating, or lacking experience, which has formed such associations, must function according to rigid programming or highly standardised operating rules. It follows that as turnover of components rises above the rate at which the components develop the associations necessary for operation, rigidity of programming increases. [1]: (Miller, 1978; p. 92)
H2-2: The more rapid reassignment of function from one component to another a long-surviving system has, the more likely are the components to be totipotential [isolated cells', like space stations' maintainability to survive through spare part replacement; rapid turnover of personnel] rather than partipotential [specialized, key function organs]. [1]: (Miller, 1978; p. 92)
H2-3: The more isolated a system is, the more totipotential it must be. [1]: (Miller, 1978; p. 92)
H2-4: A system's processes are affected more by its suprasystem than by its supra-suprasystem or above, and by its subsystems than by its sub-subsystems or below." [1]: (Miller, 1978; p. 92)

Frictions
"Among the limited number of adjustment processes which channels in living systems employ as information input rates increase are: omission, error, queuing, filtering, abstracting, multiple channels, escape, and chunking. Each of these processes applies to random and non-random information inputs except chunking, which applies only to non-random inputs with repetitious patterning to a system that can associate (or learn). Each of these processes occurs at multiple levels of living systems. Each of these processes has a cost in some sort of decreased efficiency of information processing." [1]: (Miller, 1978; pp. 103, 124, Hypothesis 5.1-3)

Below Figure 3: "Theoretical curve on logarithmic coordinates based on average performance data of five living systems (cell, organ, organism, group, and organisation) under various rates of pulse-interval coded information [bits/s]." [1] (Miller, 1978; Fig. 5-54. p. 192) is based on Table 1 data (ibid) where a spiritual ETY's number of organisms in the organization are four, in the group are two, and while the cell is part of an organism.

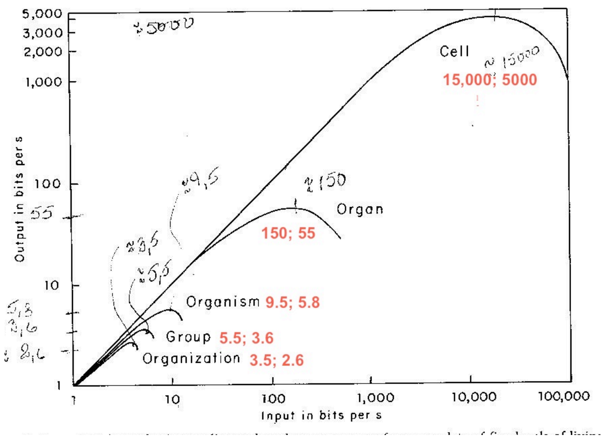

Figure 3. Theoretical curve based on experiments.

Table 1. Bit rate max points. [Miller, 1978, p. 192; adapted]

Max point bits/s	Organi-zation 4 pers.	Group 2 pers.	Organism 1 pers.	Organ [part of organism]	Cell [part of organ]
Out	2.6	3.6	5.8	55	5050
In	3.5	5.5	9.5	150	15000
[Q]	0.74	0.65	0.61	0.37	0.33

Table 1 experiment data for the Figure 3 theory, are expressed as base 2 logarithms in Figure 4.

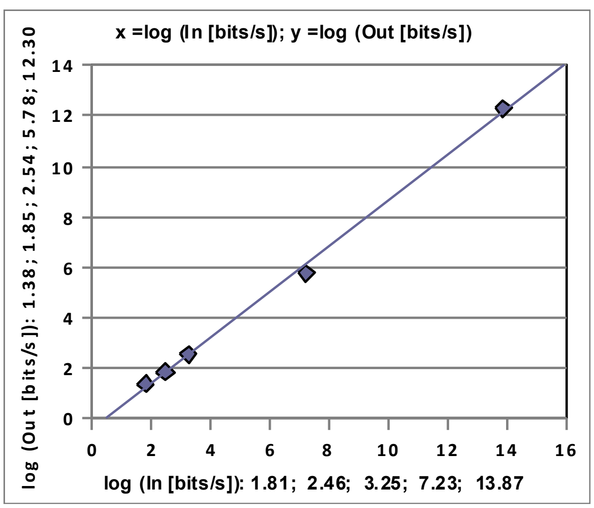

Figure 4. Base 2 logarithms of Table 1 data.

Conclusive audit

A conclusion of the above living systems characteristics may be that an entity with high general knowledge is more replaceable than a context cognized team participating specialist. That ability can, through deeper requisite variety width, participate to the higher organizational Table 1 Q-value.

For Figure 1, the MSG_{out}/MSG_{in} quotient (Q) value in Table 1 may indicate higher efficiency in organizations because of the fact that products; i.e., effects are absorbed uncertainties or entropy; i.e., information as gained knowledge. Waste is redundancy or distorting overload; e.g., contextual inadequacy.

COMPLEXITY METALANGUAGE

A basic method for analyzing complexities in systems is in [12]: (Miles, 1989). Computerization of the efforts gives opportunity to manage analyze of larger systems. To make such analyze understandable there are need of analyzing the output message: "How complexity leads to simplicity." [13]: (Berlow, 2010) Such analyze is actual in: "Systems Engineering [SE] complexity. In real terms, applying SE is often seen as a project risk because of its reputation to be complex.

Statement: 'Complexity can be managed [MGT] if the information [INF, gained knowledge] is managed [for being contextually (CXT) cognized (COG) requisite variety width (RQW)]'.

Information management [i.e., ISC] in the context of SE requires a methodology. For that, [14]: ISO 15926 offers a framework (explicit [ITY], unambiguous [COF], traceable [AUD]) [14]: ISO 15288/ISO 15926" [15]: (V. Ruijven, 2007, p. 5)

Products; i.e., Figure 1 outputs from one EPR_A can be data communications technology (DCT; i.e. TEL) components as material to be adapted (APT) as assets (AST) in another EPR_B's information system (ISY). It is the meaning in Figure 5 [15]: (Ruijven, 2007; p. 12, adapted).

The EPR_B has to communicate (COM) its system specifications ([16]: W3C; [17]: V. Renssen, 2005, 2008); [18]: Lawson, 2010) to EPR_A of which is a process from high uncertainty to lower ditto; i.e. from Table 1 right most column to the left most one.

Furthermore, the EPR_B has for internal COM, to begin with;
- EXE-0 strategic (STY) 'can be/have' auditable (AUD) policy (PCY),
- EXE-1 tactical (TAC) 'shall be' accountable (ACT) ADP or MDP role (ROL) routines or rules (RUL) for
- EXE-2 operative (OPE) 'is/has' monitored (MTR) COM of the EPR QOS mission actions (Act).

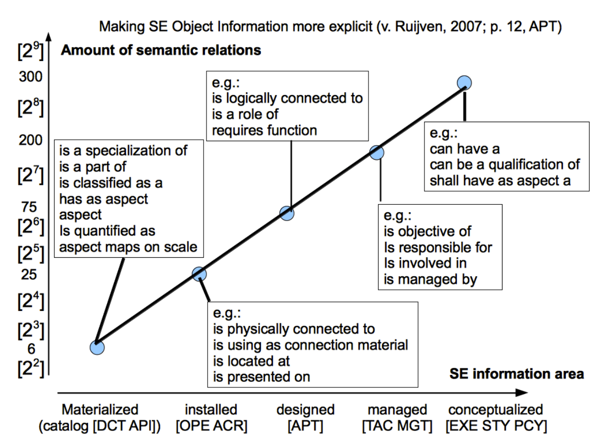

Figure 5. Organization of EPR ECA is entropy reducing

METALANGUAGE REALITY

Abbreviations

One-line meaning (MNG) in below syntaxes, as a contextual [2, G1.3] information system security machine (ISM) draft example, does not, if hit, supersede, but emphasize the MNG in ITU-T recommendations E.800, X.200 or X.800 [20].

ABY	Availability (to asset entities)
ACR	Accreditation (certified authorization)
ACS	Access (to assets in parity with role authority)
ACT	Account (of access)
Act	Action (use of access)
ADM	Administration (behavioural routines and rules)
ADP	Automated (algorithmic) data processing
API	Application; OSI layer #7 or equivalent
APT	Adaptation; SOL (ACR of COG API/ECA REL)
ARC	Archetype (is caricature of a phenomenon)
ASP	Aspect (message meaning)
AST	Asset (accessible ability)
ATH	Authority (RQW and ACT dependent right to ACS)
AUD	Audit (of behaviour with respect to EVT, PCY, ACT)
AUT	Authentic (not corrupted integrity)
BEH	Behaviour (possible authorized state variance)
CLS	Class (set of comparable features)
CLT	Culture; SOL (context dependent)
COD	Coding; OSI layer #6 or equivalent
COF	Confidentiality (confidence or secrecy)
COG	Cognition of contextual knowledge effect
COM	Communication (peer to peer interaction effect)
CQE	Consequence (effect of meaning in message)
CTR	Control (of STY, TAC, OPE)
CXT	Context (in STY, TAC, OPE)
DAT	Data (facts to be processed, stored and messaged)
DCT	Data communication technology
DPY	Dependability (ITU E.800; trusted and reliable ABY)
DSC	Data communication security (ITU X.800)
EAL	Evaluation level
ECA	Enterprise Communication Architecture; SOL
ECT	Effect (of EVT or OCU consequent MSG)
EFY	Efficiency (economy of effect in a LCP time slot)
EPR	Enterprise (QOS mission performance)
ERR	Error (is a consequence of reliability fault)
ETH	Ethic; SOL
ETY	Enabling unit with identity to be authorised for a role
EVT	Environmental event or occurrence
EXE	Enterprise executive entity
EXE-0	Enterprise executive entity - strategic
EXE-1	Enterprise executive entity - tactic
EXE-2	Enterprise executive entity - operation
FAL	Failure (is a consequence of escalating error)
FCN	Function (strict relation aspect)
FEB	Feedback
FLT	Fault (causes reliability breach indicated as error)
HW	Physical framework (architecture)
ICI	Incident (fault caused error)
IDY	Identity (to be authenticated)
Im	Imaginary (may be an Re-accompanying attribute)
INF	Information (gained knowledge caused by MSG)
ISC	Information Security (state of INF certainty)
ISM	Information System Security Machine concept
ITU	International Telecommunication Union
ITY	Integrity (consistent and not corrupted, authentic)
KNW	Knowledge (of contextual events or occurrences)
LAW	Law or other mandatory rule; SOL
LCP	Life cycle period of an entity or process
LNK	Link; OSI layer #2
MBY	Maintainability (of fault caused erroneous ICI)
MCE	Maintenance (of ERR caused QOS or LAW FAL)
MDP	Manual data processing; ADM
MEA	Measure (is evaluation)
MGT	Management; SOL (of STY, TAC, OPE)
MNG	Meaning (is message aspect)
MSG	Message (is structured transport of data syntaxes)
MTR	Monitoring (of performances)
NET	Network; OSI layer #3
OCU	Occurrence; EVT
OPE	Operation; EXE-2 ‘is/has’ relation aspect
OPU	Opportunity; SWT
ORG	Organization; SOL (of ECA)
OSI	Open System Interconnection (ITU-T X.200)
PCS	Process (of data or material)
PCY	Policy; SOL (strategic EVT and RSK concept)
PEF	Performance (of operative mission actions)
PHY	Physical medium; OSI layer #1
PRT	Protection (of dependability; e.g., a SEC state)
QOS	Quality of Service in mission performance
RBY	Reliability (fault frequency dependent)
Re	Real, tangible effect
REL	Relation (may be a function)
ROL	Role (an authorized behaviour variance)
RQW	Requisite variety width in cognition
RSK	Risk (cost of consequences)
RUL	Rule (mandatory; e.g., LAW or ADM)
SAF	Safety (the condition of being protected)
SEC	Security (a state of protected safety; e.g., DPY)
SES	Session; OSI layer #5
SGN	Signal (perceived meaning in message)
SOE	Social engineering (unauthorized BEH in ACR CXT)
SOL	Social layer (s)
SOT	Socio – technologic layer(s) (SOL, TEL)
STR	Strength (low vulnerability)
STX	Syntax (message structure)
STY	Strategy; EXE-0 ‘can be/have’ relation aspect.
SW	Software (definition of API algorithms or rules)
SWT	SWOT; strength, weakness, opportunity, threat
TAC	Tactic; EXE-1 ‘shall be/have’ relation aspect
TEL	Technologic layers; OSI layer (s) #1 to #7
TRP	Transport (of MSG); OSI layer #4
TRT	Threat (ITU-T X.800)
UN	United Nations
VUE	Value (of effect or consequence)
WEK	Weakness (vulnerable)

The broadband vision as example

Below, abbreviations within square brackets, included as comments to the extract from, [19]: (ITU/UNESCO, 2010; pp., 5f) Broadband Commission — contextual environment event (EVT) — for Digital Development Declaration [DCT; i.e., TTL] vision concerning the 2010 Millennium Development Goals (MDG), are ‘information security machine (ISM)’ aspects (ASP) with respect to [2]: (TIIM, 2011) as text book for open dictionary [11] phenomena to be structured according to system engineering [14, 15] principles. The square bracket comments are aimed as a memento of ‘information security (ISC) management (MGT) system (ISMS)’ general usability and may exemplify a step toward conceptual realization of the vision.

Forging (Informing) seven forces

For each of the "convergent and interdependent forces [ASP] of policy [PCY], infrastructure, technology [DCT; i.e., TEL], innovation, content [COG MNG] and applications [API], people [spiritual ETY] and government [EXE-0 relatively to MDG as EVT]:

• Fundamentally, this will require government-wide leadership from the very top [CXT, EXE-0], at the level of Prime Minister or Head of State, with a supporting governance mechanism [EXE-0 communication architecture, ECA-0, SOL, QOS];

• A broad-based 'bottom-up' approach is also required [DPY] to build commitment to the concept of broadband [TEL_NET] inclusion for all;

• Raising awareness [KNW] of the economic and social [SoL] benefits of broadband [TEL_NET] should be publicized among policy [PCY]- and decision-makers [EXE-0, PCY, providers, P], as well as the general public [DCT, QOS questioners, Q];

• Most of the investments for broadband [DCT] will come from the private sector [P], so policy-makers [EXE-0, STY] need to engage with industry and investors [EXE-1, TAC] to promote policy [OPE, PCY] objectives [OBJ] more broadly;

• Providing [P] policy [PCY] development skills [COG, AST] to public authorities [EXE-1, agency, AGY] could help abolish some of the existing [BEH, SWT] barriers and [FLT] factors that hinder widespread uptake of broadband [TEL_NET] use in the population [Q];

• For areas where private investments are not feasible, public authorities [EXE-1 agency, AGY] and private entities [EXE-2, EPR, ETY] should find innovative ways of [ECA-2] cooperating to achieve widespread access [DPY ACS] to and use of broadband [TEL_NET];

• Content [MSG, RQW, MNG] and applications [ACR API] development is undergoing profound change. As the creation, funding [AST], sharing and distribution of content [MSG, RQW, MNG] in the digital [SOT] world increases in complexity, a fundamental concern of business [EPR], government and civil society [SOL, EPR] should be the stimulus of local and diversified development-centric applications [ACR, API], in local languages [COG];

• Security [SEC of DPY], authenticity [AUT], and integrity [ITY] issues will become ever more important, particularly with regard to privacy [AST], protection [PRT] and confidentiality [COF], and must be addressed [AUD], otherwise large-scale investment in broadband [DCT] infrastructure is unlikely to fulfil its potential [DPY fail, FAL]." ([19], p. 19)

Content

"As has been witnessed across the ICT [DCT for conveying MSG] world, connectivity [DPY] without content [MSG, RQW, MNG] can make even the most sophisticated technologies [TeL, ACR, API, APT] irrelevant or of limited value [VUE]. In today's virtual world, it is vital that governments [EXE-0] do not neglect [FAL] the importance of content [MSG, RQW, MNG]. Policy-makers [EXE-0] have to emphasize the development of rich and diverse online content [MSG, RQW, MNG] and applications [ACR, API, APT] alongside infrastructure [DCT, EVT] and propose concrete policies [PCY] and practices [COG] for inclusion of new languages [ECA] and tools [API] for the measurement [MEA] of linguistic diversity [COG]. Some of the main issues with regard to content [COG] include making more online [OSI] material accessible [ACS, DPY] in local languages or accessible [ACS] to people with limited functional literacy skills [COG]. The digital divide is a result not only of a lack [FAL] of access [ACS] to connectivity [API, DPY] and infrastructure [DCT], but also of a lack [FAL] of relevant and locally-developed content [COG] which can make a big difference to the [QOS] lives of ordinary people. It is important to recognize that broadcasting also plays an important role [ROL] in the developing world in the creation and dissemination of rich media content [COG]." … ([19], p. 31)

Sustainability

"The MDG on ensuring environmental sustainability [EVT] spans a wide range of targets [OBJ], from the provision of safe [SAF] drinking water and basic sanitation [PHY] facilities to reducing biodiversity loss [FAL] and improving the [QoS] lives of slum-dwellers.

In virtually all these areas, broadband [DCT] networks can make an important contribution. They can swiftly transmit information [MSG] from ground sensors or satellites to monitor [MTR] the effects [ECT] of climate change [EVT] or impending natural disasters [FAL], such as drought or floods. They can provide early [ERR of FLT ICI] warning systems that reduce vulnerability [VUL, WEK] to disasters [FAL]. …

GPS-based applications [API] can also help monitor [MTR] environmental abuses [EVT] (eg, illegal logging or pollution levels) and transmit that information [MSG] to authorities [AGY, ATH]. …

Sharing experiences of what works [COG], learning from others and changing people's expectations of their living [QoS] conditions and livelihoods are all part of the complex challenge of empowering [COG] people to improve their own lives [QOS]." ([19], p. 45f)

Society

"Building global commitment to broadband [TEL_NET, EVT] inclusion for all by connecting broadband with the MDGs and knowledge [RQW, KNW] society [SoL] priorities.

a) At the global level [EVT] world leaders at the *2010 MDG Summit* must galvanize the international community [EVT] to act [Act] on a common vision of the power [ATH] of technology [TeL] and innovation, built on broadband [TEL_NET], to accelerate the achievement of the MDGs and other internationally-agreed development goals [OBJ] and key knowledge [KNW, RQW] society [SoL] priorities such as those of the WSIS by 2015, in the context [CXT] of the new digital [DCT] realities and [SWT] opportunities [OPU] of the networked society [SoL, ECA] and economy.

b) At the national level [EXE-0] governments should adopt national broadband [TEL_NET] strategies [STY], recognizing that, in the information [STX, MSG, RQW, MNG, COG, ECT] age, broadband [TEL_NET] – like water, electricity, and roads in the industrial age – is not just a tool [API] for communication [COM], but a social asset [SoL, AST] that provides one of the most cost-effective [ECT] and efficient [EFY] means [AST] for delivering services [QoS] to citizens and comprises a nation's core functions [relations], provides a variety [RQW] of services [QoS], and should be made available [ABY] to all members of society [SOL, RQW], in their own languages.

c) National [CXT, EXE-1] ICT Policies [DCT PCY] should be encouraged to build inclusive knowledge [KNW, RQW] societies [SOL] where all citizens [Qs] have the skills [COG] and confidence [COF] to create, share, and preserve information [MSG] and knowledge [KNW, RQW] to improve their [QOS] lives. Governments [EXE-0] need to promote policies [PCY] in universal access [ACS] and these policies [PCY] should include [DPY] broadband [TEL_NET] access [ACS] as an essential element of universal access [ACS, DPY] and services [QOS].

d) Special consideration should be given to the direct application [ACR, API] of broadband [TEL_NET] solutions to address the cross-cutting and cross-sectoral aspects [ASP] of the MDG agenda. Specifically, evidence pertaining to impact [IMP], new business and social [Provider/Questioner, P/A] models, and sustainability [DPY] is essential in demonstrating the benefits of broadband [TEL_NET] diffusion for scale-up and replication across all eight MDGs.

e) A mid- and long-term perspective, taking into account [ACT] the requirements [REQ] of diverse communities [SOL, EVT] and stakeholders, is essential in forming a [ECA] consensus for broadband [DCT] investment and uptake. Governments [EXE-0] should play a pivotal role [ROL] in exploring innovative financing mechanisms [ADP, MDP, RUL] and incentive strategies [STY].

f) Advocacy efforts should be prioritized for a global market in broadband devices [TEL_NET, DCT], networks, software [SOW] and solutions that will harness the power [ATH] of network effects [ECT], as well as spill-over effects [ECT] of broadband [TEL_NET] across multiple sectors, while improving framework conditions for interoperability [OSI] between broadband [DCT] products and services [QoS, API].

g) Ultimately, new national [EXE-0] development models based on universal access [ACS] to broadband [DCT, APT] connectivity and multilingual content [COG, MNG] can aspire to the goal of 'digital [DCT] opportunity [OPU]' – that is social [SoL] and economic development made possible via access [ACS] to knowledge [KNW] that can narrow [COG P/A] gaps between rich and poor and among classes and regions.

h) We urge all relevant stakeholders to continue to pose the key questions [Q] of what incentives can be created [COG] by governments [EXE-0] to encourage and enable the private sector to invest." ([19], p. 55f)

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A Case Study of Off the Job Training Course for Control Engineering

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ABSTRACT

In this paper, a case study of Off the Job Training course for control engineering designed based on the collaboration with authors and an industry is presented. This course is six weeks long and is a blended learning one composed of a face-to-face classroom, e-learning class and experiment based learning using a simple hardware. A case study suggested experiment based learning is effective, however the class schedule should be designed in a careful way.

Keywords: Off the Job Training, Collaboration with Academy and Industry, Experiment Based Learning, Blended Learning

1. INTRODUCTION

In industry, On the Job Training (OJT) is very common for fresh engineers or mid-career engineers to develop their job skill or to get wider engineering and management skill. On the other hand, Off the Job Training (Off-JT) is also enforced mainly for mid-career engineers to enhance their capabilities in the different field or to collaborate with engineers in another section of the company by studying together. In this paper, a case study of Off the Job Training course for control engineering designed based on the collaboration with authors and an industry is presented.

A company, which produces information devices and information systems with more than 1000 employees, planed an Off-JT course for mid-career engineers with authors. The objective of the Off-JT are 1) to study the advanced control technology, 2) to improve problem solving skill in the field of mechatoronics by considering the difference between the theoretical response and the real response, 3) to improve collaborate skill with engineers in other section of the company. Most of the professional territory of participants is not control engineering but other field such as mechanics, electronics, chemistry and so on.

Basic control engineering is very essential knowledge for every engineers and covers wide area such as mathematics, physics, chemistry, mechanics, electronics and so on. Figure 1 shows standard learning process of control engineering. Firstly, students learn control theory by instructors in a class using mainly textbook. Secondly, they verify the studied theory by digital simulation using CAD tools and so on. Finally, they verify the actual motion by experiment. Each process and combinational study of these three process are very important. In particular, essential practical details can be lost if learning is reduced only to lectures and digital simulations bypassing physical experiments because of their relatively high costs or time-consuming [1]. Experiment-based teaching or learning is absolutely necessary.

So far, authors have developed several Off-JT control engineering course in collaboration with industries as follows.

1) One Month Intensive Course:
   Study topics are learning theory, designing controller, verifying by simulation, implementing digital controller and analyzing the actual motion using a simple robot with group-wise work.
2) One Week Intensive Course:
   Study topics are learning theory, designing controller, verifying by simulation and analyzing the actual motion using given controller of a simple robot with group-wise work.
3) Three Days Intensive Course:
   Study topics are learning theory, designing controller, verifying by simulation and analyzing the actual motion using given controller of a simple robot without group-wise work.

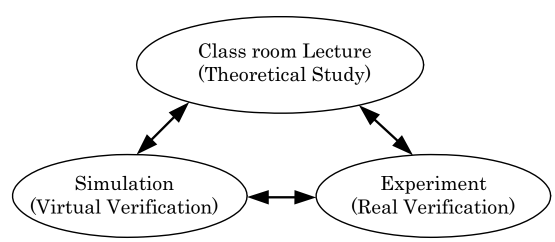

Fig. 1 Learning process of Control Engineering

One Month Intensive Course was the most effective one for engineers, however it had time-problems for both engineers and industry. One month Off-JT course is too long to be difficult to enroll for mid-career engineers because they have daily routine work. Three Days Intensive Course is good for their time-schedule, however they have no time in the course to try their own control idea or to follow through the theory by simulation and experiment. They only studied lecture's explanations or follow prepared experimental results. One Week Intensive Course is better than three days one, however they don not have enough time to consider, for example a couple of days, or to try their own control idea and to implement own digital controller.

According to these experience, experiment-based learning is found very effective as shown in [1]. However, for both engineers and company, an intensive course is very difficult due to their daily routine work. A virtual lab system or a remote experience lab system will be one of the learning style instead of real experiment-based learning [2],[3]. On the other hand, e-learning using Internet is getting popular from viewpoint of learning at anytime and anywhere [4],[5].

Authors designed a new course, which includes face to face class lecture, e-learning and experience-based learning according to a company's request. In this paper, the course design and some results are described.

2. COURSE DESIGN

Most of companies have planed and organized many kinds of On the Job or Off the Job training course for fresh engineers or mid-career engineers to develop their job skill or to get wider engineering and management skill.

This time, the company's request to Off-JT course for authors is as follows.

1) students:
   About 10 mid-career engineers who belong to different section and have different specialized field each other.
2) class room:
   They can attend a class opened in industry full or half day (four to eight hours) once a week. The course should be one to two months.
3) objective 1:
   They want to learn the principal of a control system from viewpoint of "Monozukuri" (Manufacturing), especially the design approach based on control theory.
4) objective 2:
   They want to study in cooperation with other section's engineer due to carry out a complicated and big project in industry.

Authors have several classes for control engineering, electric engineering and mechatronics laboratory in each university and have knowledge that a hands-on mechanical system with a microprocessor called Arm-Robot, control design CAD (Scilab$^{@}$), web-based discussion forum and group-wise work using Arm-Robot are very effective educational materials [6],[7].

The structure of the Arm-Robot is shown in Fig. 2. A small motor (1 Watt) with gears drives a small bar called the arm. The angle of the arm is determined with a hand-made encoder.

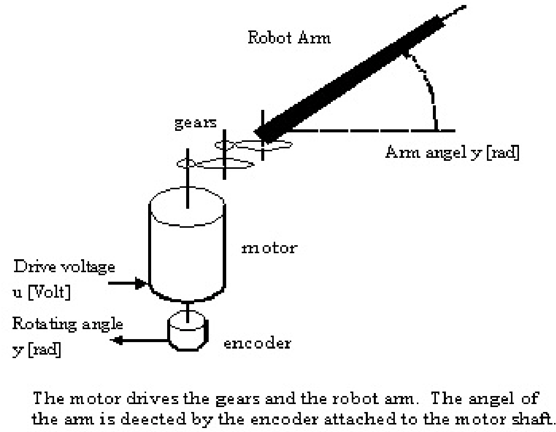

Fig. 2 A single axis Arm-Robot

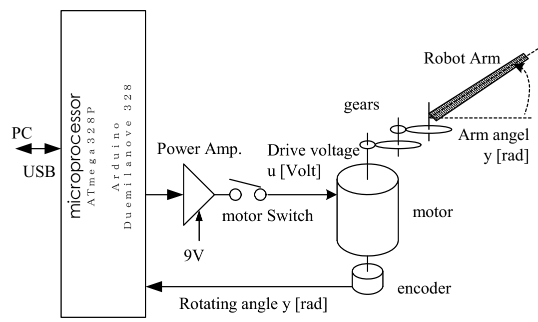

Fig. 3 Controller Board with a microcontroller

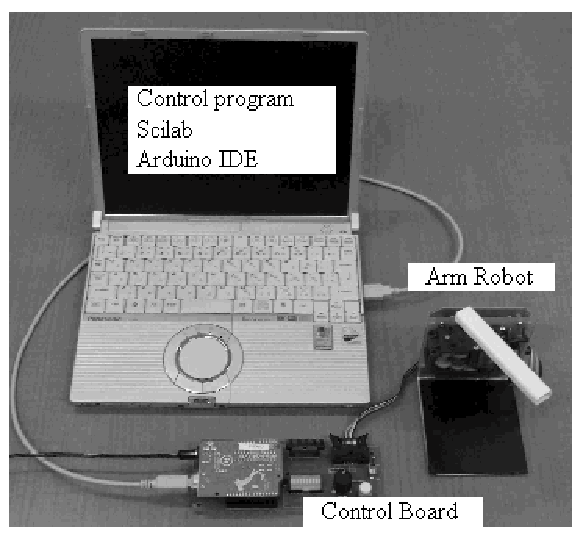

Photo 1 Course materials
(Control program (see Fig.6), scilab and Arduino IDE is installed in PC. Control Board is connected to PC by USB.)

The control board with a microcontroller shown in Fig. 3 is a digital controller of the robot and has an interface with a PC. The control program (based on C) of the microcontroller can be easily changed by the PC. Photograph 1 shows the arm robot and the amplifier.

Authors designed a following new course as a result of consulting the company's supervisors.

1) Course Materials:
   Hardware: Arm-Robot, controller board and PC
   Software: Scilab@ , Arduino@ IDE and control programs
2) Course Style:
   The course is totally six weeks combined with face to face classroom (once a week) and e-learning class. Each student has one set course materials (an Arm-Robot, controller board and PC).
3) Course Contents:
   Web-based lecture note, web-based simulation tools and Remote-lab system are set up.
4) Course Topics :
   Basic control theory such as transfer function, stability, PID controller design, digital controller implementation, Group-wise Project (system design with three robots)

3. COURSE MATERIALS

3.1 Arm- Robot System

It is a big problem which kind of experiment system is better for students [6]. In this course, we focus on a simple and low-cost hands-on system [7],[8]. This system is basically composed of following three parts as shown in Fig.1 and Photo.1.

1) An Arm-Robot
2) A Control Board with a microcontroller
3) A control program for the Control Board, Scilab and Arduino IDE on Windows system

The Arm-Robot system is so simple that its linear dynamic equation is derived as

$$J\frac{d^2}{dt^2}y(t)+c\frac{d}{dt}y(t)=ku(t) \tag{1}$$

where, J: moment of inertia, c: coefficient of viscous friction, k : coefficient of motor torque.

A real step response of PID controlled system is usually different from a theoretical one because of its non-linearity as shown in Fig. 4. Recognizing and analyzing this difference is the most important practice for control engineers. The simulation considering its non-linearity is one of good practice for students. This means that Eq.(1) will be modified as

$$J\frac{d^2}{dt^2}y(t)+c\frac{d}{dt}y(t)+\alpha\left(\tfrac{d}{dt}y(t)\right)=\beta(u(t)) \tag{2}$$

and students are going to find out more precise mathematical model of the target system. On the other hand, as the objective of the control is tracking the reference, tuning PID parameters is the another good practice to achieve the objective as shown in Fig. 5. This shows the advantageous effect of feedback control system that a small model error is reduced by high gain feedback technique.

[2] shows emulation-based virtual laboratories. The above experience can be possible by simulation, however a complicated nonlinear model as Eq.(2) is necessary and its realistic derivation is sometimes very difficult.

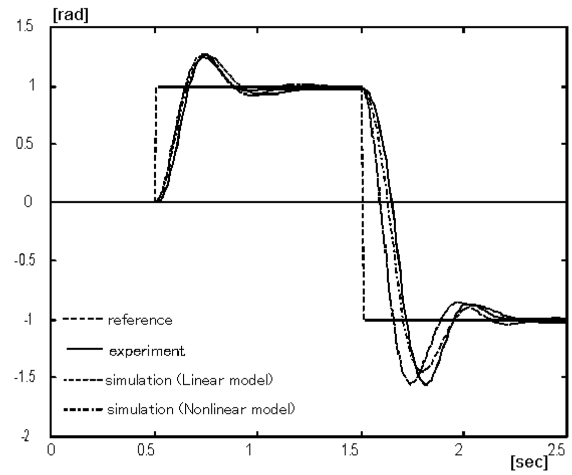

Fig. 4 Step Response Comparison
(Linear model is based on Eq.(1) and Nonlinear mode is Eq.(2).)

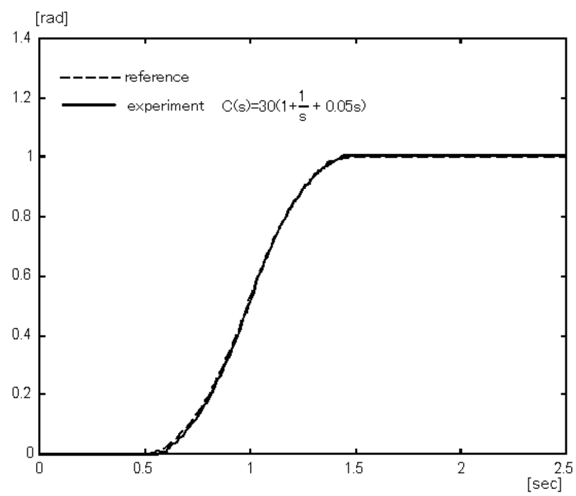

Fig. 5 Tracking Response
(C(s) is transfer function of PID controller.)

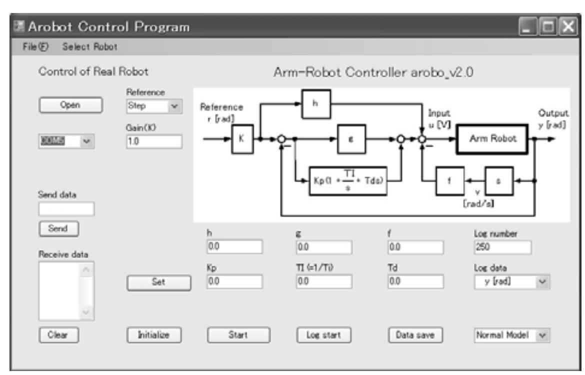

Fig. 6 Control Program on PC
(It is only necessary to change controller's parameters.)

The control board uses a microcontroller called Arduino, which shall be easily programmed by C language using Arduino IDE, so students can learn digital control algorithm and will try their own idea. A couple of programs, a control program on PC and a digital control program on Arduino, is prepared for beginners to study and analyze the standard PID feedback control system for the Arm-Robot. Figure 6 shows the snapshot of the control program on PC. At the first experiment, students only need to change controller's parameters.

Authors have set up and used five kinds of course contents. First one is animated simulation of Arm-Robot motion on the web, which is used as first experience for students. Second one is simulation on the web based on Java script. Students who can not use CAD tool, can easily get step response by setting parameters. Third one is CAD tool "Scilab", which is installed each student's PC. After mastering usage of Scilab, they do not have to use the second one. They can make up more complicated control system configuration. Forth one is Arm-Robot experiment system. All students are given their own experiment system with their own PC (Photo. 1). Last one is Remote-lab system for Arm-Robot (see Photo.2, Fig.7 and Fig.8). When students can not use their Arm-Robot system, they can access this Remote-lab system via the Internet and get the real response.

3.2 Blended Learning

Figure 8 shows the educational setting of this course. Each student has their own PC and hands-on Arm-Robot system, which can be used in a classroom and at their office. We developed 1) Lecture note, 2) Discussion forum, and 3) Remote-lab system on a web serve in our university [7]. Off the Job training consists of a face-to-face classroom during working hours and self-study (e-learning class) after office hours,

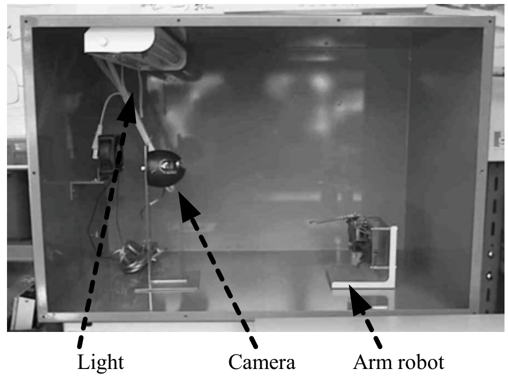

Photo.2 Inside of Remote-lab system
(The controller is behind this box.)

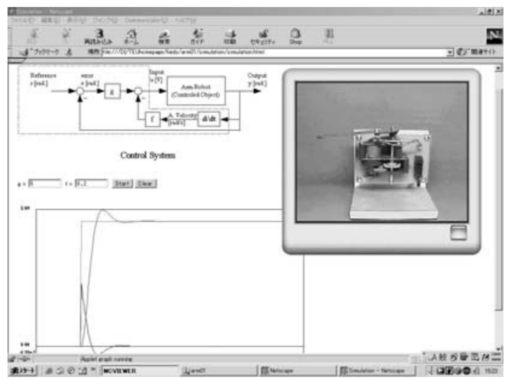

Fig. 7 A snap shot of Web page in Remote-lab operation

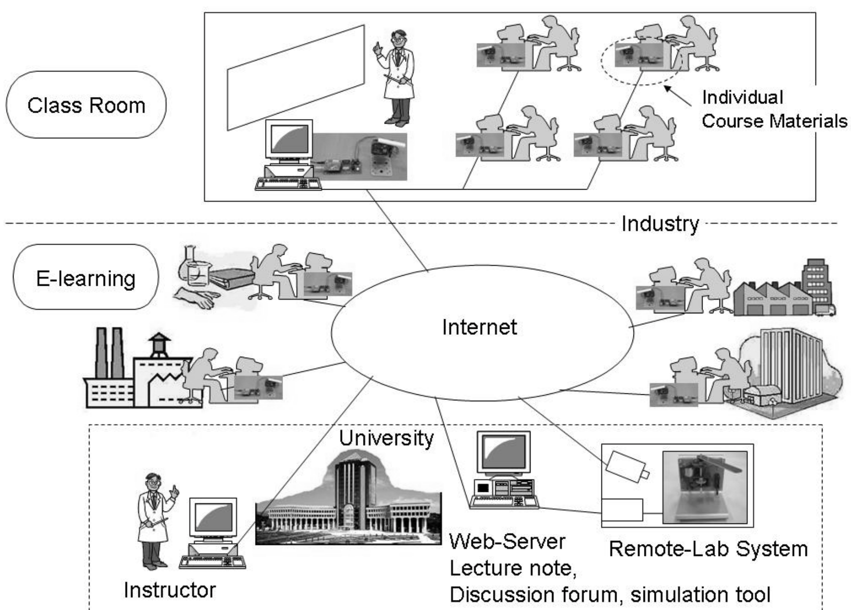

Fig. 8 Blended Learning and Course materials
(Each student has one set of course materials. They can use them in the class room, in their office and at home.)

both of which are included in their working hours in this training term. The classroom is opened once a week and students can discuss with instructors or other students. At any other time, students can discuss with each other or instructors by using web discussion forum system. It is important that students have come from different section of the company and they seldom have the opportunity to meet during working hours. In this point of view, blended learning as Fig. 8 is necessary and considered effective.

Collaborative learning using web system is very popular these days [3],[5]. There are many type of web system, on which students can discuss each other or lecture can timely advise each student. Authors use a hands-on simple web forum system shown in Fig. 9.

3.3 Group-wise Project

The Arm-Robot system uses a microcontroller board, which can be easily programmed by PC and has several unused I/O ports (Fig. 3). After designing an optimum control system, students can connect each robot by using these ports and can make robot system with collaborative motion. Final group-wise project assignment for student, where one group consists of three members, is such that "Design and make sure a tracking PID control system for the Arm-Robot and build up a cooperative robot system using three Arm-Robot". This type of group work is intended to summarize or review the course. Authors have fond this work was very effective for university students.

4. A CASE STUDY

4.1 Schedule

Nine engineers who belong different section joined this class in 2009 and 2010 respectively. The class schedule is shown below.

Table.1 Class Schedule

WEEK	TIME	TOPICS	ASSIGNMENT
Pre-week		Individual Preparation	Self-introduction
1st week (Mon.)	9:00 - 17:00	Course Navigation	PD control system
2nd week (Thu.)	13:00 - 17:00	Analysis of Control system	Stability and Step Response
3rd week (Thu.)	13:00 - 17:00	Design of PID control system	Simulation and Experiment
4th week (Thu.)	13:00 - 17:00	Implementation of digital controller	Group-wise Project
5th week (Thu.)	13:00 - 17:00	Evaluation method of control system	Group-wise Project
6th week (Fri.)	13:00 - 17:00	Presentation of project theme	Group-wise Project

4.2 Discussion

The topics and assignments in each week is as follows.

Pre-week: The discussion forum is opened 2 weeks before the class to introduce each other, because students belong to different section and they do not know each other until staring of this course. On the web, students have to pre-study contents such as fundamental mathematical knowledge, basic idea of feedback control system and control trial using virtual animation tool or remote laboratory. As a result, all students posted their self-introduction and instructors answered their submission and both students and instructors could understand each background.

1st week: 1st lecture is called "Course Navigation", which shows students the outline of the course and how to use software and hardware. It took full day and trial and error controller design was the most important study for students.

2nd week: The main topic is fundamental control theory such as modeling, Laplace transform and stability. Students measure real physical parameters of their robot and verify their validity by simulation and experiment. The assignment is the review of the lecture, however some of students could not keep the due date because of their daily routine work.

3rd week: The main topic is PID controller design. The integrator of PID controller usually works well, however sometimes does not work well because of mechanical static friction. The experiment using Arm-robot explicitly show this phenomenon, which is very difficult to understand by simulation. Through these experiment, students can acquire optimal parameter tuning technique.

4th week: The explanation of group-wise project theme and programming technique of controller are topics. Some students are inexperienced in programming, however they solved assignment in a group setting.

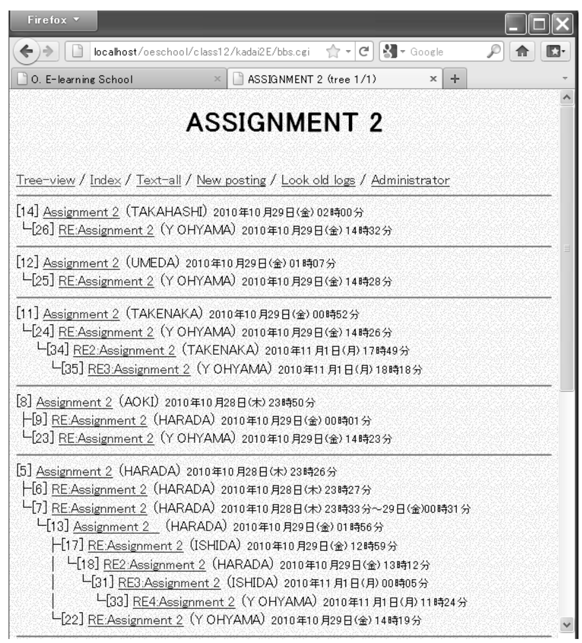

Fig. 9 A snap shot of Discussion Forum
(Ex. [5],[6],[7] and [13] are posted ones by a student and [17] is a comment by another student. [22] and [33] are comments by an instructor.)

5th week: After showing the final assignment and frequency analysis technique shortly, students got to work on group project. It was very difficult for students to take time to work together due to their daily work. This was unexpected when authors designed this course.

6th week: Last class is each groups presentation and demonstration of the final assignment (design a controller according to the given specification) and group project. The group project theme is "build up a cooperative robot system using three Arm-Robot ". Supervisors of students took part in the presentation.

4.3 Questionnaire

Students' questionnaire results are follows.

1) Experiment based learning is very easy to understand. (61%)
2) I understand the difference between the real response and the simulation response. (44%)
3) Discussion on the web is good because we can read other's answers or comments. (44%)
4) Programming in the project is rather hard work. (11%)
5) We need more time to review topics and to discuss with other members. (56%)
6) It is very difficult to collaborate with other members for the final project. (22%)
7) I want to use Arm-Robot system in pre-week.
8) I think group presentation every two week is better.
9) Mathematics is very difficult.
10) I do not use Remote-lab system, because I could use my own experiment system. (80%)

These show that Experiment based learning using a simple structured robot is effective, however learning contents are too much or too wider. At the same time, it was difficult for students to arrange study time under their daily routine work.

5. CONCLUSION

In this paper, a case study of Off the Job Training course for control engineering is presented. Six weeks blended learning course which includes once a week face to face class, e-learning class with discussion forum and Remote-lab system and experimental based learning, is designed based on the collaboration with authors and a company. Experiment based learning using a simple structured robot is found effective for mid-career engineers whose professional filed are not control engineering. The blended class is also effective for such a vocational education, however we have to consider the class schedule in a careful way. Authors will try to change study items or use longer class period while discussing with the company's supervisors.

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Designing a Technical System – Deliverables of a Process

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ABSTRACT

Many students of the science and engineering faculties of the University of Twente finish their bachelor's programme with an individual research assignment of typically 1 to 3 months. These assignments are often evaluated on skills that are implicitly taught during the assignment itself. In order to improve this improper situation, it was decided to explicitly include the topic 'designing a technical system' in one of the courses preceding the research assignment. The complexity of the many steps the student has to take hold of during the assignment should not be underestimated. Therefore a step-by-step approach is presented in this paper for any typical process of designing a technical system. The different processes to come to the final design are discussed and the deliverable per process is mentioned. The design process is based on partitioning the main function of the system to be designed in smaller functions that can be implemented by subsystems. The whole design process is guided by clearly stated deliverables, being the hold on for the students to finalize successfully their research assignment. The design process proposed in this paper is illustrated with the design of a sensor system for water quality monitoring.

Keywords: system design, process deliverables, sensor system.

1. INTRODUCTION

In many engineering programs, courses are about the detailed analysis of components or subsystems to come to a mathematical model description. However, understanding the operational principle of a certain component or subsystem and being able to derive a model is only one of the required steps to get from a pursued goal to a realized technical system. This paper is about all those other steps required for the synthesis of such a system. The necessary processes are described as well as the deliverable of each of these processes. This paper is targeted at sensor design as will become clear from the example given at the end. Nevertheless, the system design process described here is not only valid for sensor design but it is applicable to the design of any engineered system.

Several terms will be used often and may lead to confusion if not properly defined. The terms: process, deliverable, function and system will therefore be defined first [1].

Process Sequence of interdependent and linked procedures which consume resources (employee time, energy, machines, money) to convert inputs (data, material, parts, etc.) into outputs. These outputs then serve as inputs for the next stage until a known goal or end result is reached.

Deliverable Something that has been created by someone or some process.

Function The normal or characteristic action of a system; the purpose for which a system is designed; its role. (A function, being an action, cannot be put into a box.)

System An organized, purposeful structure regarded as a whole and consisting of interrelated and interdependent elements (components). These elements influence one another to maintain their activity and the existence of the system, in order to achieve the goal of the system (= to perform a certain function). (A system, being a set of components, can be put into a box.)

2. THE PROCESS OF DESIGNING

Designing a sensor system is a process, consisting of a series of smaller processes [2]. Each of these processes may have a particular deliverable. The processes and their deliverables are discussed below.

The input of the first process is a question or a problem. That process is carefully listening to this question and discussing the problem. This process has as output or deliverable the goal and main function of the sensor. It is therefore very important as its main function should address the original question as closely as possible and its goal should be to solve the problem.

The next process is that of functional analysis. Now, the main function of the system-to-be-designed must be described as complete and as exhaustively as possible. All facets of that main function should be treated. Apart from those facets, other boundary conditions that are not directly related to the main function are equally important to take into account for arriving at the deliverable of this process: the specifications.

The following process is partitioning. This process is necessary because the main function of a complete system is often described at such an abstract level that even beginning to think of implementing the main function into a system is yet impossible. Therefore, a set of functions should be found, all together fulfilling the main function, when acting in the right order. Each of these functions should have such a low level of abstraction that a possible implementation into the form of some system dawns. The deliverable of this process is a functional diagram.

Now, the process of systematic analysis and modeling starts. The operational principles of the subsystems and their possible alternatives, accomplishing the required action of one of the functions are investigated and models are derived. The deliverable is a set of general models, each describing one of the subsystems. This process is repeated for all subsystems that form the possible implementation of a function.

Next is the process of choosing between a subsystem and its alternatives, being different implementations for one function. In this process the specifications play an important role. So, in this process the number of subsystems per function is brought back from several alternatives to only one: one subsystem performing one function. The deliverable is a system diagram: blocks of all the subsystems with their relations or connections which in in total forms the complete system.

The following process is the actual design of each subsystem. Using the models per subsystem and the specifications, the parameters in the general model get their appropriate values in order to meet the required function per subsystem. This design process must be repeated for each subsystem. The fact that subsystems are connected might pose additional conditions for the final design. The deliverable is a blueprint of the complete system, in which all the subsystems and their relation and connections are described in detail.

Subsequently, the process of the actual realization and integration can start. From the blueprint, all the required components of each subsystem are obtained and every subsystem is realized. Then, the realized subsystems are connected according to the blueprint. The obvious deliverable of this process is the realized complete system.

Then, the process of testing will begin. A set of inputs can be given to the realized complete system. These inputs should cover the full range as given in the specifications. The deliverable is a set of outputs or results of the system.

The final process is that of evaluation. The results of the complete system should be compared to the defined main function of the system taking the specifications into account. The deliverable could be a 'go' (with many additional consequences) or a 'no-go' probably requiring the iteration of one or more of the described processes. The possible iterations are not discussed here.

Each process has an output, a deliverable that is the input for the next process. This means that the complete designing process can effortlessly be summarized in one flow chart, as shown in figure 1. In figure 1 the deliverables, being real things that can be held, are separated from the processes, being mental exercises.

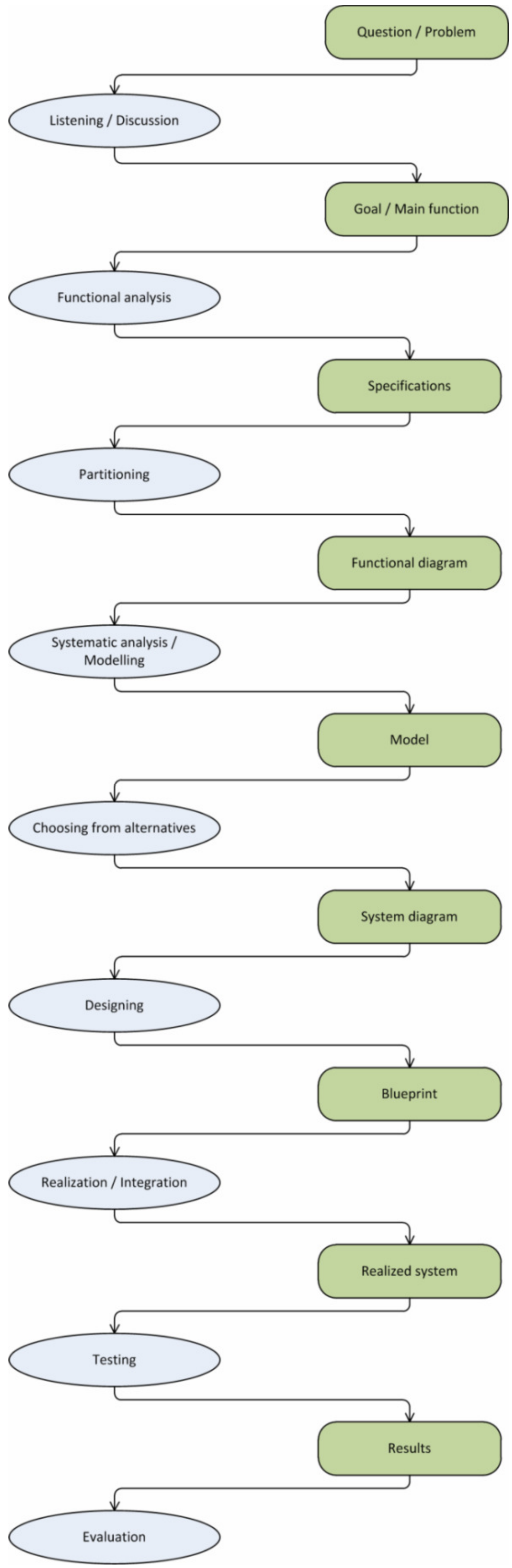


Figure 1 Flow chart of the process of designing, clearly separating the processes (left) from the deliverables (right).

So far, the designing process has been described on an abstract level. Now before giving a real practical example, an intermediate stage of the process of designing is treated, fully in accordance with that of figure 1, but more clearly illustrating the parallelism in some of the processes and hence in some of the deliverables. Thus, it becomes clear where alternatives should be developed and where choices have to be made. This extensive flow chart of the process of designing is shown in figure 2. The processes and deliverables as discussed before are also included in figure 2.

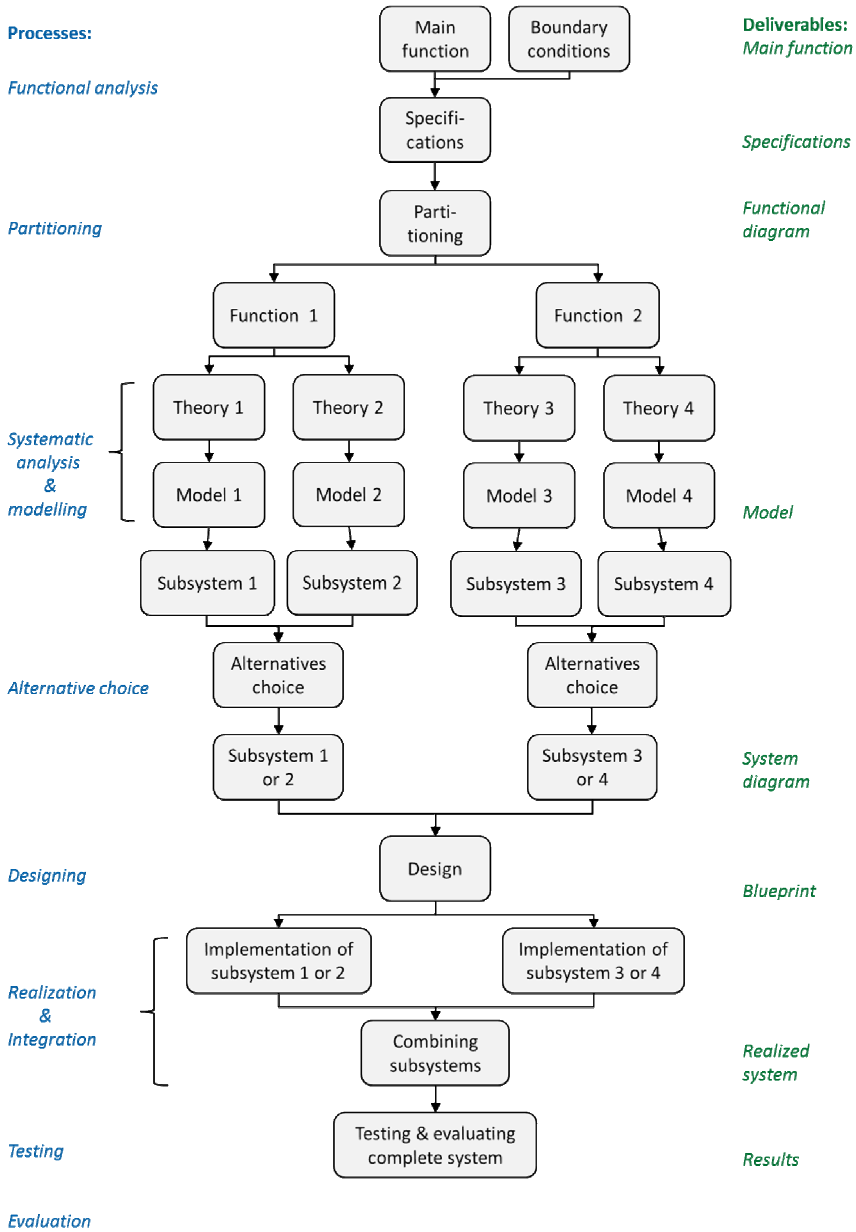


Figure 2 The design process showing the parallel steps indicating alternatives and the need for making choices.

Note that processes in parallel as indicated in figure 2 can excellently be carried out by a team, working on the designing of a system. Different members of a team can work at the same time on processes in parallel, thus speeding up the complete design.

3. EXAMPLE

The process of designing a sensor system is now illustrated by providing an example. In this example, many things are simplified, but it serves to explain all concepts: showing the deliverables of processes and giving examples of systems and functions.

The problem to be solved is to reverse the disappearance of biological life in a local river. The general question asked to a team of engineers is how to bring back biological life in the river?

Problem: disappearance of biological life in a local river

This question is the input for the process of listening and discussion about the most probable cause of the disappearing biological life. In the end it is hypothesized that silver ions in the waste of some industry, located upstream is the reason for the decaying bio-life. To test this hypothesis, it is decided to design a sensor system with one main function: the determination of the silver ion concentration.

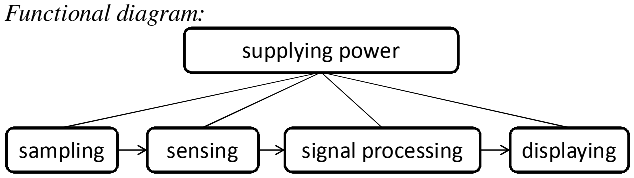
Main function: the determination of the silver ion concentration

Functional analysis is now needed to determine how this main function specifically should be accomplished; what is the maximum allowable silver ion concentration before endangering bio-life, what maximum concentration can be expected from the waste water, how long should a typical measurement take, how accurate should this concentration be determined, how often should the system be calibrated, should the determination be carried in a laboratory or on-site, how trained is the person actually doing the measurement? The answers to all these questions, including boundary conditions like cost and size, really specify how the main function is to be fulfilled in detail, obviously resulting in specifications.

Specifications:	Low limit of detection: 0.1 mM
	Response time: 10 seconds
	Drift: less than 3% per day
	Portable system
	Range: 0.1 to 10 mM
	Accuracy: 10% off from true value
	Operation by trained people
	Production price: less than €200

Now the main function should be partitioned in smaller functions with a low level of abstraction that can somehow be fulfilled by an available subsystem. Functions that are definitely required to fulfill the main function are: river water sampling, silver ion concentration sensing, signal processing, displaying the result and supplying power to the system. These functions and their order can be illustrated in a functional diagram.

Functional diagram:



Systematic analysis and modelling is next. For each function a subsystem and possible alternatives should be proposed and its theory should be investigated, resulting in a model description per subsystem for each function. In this example only the functions 'sensing' and 'signal processing' are elaborated. Sensing can be performed by amperometric or by potentiometric sensors [3]. Amperometry is based on the theory of mass transport resulting in the Cottrell equation as its model. For an amperometric sensor, a working- and counter electrode are required. Potentiometry is based on the theory of statistical distribution of electrons by their energy and results in the Nernst equation as model. A working- and reference electrode are needed. Signal processing comes down in this example to using filters, which can be analog or digital. Analog filtering is based on classical network theory and can be modelled as a transfer function for a first-order RC-filter, requiring some resistors and capacitors. Digital filtering is described by digital signal processing theories and can be modelled by the expression for a digital moving averaging filter. Such a filter could be implemented by a microcontroller and some software. So in the end each proposed subsystem is described by a model.

Models per subsystem and its alternatives for each function:
Function: sensing
Amperometric sensor model: Cottrell equation
Potentiometric sensor model: Nernst equation *(alternative)*
Function: signal processing
Analog filter model: transfer function of a 1st-order RC-filter
Digital filter model: expression of a moving averaging filter *(alternative)*

The steps taken so far with the parallel branches per process are shown in figure 3.

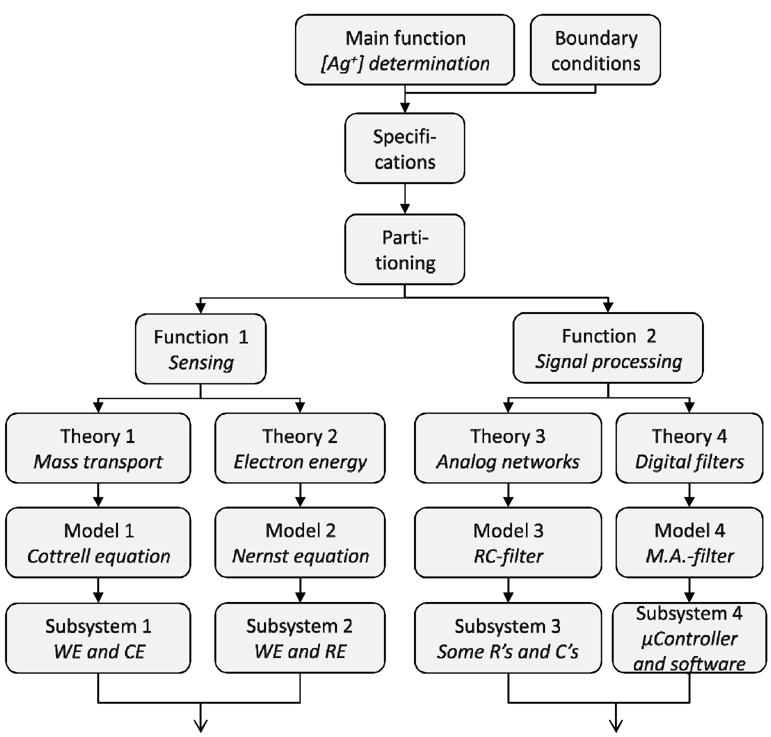
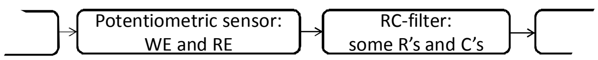


Figure 3 Interim overview of the process of designing a sensor system, showing the several options per branch in some of the process steps for this example.

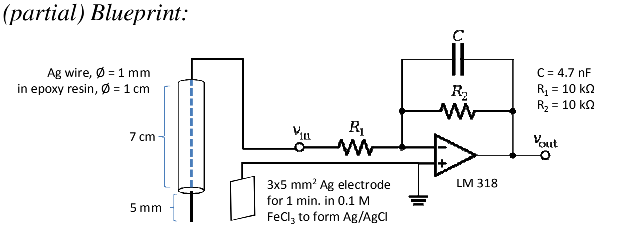
Now, choosing between the alternative subsystems has to be done, based on the specifications. The result is one subsystem per function. After the choice has been made, a system diagram can be sketched. Here, the chosen subsystems for only two functions are shown.

System diagram:



Each subsystem can now be designed. From the Nernst law and the specifications, the actual size, shape and type of material, etc., of the working electrode must be determined. The same for the reference electrode: the preparation and the final thickness of the Ag/AgCl layer, etc., must be put on record. From the desired cut-off frequency of the RC-filter, the real values for the resistor and capacitor should be calculated and the final circuitry should be determined. The fact that the RC-filter is connected to the potentiometric sensor poses extra constraints on its design: the signal from the potentiometric sensor should not be attenuated by the filter, possibly requiring an active filter equipped with an operational amplifier. The result is a detailed building plan, a blueprint of the complete system, part of it shown here.

(partial) Blueprint:

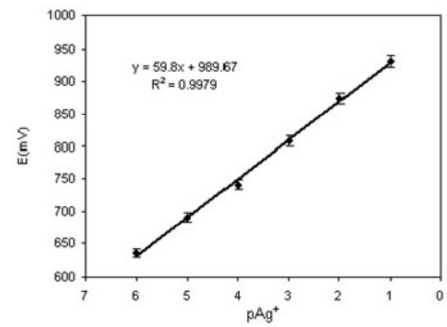


From this blueprint, the actual system can be realized. Electrodes have to be ordered, shaped, packaged and modified. The components of the electronic circuit must be obtained and soldered. The electrodes of the sensor system must be connected to the realized filter. If this is done for all subsystems, the complete system is ready.

(partial) Realized system:

This system is now ready for testing. Several silver ion concentrations within the specified range to be measured form the input of a series of tests. Subsequently, all the criteria form the specifications should be tested and the results must be compared to the specified values.

Results:



Calibration curve of the Ag/AgCl electrode

Finally, in the process of evaluation the agreement and discrepancies between the results and the specifications should be discussed; is the target of the main function reached or not? The result might be a simple 'go' or 'no-go'.

Evaluation result:

In reality, the result will often lead to partial redesign and improvements of some of the subsystems. This is not treated here. Neither are the next steps of patenting, mass-producing, advertising and selling, etc., elaborated here, in case of a 'go' situation.

4. CONCLUSIONS

In this paper a design process for technical systems is proposed based on partitioning the main function of that system into smaller functions that can be implemented by subsystems. This design process consists of a series of processes with each its particular deliverable. These deliverables form on the one hand a clear set of targets for the students during the design process for, e.g., their individual research assignment, and on the other hand help the supervisor to more objectively evaluate the skills of the student, based on those deliverables.

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Micro-Cognitive-Processes at the Interface Research-Education-Problem Solving

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ABSTRACT

A first part gives a rough picture of some difficulties encountered in research, in education, and in problem solving, for integrating them to one another. One can notice a much too global characterization of cognitive processes and a lack in the characterization of semiotic aspects. A second part analyses some theoretical limits to this integration. They are mainly due to the current conception of memories unable to take into consideration the micro-cognitive-processes at work under the reorganizations of knowledge when actualized within the situation. A third part presents a way toward the integration research-education-problem solving, relying on a cognitive approach of Culioli's enunciative theory of language, and presents some of the author's data. micro-cognitive-processes are depicted in terms of the construction of aggregates (declarative versus procedural ones, standing at different levels of internalization and externalization), and of different processes of detachment from the situation. Then several kinds of interactions allow an on-line identification of the constraints of the task. The characterization of these constraints seems basic for each of the considered areas, research, education, and problem solving.

Keywords: micro-cognitive-processes, functional meaning, reorganization of knowledge, cognitive linguistics, cognitive units, declarative versus procedural units.

1. INTRODUCTION

Our suggestions for integrating research, education, and problem solving are both theoretical and methodological. Our intent is to provide some hints about micro-cognitive-processes underlying information processing and decision making. For that, we will depict a rough picture of some difficulties and limits encountered in each of these areas. Then, we emphasize some theoretical dead ends, underlying those limits. Finally we review some of our data showing how we try to open a way possibly integrating the three areas research, education, and problem solving.

2. PROBLEMS FOR INTEGRATION

A multiplicity of ingenious and various simulations have been proposed in the problem solving area, especially at the interface between education and informatics. But the help they provide to subjects' learning remains very limited, and can hardly be generalized to other situational contexts. Indeed, most of them suffer from an inadequacy in the theoretical and methodological analysis of the cognitive aspects which are simulated. The challenge is to understand how learning proceeds. An important step was made in CLARION model [16] which constructs an interaction between implicit and explicit knowledge, close to Piaget's theory [11]. The interesting point stands in a process of re-inscription of implicit knowledge in explicit form. That allows the construction of new rules and of a functional planning. Nevertheless, the usual identification remains between declarative and explicit levels and between implicit and procedural levels, and the distinction between internal and external knowledge remains confused.

Another difficulty concerns the identification of semiotic aspects. Most researches rely on a conceptual approach which directly refers to events or objects or knowledge stored in memory. The notion of functional meanings in Piagetian theory [11], [12], allows to describe the way in which children attribute meanings to the situation. For example, Blanchet's experiment with a train[1] shows some early difficulties for young children, linked to external meanings attributed to the situation [11]: to partition the train into procedural units; to attribute the meaning of a parking track to the goal track; to understand that for turning the train right, the turning slab has to turn left. Following Cellerier [6], this example shows that the procedural units have to

[1] At a triple intersection of tracks forming a T, a train has to pass over a round turning slab on which only the engine and a truck can take place. The children have to make the train turn along one side of the two opposite tracks of the T.

be coordinated with the representative declarative units and re-inscribed at a more abstract level. Furthermore, the structured procedural units may become representative units. This interesting approach is generally ignored by most researchers. And the understanding of functional meanings attributed by children to objects and actions remains poor most of the time in many researches. In fact, a well-known limitation to the Piagetian approach is that the formal cues of functional meanings are generally not clearly defined.

Moreover, the usual distinction between verbal modality and imagery remains too rough. Opposite systems may appear within an analogical level, as shown by Caron-Pargue's children's drawings of two cubes with two labels stuck respectively on the middle of two adjacent versus opposite faces [5]. Fig. 1 shows that the correct 3-D Necker graphical representation of a cube becomes a 2-D perceptive representation. The faces of the cube are partitioned by graphical lines into several parts on which the stickers are drawn. The functional meaning of this drawing is given by the difference between the graphical positions of the stickers beyond the analogical common graphical representation of the cube itself.

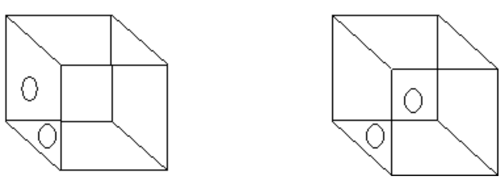

Fig. 1. Ten-year-old drawing of two cubes with labels stuck respectively on adjacent and opposite faces.

Finally, most cognitive researches rely on the subjects' performances without considering the different cognitive processes which can underlie the same performance. Furthermore, these performances are mainly evaluated in the case of well-defined strategies, for example when the strategy is optimal with the Tower of Hanoi puzzle. The strategy of novices is rarely considered in spite of Newell and Simon's early approach [14]. The usual characterization of cognitive processes remains much too global, in terms of goal-stacks and recursive strategies, or of priming, strengthening, inhibitions, and interferences. However, we must mention the interesting distinction made by some authors (e.g. Clancey [7], VanLehn [17]) between two kinds of generalization, one, linked to abstraction, which requires attention and time, the other, automatic, leading to a improvment in performance. Likewise, the notion of external memories must be mentioned, even if their construction and the processes of their interactions with internal representations must be specified (cf. Clancey [8], Zhang [18]).

3. THEORETICAL LIMITS

The above difficulties and limits are linked to the current cognitive conceptions of memory and of language, for which the micro-cognitive-processes at work have still to be defined. The possibility of this definition depends on several theoretical points.

A first point is that the reorganizations occurring between knowledge stored in memory and knowledge contextualized in the current situation must be taken into account, and formalized. In fact, the retrieval of knowledge stored in memory is generally conceived as a process of activation by external cues of a subset of this memory composed of more or less associated elements. But no reorganization of the previous structure of knowledge is conceived within the retrieval. In fact, if reorganizations are considered, they are conceived through generation processes. And only the result of these reorganizations is considered as stored in memory. The micro-cognitive-processes at work throughout the process of generation remain unknown. The knowledge is generally considered as being automatically activated by external information. That is the case only when the context remains rigorously the same or when knowledge becomes completely decontextualized. But the different steps of decontextualization remain unconsidered in such theoretical approaches.

A second theoretical limit concerns the way in which semiotic aspects are considered. Most of current models of memory characterize cognitive meaning as conceptual. Indeed, it is necessary to start with something. But the inadequacy stands in the way in which flexibility is added to this conceptualization. It does not take into account the micro-cognitive-processes at work in the semiotic modifications of concepts. Some progress was made toward taking into account functional or contextual meanings with the notion of affordances. But here again the inadequacy stands in the automatic activation of every properties of the concept. In fact, affordances are generally conceived as giving access to abstraction, i.e. to all connections given by the concept, themselves considered as always operating in the current situation. However, as it is well known in education, these processes cannot be automatically at work [11], [15]. They must be constructed but the challenge is to know how this is done. The theoretical inadequacy concerns the way in which the micro-cognitive-processes allow to identify the constraints of the task. In other words, how can the contextual meaning be generalized? More generally, the interactions between internal and external memories cannot be viewed as simple exchanges of information, without any reorganization. It is the support of information, its medium, which plays a role in the transformation of information, and refined semiotic aspects have to be taken into account at this level.

Finally, similar limits due to semiotic aspects occur with language, notably for its psychological approaches, which rely generally on a litteral conception of meaning mistaken for reference. That entails misunderstandings in the use of verbal reports [2], [3]. Therefore such a view is unable to account for cognitive strategies, and many researchers do not want to consider verbal reports. Another consequence is a disconnection between studies bearing on the cognitive representations, and those bearing on communication. However, language plays an important role, notably in education where communicative and representational purposes should always be integrated together. In fact, language should be considered as a behavioral observable cue as worthwhile as every other else. The key point is not the information itself but the way in which information is given. For example, different lexical choices referring to the same event or object have to be differentiated in order to grasp the functional meaning attributed to this event or object. Our view relies on cognitive linguistics [9], [13], for which syntax is meaningful, and constitutes formal cues open to a cognitive interpretation.

4. TOWARD INTEGRATION

In this part, we will refer to our data in order to show how we began to solve these difficulties. We referred to the cognitive interpretation of two kinds of enunciative operations, the basic operation of location, and the processes of detachments from the situation. That led us to a functional distinction between declarative and procedural levels.

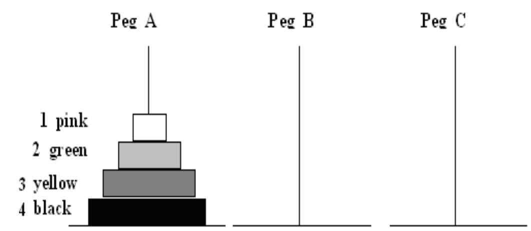

Fig. 2. Tower of Hanoi puzzle: configuration of the initial state. Goal: move all disks to peg C with the same configuration.

All our examples will refer to verbal reports obtained simultaneously to the solving of the 4-disks-Tower of Hanoi puzzle (cf. Fig. 1). The subjects have to move all disks to peg C, one disk at a time without placing a big disk on a smaller one.

To grasp micro-cognitive-processes

To grasp micro-cognitive processes is a complex challenge. In fact, it involves the articulation of many theoretical fields, on specific points which are not always completely constructed. For that, we think that the formal linguistic model of Antoine Culioli [9], [10], constitutes an interesting approach. Indeed, this model relies on an original articulation among philosophical, semiotic, and linguistic approaches. Language is viewed as basically intersubjective and is formalized by means of enunciative operations at different steps of reorganizations between notions (stored in memory) and the discursive contextualized situation. Our claim is that a cognitive interpretation of enunciative operations must lead to a grasp of some micro-cognitive-processes at work throughout the reorganizations of propositional contents stored in memory. Indeed, it is a fact that not every cognitive activity leads to a linguistic expression. But elementary micro-cognitive-processes could not be so numerous. So, when they begin to be identified, they can be considered as underlying as well linguistic levels as non-linguistic ones.

Aggregates toward chunks

The cognitive interpretation of the basic enunciative operation of location (in French: ‘repérage’) is close to the notion of ‘point of reference’ in Langacker’s cognitive linguistics [13]. Then, in Culioli's terms, the location of the 'locatum' *b* located relatively to the 'locator' *a* in the oriented predicative relation < *a R b* > can be interpreted as *a* and *b* coming together, with an attentional focus bearing on *a*.

The interesting point, notably for education, stands in the possible identification of elementary cognitive units, which we called 'aggregates', when the operation of location is applied to two consecutive events or actions. For example, in the case of the solving of a puzzle like the Tower of Hanoi, the operation of location is marked by the repetition of lexical choices *the green disk* in *I put the green disk on peg C – I put the pink disk on the green disk* and the repetition of *peg C* in *I put the green disk on peg C – I put the pink disk on peg C*. That shows that the subject is thinking of one mental action instead of two. Then, it is possible to follow the progressive construction of bigger cognitive units.

Aggregates constitute elementary cognitive units, which contribute to the construction of chunks [2], [3], [4]. In fact, a chunk may be considered as resulting from two reverse aggregates, bearing on the same elements but with a reverse attentional focus between them. Nevertheless our analyses showed that subjects used to construct aggregates most of the time but rarely true chunks.

Detachments from the situation

But the most interesting aspects concern the identification of two kinds of detachments from the situation, one marked by starting terms, the other by modal terms [3], [4].

Starting terms: One of the two arguments of an oriented predicative relation takes the status of starting term if it is extracted from the predicative relation and replaced by an anaphora. For example, *the green disk* takes the status of being a starting term first argument, marked by anaphora *it* in *the green disk I put it on peg C*. Likewise *the green disk* takes the status of a starting term second argument marked by anaphora *it* in *I take the green disk I put it on peg C*.

The status of starting term defines a first level of contextualization of the predicative relation which can be located either relative to the starting term or to the situation. Then in our data we interpreted the starting term as the marker of the distinction between an internal representational space and an external one [2]: the internal space is marked by the presence of a starting term; the external space is marked by the absence of a starting term. Then, different kinds of aggregates were defined [3], [4]: external aggregates, when there is no starting term; internal aggregates when there is an aggregate between two starting terms, due mainly to an anticipation (e.g. *the green disk I put it on peg C in order to move the pink disk – the pink disk I put it on peg C)*, or to a return to the previous action (e.g. *the green disk I put it on peg C – the green disk is on C I take the pink disk I put it on peg C*).

Another basic enunciative function of a starting term is to give access to abstraction and to reconstruct the notions within its previous place in the predicative relation. We proposed an articulation of this function with Piaget's processes of internalization and externalization ([2], [6], [15]). That led us to consider the cognitive function of the starting term as marking the reconstruction of the external aggregates at the internal level, that is internalization, and as the reconstruction of the internal aggregates at the external level, that is externalization. Then an intermediary aggregate, called 'categorized aggregate' was defined as marker of interaction between internal and external spaces. In the example *the green disk I put it on peg C – I put the pink disk on peg C*, the external aggregate marked by the repetition *on peg C* is categorized by the starting term *the green disk*, itself marked by anaphora *it*, and reconstructed at the internal level. Its reconstruction appears as detached from the current situation and can be re-used in another situation. This decontextualization may be completed when it will be articulated with another categorized aggregate giving rise to its externalization (see [3] and [4]. Then, the starting term appears as the marker of a process of decontextualization by means of an articulation between internalization and externalization, in contrast to the classical process of decontextualization by repetition of similar events or actions. Categorized aggregates are the necessary condition of an elementary step of generalization to another situation.

Modal terms: At the enunciative level, modal terms involve a detachment from the current situation, with the purpose of reorganizing the situation. In our data, we interpreted the presence of a modal term in terms of a differentiation between a strategic access to memory and an automatic one

[3], [4]. This differentiation concerns as well the planning (with modal verbs such as *can*, *want*, *have to*), the initialization of a sequence (with interjections such as *well*), the storage in memory (with interjections in the context of action *oh*, *oh yes*, *no*), and the retrieval (with modal evaluations such as *oh it is fine*, *I believe that I am blocked*). These strategic activities mark uncertainty and difficulties because the subject does not understand well all the internal constraints of the situation. At the opposite, when there is no modal term, the subject remains within the situation, without major subjective difficulties, structuring the external space. Finally, the basic property of modal markers is to consider information at different levels of processing in order to reorganize the current situation.

Identification of constraints: The enunciative theory of Culioli considers various kinds of detachments which can be added to one another so as to turn back to the situation. It is the case with the strange loop (cf. fig. 2). In fig. 2, *p* is the situation, and *p'* anything else other than *p*; *pp'* is a detachment from both *p* and *p'*, and *pp'** a detachment from *pp'*; the arrows mark the allowed paths from a level to another one. Each of these arrows is matched to a detachment process. We can see that we can be detached from the current situation *p*, and that, adding several kinds of detachments, following the arrows, we can return to *p*. The loop becomes strange when the path passes across *p!*.

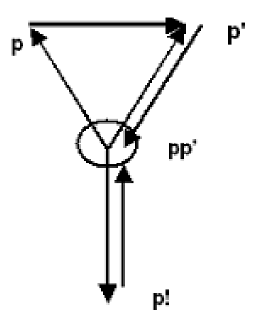

Fig. 3. Culioli's diagram

In our approach, we placed on Culioli's diagram every consecutive occurrence of one or other of our two kinds of detachments, marked by modal terms or by starting terms, during a complete solving of the Tower of Hanoi puzzle. The successive steps of this path were cognitively interpreted according to Culioli's theory and to the current state of the problem.

In fact, each current state of the problem can be situated on the diagram in two ways: first, referring to the position implied by starting terms and aggregates; second, taking into account the modifications of this first position due to modal terms and to the history of previous states. Then we cognitively interpreted the enunciative operations underlying these modifications. For example, it was possible to characterize:

1) The states where the subject anticipates that everything goes well or goes wrong, marked by the modification *p-p!* and positive versus negative interjections.
2) The states where an internalization is broken from material context, or where the externalization leads to a reunification or a sticking marked by the material context, with the modification *pp'-p!*.
3) The states where the subject identifies a constraint or only its existence without understanding its nature, marked by the modification *p'-pp'* and positive or negative evaluations.

Finally, it is only when the path reached again the situation *p* after a loop, that the modifications disappeared, giving rise to stabilizations and to the understanding of the constraints of the task.

Declarative-procedural interactions

Our approach takes semiotic aspects into account at the level of lexical choices, establishing functional meanings from their differentiations and giving them the status of linguistic markers. For example, the criterion based on the "repetition" of a lexical choice, already mentioned above, contrasts with any change in this lexical choice referring to the same object. That led us to a functional semiotic distinction between declarative and procedural aspects, as classically defined [1]. Therefore procedural aspects may appear at the declarative level, and declarative aspects at the procedural level. Then dynamical interactions between declarative and procedural levels may be conceived in the line of Cellerier [6].

The criterion we chose in our data was to consider the operations of location between moved objects as being at the declarative level, and the operations of location between the places where the objects have to be moved at the procedural level. Then, in our above examples, the repetition *the green disk* between the naming of disks defines a declarative aggregate, and the repetition *on peg C* between the naming of pegs to which disks have to be moved defines a procedural aggregate [2], [3], [4].

Then different kinds of aggregates can be defined at declarative and procedural levels [3]. That allows an on-line identification of the specific construction of chunks, and aggregates, at both declarative and procedural levels. They can be generalized by internalization and externalization at both level, but they do not develop at the same time [2], [3], [4].

6. CONCLUSION

In this paper, we use our data and the theoretical background underlying them suggests a possible way integrating several areas, namely research, education, and problem solving.

In fact, these data have to be considered as belonging to an exploratory research. Many other results have to be discovered in this line. The theoretical background must be developed. Other criteria in order to grasp micro-cognitive-processes must be developed. Furthermore, our approach was mainly directed toward an integration of language. But many issues beyond language must be developed.

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Integrating Field Research, Problem Solving, and Design with Education for Enhanced Realization

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ABSTRACT

Developing the right set of educational objectives and activities are some the key factors for a successful education program. Since almost all educational processes intend to improve quality of life or realty it is important to consider the human interaction with reality and its objectives before designing the educational experience. In this paper the concept of realization or dealing with reality is revisited in an attempt to address why the field activities of research, problem solving and design should be integrated with the educational programs.

The expanded realization concept includes the virtual and perceptual realities as valid domains of realization. These domains of realization and their interactions with the physical reality are studied along with the relationships between research, problem solving, and design. Bloom's cognitive domain educational objectives are also aligned with the expanded realization concept. Finally, to provide a model for how the field activities of research, problem solving and design could be integrated with an education program, and to assess the role of different learning experiences in achieving enhanced realization, an engineering case study utilizing alumni survey data is presented.

Keywords: Realization, Education, Research, Problem Solving, Design, Perceptual, Virtual.

1. INTRODUCTION

There have been a growing number of national reports and articles that document the need for incorporating innovative forms of teaching [1, 2]. To design, reform, or continuously improve an educational program, a set of clear educational objectives must be defined. In addition, all learning experiences, courses, and activities, must be streamlined and aligned to deliver the desired learning outcomes and ultimately achieve the objectives. The program outcomes should always be derived from the program educational objectives and not the reverse. Therefore, developing a meaningful and effective set of educational objectives will always be the cornerstone for success in education. In the following a study for integrating field activities of research, problem solving and design with the objectives and activities of educational programs is conducted. In addition, to demonstrate and assess the results of such integration an engineering case study is discussed.

2. REALIZATION AND REALITY DOMAINS

For understanding the role of research, problem solving, design, and education in enhancing realization it is important to specify what the term realization actually means. A definition, that reflects the current use of word realization, considers realization as [3]:

1. An act of figuring out or becoming aware.
2. The act of making real.
3. The result of an artistic effort.

Building on this definition it can be stated that the act of realizing is the interaction with a reality to figure it out, utilize it to achieve desired results, and alter it by eliminating or bringing new objects to it. Therefore, realization is the interaction with a reality to:

1. Understand it
2. Utilize it
3. Alter it

It is also clear from the current definition that reality could be expanded to include other dimensions or domains that go beyond what is physical. Among these dimensions the following three forms or domains of reality are considered [4]:

1. *Physical reality*: represented by the physical universe we live in and can be realized with our senses such as seeing, hearing, touching, smelling, and tasting.
2. *Perceptual reality*: represented by our individual paradigms or the internal image of other realities.
3. Virtual reality: represented by the virtual modeling and simulation of physical, perceptual, and other realities.

By examining all three realities, it could be observed that the perceptual is the domain where the individual realization is being formulated (developed and validated). While perceptual reality is unique and may be subjective, for each individual perception is reality. For example, the act of having a new perception or paradigm shift is an act of realization. An individual will usually use the phrase “I realized” when a new perception or a perceptual paradigm shift happens.

The virtual domain is the domain where collective and shared perceptions are being formulated (developed and validated). For example, when some information or knowledge is shared a new shared perception or a virtual realization is created.

The physical domain is the domain where physical reality is being actualized (developed and validated). For example, when perceptual realizations of a design team are shared in the virtual domain and manufactured an altered reality is achieved in the physical domain.

In all three domains of reality there are interacting elements or objects specified by:

- Forms (shapes and substances)
- Functions (purpose and performance)
- Interactions (actions and reaction) with other object through fields of activities (interaction fields).

The transfer between the three reality domains is through mapping. The main two elements for mapping are modeling and simulation [4].

A model: is a representation of an object. Depending on the reality domain a model is:

- A physical representation of an object (physical)
- A cognitive representation of an object (perceptual)
- An abstraction using mathematical language or computer programming to represent an object (virtual)

A simulation: is the act of an object or its model performing in an actual or simulated environment. Simulation is used to show the actual or eventual performance of an object in the actual or intended environment. Simulations are used in all three reality domains:

- Physical simulation or actual utilization of an object actual or physical model (physical domain)
- Mental simulation of an object’s perceptual model (perceptual domain)
- Virtual simulation of an object virtual model (virtual domain)

Key issues to consider in mapping through modeling and simulation between domains are:

- Acquisition of valid information about the object for accurate representation of the object and its environment.
- Selection of key characteristics and behaviors to establish meaningful correlations.
- Use of simplifying approximations and assumptions
- Fidelity and validity of the modeling and simulation.

To map objects and their environment between different realities using modeling and simulation requires deconstructing and reconstructing using analysis (for deconstructing) and Integration (for reconstructing).

To illustrate the realization concept discussed so far consider the following example [4]: An object represented by a football in the physical domain, made of a specific form and materials, interacted upon by a quarterback who is throwing it to a receiver in a football field during a game. At the time of the throw the wind in specific direction is 15 mile per hour. The quarterback perceives the whole physical domain of the field in his perceptual domain through the perceptual modeling ability (interaction between physical and perceptual domains). Before throwing the ball he performs a perceptual simulation of the location of the receiver, the speed, and direction required to place the ball at the hand of the receiver away from the defenders. The receiver models and simulates the physical reality in his perceptual domain and translates it into a physical movement to be at the right place and right time for making the catch (interaction between physical to perceptual and perceptual to physical). For the viewers watching the game being broadcast on T.V. the physical reality on the field is communicated (mapped) through the virtual reality to the perceptual reality of the viewers (interaction from physical to virtual and from virtual to perceptual). It can be noticed that for the viewers each perceptual realization to the physical reality on the field may be slightly different from the others due to the emotional, cognitive, objectivity, and experience level with the game. Moreover, while reading this virtual example written in the physical domain, the reader has formulated a perceptual domain image of the situation (interaction between perceptual and virtual domains).

Both analysis and integration use modeling and simulation at different degrees [4]. As shown in Fig. 1, analysis is performed with mostly simulation and some modeling while integration is performed with mostly modeling and some simulation. It is also obvious that both analysis and simulation are logical and analytical in nature while modeling and integration are more holistic and creative in nature.

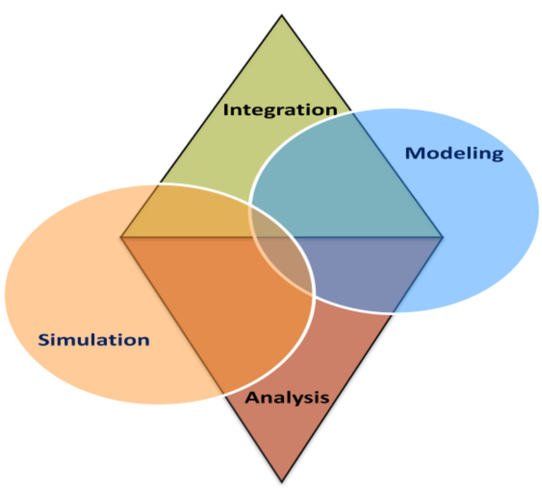

Figure 1 – Different realization processes

3. REALIZATION ACTIVITIES

The main objectives for interacting with any reality are:

1. To understand it (know it)
2. To utilize it (use it)
3. To improve it (alter it)

These three objectives are interconnected and overlapping because utilizing or altering a reality requires an understanding of it. Also utilizing or altering a reality brings a better understanding of it. In addition, these three objectives create the following three distinct but interconnected human and reality interaction activities:

1. *Research:* aiming at understand reality
2. *Problem solving;* aiming at utilize reality
3. *Design*: aiming at improving or altering reality

These activities can happen in any reality or across all three realities. Also, the aim of each activity does not exclude the activity from achieving other objectives. In other words, to understand a specific reality may require the utilization of another reality and improve a third reality. For example, performing research to understand a specific phenomenon in the physical domain may require the use of the virtual domain to improve the unacceptable state of lack of understanding in the perceptual domain. Each of the three activities is started due to one of the following states and ends after reaching another state of the three, as shown in Fig. 2. These states are [4]:

1. *Unacceptable Reality*
2. *Acceptable Reality*
3. *Improved or altered Reality*

Figure 2 – Beginning and end states for different activities

As shown in Fig. 2, research starts due to unsatisfying state of understanding in the perceptual and virtual domains and ends by reaching a state of improved understanding at the perceptual and virtual domains. Problem solving starts due to unacceptable state (things are not the way they should be) at any of the three domains and ends by reaching the desired state (things are the way they should be) at same domain. Design starts from a state of acceptable reality due to the desire for improved reality in the physical or virtual domains and ends by reaching a state of improved or altered reality at the physical or virtual domains. It is important to recognize that while the starting domain can be different, for each activity, all three activities are initiated by the perceptual domain. Each of three activities can be further explained as:

Research

Research is an activity initiated and conducted by the perceptual domain aiming at understanding all three reality domains. While a research activity may utilize the virtual or physical domains the goal state is always an improved state at the perceptual domain.

The processes to perform research are mainly analysis and integration. Analysis is mostly conducted utilizing the perceptual domain and performed in the physical domain with the help of the virtual domain as needed. The gained insights are usually integrated utilizing the perceptual domain and communicated through the virtual domain. Both analysis and integration use modeling and simulation across the three domains as sub-processes at different degrees. For example, to improve the efficiency of a specific product the need for conducting research was created. This research would start due to unacceptable state of understanding for the product performance and the parameters affecting it. The research would be conducted until a desired improved state of understanding is reached, before attempting to change the current design. Utilizing the perceptual domain of the researcher(s) and conducting the research in the physical and /or virtual domains, through testing physically simulated models and /or virtually simulated models of the product, could produce an improved state of realization in the researcher(s) perceptual domain. If the research results are documented and communicated or published an improved state of realization in virtual domain would result as well.

Problem solving

Problem solving is an activity initiated and conducted by the perceptual domain aiming at transforming unacceptable state of reality to acceptable state of reality in all three domains. Problem solving activity may take place in the perceptual, virtual, or physical domain the goal state is always an acceptable state at the domain of the starting state.

Similar to research, the processes to perform problem solving are mainly analysis and integration. Analysis is mostly conducted utilizing the perceptual domain and executed in the physical or virtual domains depending on the problem context. In educational settings solutions are usually performed in the virtual domains. The gained insights are usually integrated utilizing the perceptual domain and used to solve the problem in the execution domain. Both analysis and integration use modeling and simulation across the three domains as sub-processes at different degrees until the acceptable state of the problem solution is reached. For example, if during a research activity an object is not working as expected in any of the three domains a problem is identified by the perceptual domain. To develop a solution may require the utilization of the virtual or physical domains in addition to the perceptual domain until a solution is reached in the same domain where it was identified.

Design

Design is an activity initiated and conducted by the perceptual domain aiming at altering reality from an acceptable state of reality to improved state of reality in the physical and/or the virtual domain. While design activity may take place in the perceptual, virtual, and physical domains the goal state is always an improved state at the domain of the starting state.

The processes to perform design are mainly integration and analysis. Integration is mostly conducted utilizing the perceptual domain and executed in the physical or virtual domains depending on the desired end product context. In educational settings designs are usually performed in the virtual domains. The problems or lack of understanding faced during integration are addressed through problem solving and research performed using analysis and integration. Perceptual domain creativity is usually utilized to solve the design integration issues in the execution domain. Both integration and supporting analysis use modeling and simulation across the three domains as sub-processes at different degrees until an improved state of reality with a new product design is reached. For example, utilizing the improved perception during a research activity to design a new product can produce an improved performance in the physical domain.

It must be noted that while the initial state trigger a specific activity the other two activities may be involved to achieve the end state. For example it may take some research and design activities to solve a specific problem. In fact some design engineers and researchers due to their analytically dominated thinking and training in problem solving like to start their design (a creative activity) by defining what they call the design problem [4].

4. REALIZATION AND EDUCATION

Understanding the reality domains and realization activities is important for the design and development of a highly effective education programs. In addition, since all realizations are propelled and conducted by the perceptual domain it is important to focus on how perceptions are formulated (physical and virtual realities mapped or modeled and simulated). Both teaching and learning are perceptual domain exchanges between the teachers and the learners. These exchanges are usually shaped by the educational objectives in addition to the teachers and the learners thinking preferences. Bloom's classified educational objectives into the following three domains with different levels of objectives in each [5]:

- Cognitive (thinking skills)
- Affective (values and emotions)
- Psychomotor (movement skills)

Focusing on the objectives related to the perceptual domain activities of problem solving, design and research the following are Bloom's cognitive domain objectives:

1. **Knowledge** – information gathering without necessarily understanding, using, or altering it.
2. **Comprehension** - understanding the gathered information without necessarily relating it to anything else.
3. **Application** - using general concept gained through comprehension to solve a problem.
4. **Analysis** – disassembling something down into its fundamental elements.
5. **Synthesis** - creating something new by integrating different elements.
6. **Evaluation** - differentiating the subtle differences in objects or methods.

Aligning these cognitive domain educational objectives with the three main realization objectives discussed previously it is clear that:

1. Knowledge and Comprehension can be aligned with **understanding realty**
2. Application and Analysis can be aligned with **utilizing realty**
3. Synthesis and Evaluation can be aligned with **altering realty**

In other words, Bloom's cognitive domain educational objectives are aimed at developing the knowledge and skills of dealing with a specific reality of a certain field. These objectives are also aligned naturally with the progression to a higher or enhanced level of realization starting with understanding and ending with altering of reality as shown in Fig. 3. In fact Bloom's highest objective of evaluation can only be reached with refined realization at the perceptual domain. Therefore for achieving enhanced levels of realization, educational programs should include conducting research, problem solving, and synthesis activity in the field of the intended reality.

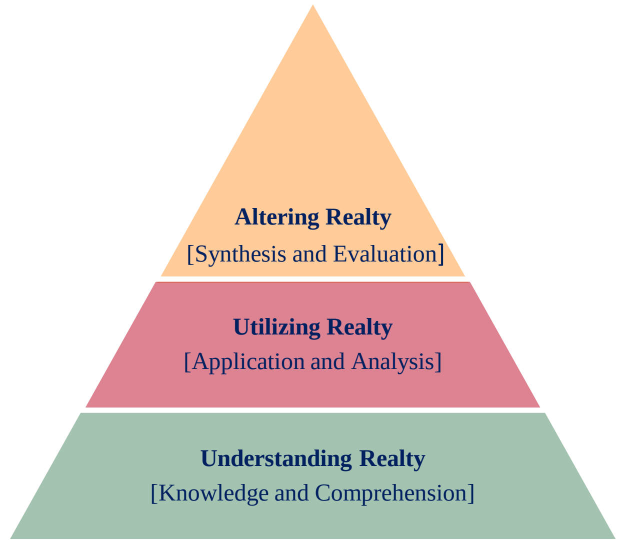

Figure 3 – Progression of Realization Objectives

5. ENGINEERING EDUCATION CASE STUDY

To identify the practices in the field of the intended reality for engineers, the Transferable Integrated Design Engineering Education (TIDEE) consortium of colleges in the Pacific Northwest developed an engineer profile by compiling accreditation criteria, codes of ethics, attributes valued by employers, and core competencies valued by professional societies. Synthesis of these traits produced a set of ten holistic behaviors of an engineer. These ten roles include those of analyst, problem solver, designer, researcher, communicator, collaborator, leader, self-grower, achiever, and practitioner. The Holistic Behaviors associated with the roles and observable actions of an expert engineer are listed in [6]. In this engineering case study the intended field of practice learning experiences, including the TIDEE ten roles, were considered as program educational objectives. In addition to providing the fundamental knowledge and skills needed for professional practices in classroom activities, the program includes a cooperative education experience for each undergraduate student to achieve a targeted level of performance before graduation. In the cooperative education program, the undergraduate alternates between working in an industrial setting and classroom instruction at the university. Through cooperative education, students are exposed to the field reality that they will face as engineers. Students begin their cooperative education rotation normally in their freshman year and must successfully complete multiple cooperative education terms as a graduation requirement. For continuous improvement purposes, the alumni of the program are periodically surveyed about both their classroom and the cooperative education worksite learning experiences. The alumni surveys are usually conducted by the Office of Institutional Effectiveness and adhere to the standard practice in higher education. Surveys are conducted for alumni three years after graduation. The typical number of graduates surveyed is approximately 400 per class with a return rate of approximately 16% [6].

In this case study, the 2008 alumni survey data [6], is used for assessing the role of both classroom and cooperative education learning experiences, in achieving large increase in ability, focusing on the roles of problem solver, designer, and researcher. In addition three other roles of an analyst, practitioner and achiever were added for their significance to this case study. The results are shown in Fig 4.

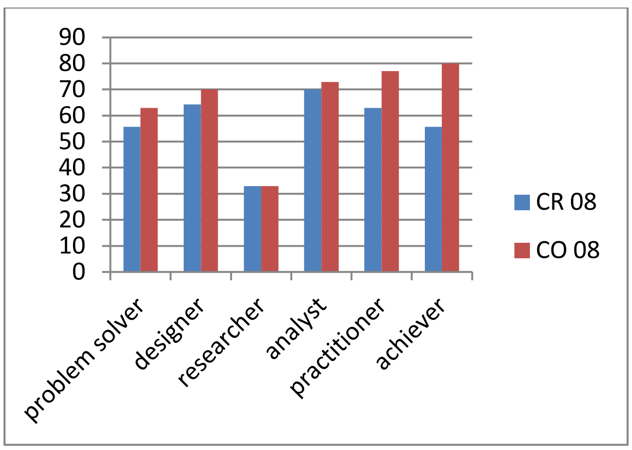

Figure 4 – Setting accounted for a large increase in ability

As shown from Figure 4 the cooperative education real life experience provided higher increase in ability than classroom experience for both problem solving, and design with equal ability in research. Similar increase in ability is shown in analysis which a common sub-process in all other three activities. As it would be expected the largest increases are achieved in the abilities of being a practitioner and achiever.

6. CONCLUSIONS

Since the start of human life on earth two realities have emerged, the physical reality and the human perception of it. To deal with the physical reality and share the formulated perceptions humans introduced the third domain known as the virtual reality. Considering these added realities, the concept of realization could be expanded to include all three reality domains. Therefore, the three types of realization are the perceptual realization which is unique for each individual, the virtual realization which is shared with different individuals and the physical realization which is universal.

Research, problem solving, and design are realization activities performed in different domains. All three activities utilize analysis and integration through modeling and simulation as basic elements of mapping between realities. Therefore, integrating these activities in real life settings is necessary for achieving enhanced realization in any education program. This integration should be started with the educational objectives and implemented with all program and classroom activities.

The presented engineering program case study demonstrates that real life experience has equal or superior effect on enhancing the abilities for conducting all realization activities. However the largest increases in abilities are in the perceptual domains of the learners when dealing with professional realities with the confidence of being achievers.

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Agile Training: An Innovative Educational Process for Information Technology Educators

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ABSTRACT

Information technology (IT) plays an important role in the growth of small businesses. Many businesses unfamiliar with technology tools risk being left behind in the so-called digital divide, rendering them unable to compete in today's business environment. Efforts to train owners of microenterprises often employ plan driven training, which emphasizes structure and linear learning with pre-defined learning objectives. This has been effective to a point, but it is sometimes insufficient to help microenterprises to cross the digital divide. This study proposes an alternative educational method, known as agile training. Agile Training is adapted from the Agile method of information systems development. Agile Training is an iterative method, designed to produce a demonstrable set of valuable technical skills on a short timetable. This innovative educational method adds process and psychological factors to standard plan driven training.

Keywords: Agile methodology, training, education, microenterprise, digital divide

1. INTRODUCTION

Microenterprises are a significant part of the economy in the United States. According to the Association for Enterprise Opportunity, microenterprises are defined as businesses with fewer than five employees [1]. These businesses constitute a vital part of a region’s economy, providing not only jobs, but the innovation and entrepreneurial dynamic that benefit communities as a whole [2].

Businesses unfamiliar with technology tools risk being left behind in the digital divide, rendering them unable to compete in today's business environment. Discovering more efficient processes for keeping microenterprises abreast of technology skills and tools will help ensure that more businesses will be able to compete in the marketplace, thus sustaining and growing local economies.

Information technology (IT) plays a critical role in the development of small businesses by increasing efficiencies, providing access to new markets, and fostering the development of new products and services. Microenterprises often face great challenges in using IT effectively. They may suffer not only from a lack of resources and skills, but also the awareness, knowledge, and confidence needed to adopt technology successfully [3].

In the field of technological instruction, plan driven training has been effective to a point, but it is sometimes insufficient to help microenterprises to cross the digital divide [4]. In this context, plan driven training refers to instruction in technology skills, with little attention paid to psychological factors [3]. Traditional education uses a plan driven approach, documented through a course syllabus and training material prepared ahead of time. Technical training programs that are part of microenterprise development programs typically involve courses or workshops with well defined, but previously determined, learning objectives and pedagogical methods [5]. Even in more customized technical assistance, the training process typically begins with an interview of the subject, in which the technical needs of the subject are taken into account. Information from the interview is used to devise a technical instructional plan for the subject. Each instructional session is intended to move the subject closer to the overall goal of the plan. This is a linear process with prescribed goals that is difficult to adapt to changing circumstances. While such training often produces positive results, in other cases the impact has been negligible. The elements that separate a high impact interaction from a low impact interaction are not well understood; however, psychological factors may play a role in the impact of the interaction [6] [3].

This paper reports on research in progress to make technical training and assistance more effective in an unconventional educational setting, such as that of the microenterprises. Through the use of agile training methods, participants will overcome the barriers to learning that arise from gaps between learning objectives and the prior knowledge, skills, abilities, and perceptions [7].

2. AGILE EDUCATION

Agile education extracts principles from the agile software development method and adapts those principles for use in traditional classroom learning situations.

The agile development method was devised as an alternative to heavyweight, inflexible systems development methods. The principles underlying agile development are expressed succinctly in the Agile Manifesto [8]. The agile method is characterized by adaptive planning, customer collaboration and rapid response to changes in the environment. This method has been successful in delivering high quality software products, particularly in chaotic environments where requirements change often. Agile principles have also been adapted for other fields, such as project management and education [9].

The adaptation of agile principles for use in education led to the development of the agile education method. It has been used as an alternative to traditional educational methods. Agile education has already demonstrated success inside the classroom, and is amenable for use in various educational situations [10] [11]. Computer Science faculty have used the Agile Education principles in courses about the software development process, with noted success [12] [10]. Agile Education principles have also been used to teach writing and communications skills in a University setting [13].

3. AGILE TRAINING

Agile training is a pedagogical method similar to agile education. The principles were taken from the Agile Manifesto and adapted for use outside the classroom.

Agile training addresses the shortcomings of plan driven training. The chart below illustrates the adaptation of agile principles for use in unconventional educational settings. Further elaboration on the adaptation of the 12 underlying principles of the Agile Manifesto may be found in the appendix.

Principles of the Agile Manifesto	Principles Adapted for Use in Unconventional Educational Settings
Individuals and interactions over processes and tools	**Individuals and interactions** over pre-determined methods
Working software over comprehensive documentation	**Demonstrated learning of useful IT skills/concepts** over tutorials
Customer collaboration over contract negotiation	**User collaboration** over “student teacher” relationship
Responding to change over following a plan	**Responding to user** over following a plan

4. MENTAL MODELS

Agile training addresses the process of the instructional interaction. Particular attention is paid to the psychological factors of training [6]. The psychological factor measured in this paper is so-called “mental models”.

Peter Senge's work with the concept of mental models led to many advances in the field of organizational theory. Mental models are the “deeply held internal images of how the world works, images that limit us to familiar ways of thinking and acting” [14]. If a business owner has deeply ingrained beliefs about both technology and the role the technology plays within the business, he/she takes actions based on those beliefs. When those beliefs are incorrect, the business owner is unlikely to achieve the desired impact.

Making decisions based on ill-formed mental models about technology leaves the typical small business owner mired in inefficiency. Attempting to teach individuals with undiscovered mental models leaves the teacher mired in inefficiency, as well. Consequently, a tool for measuring mental models is used in order to create a high impact interaction.

5. METHODOLOGY

Action research involves utilizing an iterative method of planning, taking action, observing, evaluating (including self-evaluation) and critical reflection prior to planning the next iteration [15] [16]. Action research asks the researcher to execute an observation, orientation, decision, and action loop [17]. These four actions take place within each session, changing the trajectory of the session/s when necessary. The Action Research method is often used in both information science research and service learning courses [3]. This method is also similar to the agile method itself, as it is developed through iterations, and focuses on flexibility over a fixed plan.

The setting for the application of agile training is a technical project undertaken for and with a microenterprise by a “team” – a pair of individuals who may be consultants, students in a service-learning class, etc. [4]. Each microenterprise identifies at least one technical project that needs attention within their organization. The team acts both as consultants (using technical expertise to guide the project) and educators (using expertise to teach technical skills). The duration of a project depends on a number of factors, but each project takes on average 6-8 consulting sessions to complete. A session is a single visit to a microenterprise, typically lasting one to two hours. Each session with a microenterprise is counted as an iteration of the agile training method. Each session incorporates the cycle of observation, orientation, decision, action, and critical reflection. Insight gained from each session is then used in subsequent sessions.

Prior to the initial session, an interview is conducted to determine the mental models of the participants concerning their attitudes/perspectives of technology. Interview questions also determine hardware/software availability, and nature of technological need.

A second survey is administered to the participants to collect additional data about participants' mental models, specifically around the four constructs of fear, frustration, confidence and empowerment. These four constructs emerged out of multiple years of experience with microenterprises. Statements cropped up repeatedly, statements such as "I never get this right" or "The system just won't let me do anything". Researchers noticed that microenterprises with positive impact results also tended to make positive statements (reflecting confidence and empowerment), and vice versa with negative statements (reflecting fear and frustration). A clear understanding of mental models is essential for effecting change [14]. Each microenterprise is given a rating according to measured level of each construct.

The ratings are used as an initial guide for the investigators, in order to assess a formal "starting point" for each microenterprise. The approach for each microenterprise differs according to the ratings. The four constructs are measured informally within each session throughout the training period. During the course of each session with a microenterprise, special attention is paid to the statements and body language of the participants, in order to note changes in perceptions of technology. Any general shift toward either positive or negative constructs is recorded. Training for each session alters according to the perceived levels of positive and negative constructs. For example, if the participant is making frustration based statements, the instruction pauses while the team attempts to determine the reason behind the statements. If the reason cannot be determined within the session, the team resumes the session and determines post session if/how the course of the project should change.

The first session is a planning session between the team and the participants. Given the overview of the technical situation, the team and participants identify and prioritize user stories that are collated into technical projects which can be done within time/availability constraints. This project is agreed upon by everyone, and broken into smaller project goals/technical lessons that are accomplished within each session.

This approach mirrors the agile development method, which collects user stories and prioritizes them in order of project importance. It also brings to the table everyone who is concerned with the project (stakeholders). The method of breaking large technical projects into smaller, more manageable pieces serves as a bit of instruction in itself for the microenterprise owners. In the future, they will be more empowered if this skill is something that they can repeat for themselves.

The remaining sessions focus on the smaller project goals/technical lessons that were previously agreed upon. Before each session, the team decides on specific technical lessons for the session. As the session proceeds, the team members use interactive methods to teach each lesson. The participants work hands-on with the hardware/software whenever possible.

Impact measurement takes place during each session. Near the end of each session, the team determines if a skill has been successfully taught by asking the microenterprise owner to teach them the skill as if they were a new employee. As an alternative, the participant will be given the opportunity to perform the evaluation at the beginning of the next session, rather than immediately, if that makes the participant more comfortable. This evaluation accomplishes several goals. It causes the microenterprise owner to assimilate the new information before the session breaks. In having the participant to try to explain the new information to another person, the approach identifies holes in the participant's learning. These skills/tools/techniques are measured on a pass/try again basis. At the beginning of the next session, the participant is offered a second chance at the skills that were not passed.

After each session has ended, the team meets at a separate location to evaluate the impact of the session. A list of technical lessons learned is recorded. In addition, critical reflection takes place. Critical reflection consists of the team members discussing the session, particularly where the participant's reactions seemed out of the ordinary. The participant's responses to the session are noted, and further alterations to the trajectory of the project are proposed if needed. Patterns that produce positive mental models in the participants are determined and encouraged. Patterns that produce negative mental models are also discovered and minimized. A plan is outlined for the next session. The effect of the session is determined by shifts in mental models on the part of the participants. These are determined both directly and indirectly, using participant behavior as the principal measure. The effect of the session is also measured by skills demonstrably learned on the part of the participants.

The final session takes the same format, except the team does not teach the participant new skills. Rather, they review the process for breaking large projects into smaller ones, and unveil the result of the project/s. There is also some skill review as a spot check.

Defining an effective method requires the measurement of impact. This paper describes impact in terms of first order effects, both in number/quality of skills learned, and shifts in the mental models of participants.
First order effects are defined as effects on the individual. When an interaction is complete, how many new skills has the participant learned? What can s/he do with technology that they could not do before? Has the participant gained any new tools, software or otherwise? What is the level of mastery that the

participant has been able to attain with the new tool? Was the participant able to learn any new techniques during the process of the interaction? Have these techniques influenced the participant's daily work? Finally, has the participant learned new options for making progress with problems which had previously seemed insurmountable? Are there any new alternatives/workarounds available?

First order effects will be measured in terms of the psychological factors/mental models under examination. Has the individual's attitude toward technology changed? Has the individual's attitude toward themselves using technology changed? How have their statements about technology changed during the project? Overall, how has their body language changed?

Plan driven training focuses on the teaching and retention of skills. In agile training, skill instruction, process, and psychological factors play equally important roles. Adjustment of the teaching process will enable the participant to retain more information. Affecting psychological factors toward more positive mental models will enable the participant to continue to make progress on technical skills in the future.

6. AGILE TRAINING IN PRACTICE

The following is an illustration of the Agile Training process. As previously mentioned, research on Agile Training is currently underway at the University of Nebraska at Omaha. A number of sessions have been conducted. These sessions are the basis for this illustration.

The owner of a gym ("participant") requested assistance with a marketing campaign. The team decided to introduce the participant to two software programs, Prezi and YouTube. Both programs were entirely new to the participant. These programs were chosen for their centrality to his new marketing campaign. The skills and concepts for these new programs were taught to him within three working sessions. The first session provided an introduction to basic tasks in YouTube and Prezi. The second session delved into more advanced skills of both programs. Between sessions, the participant was asked to use the skills to prepare a video and a presentation. During the third session, the participant and the team reviewed both presentation and video. At the end of each session, the participant was asked to role play by teaching the skills back to the team members.

The participant scored highly on the confidence and empowerment constructs in the mental model survey. These qualities were observed by the team throughout all three sessions. For example, the participant asked many questions about video streaming, developed new ideas for using video in his business, and expressed that he did not feel as inept with technology as he had before. The participant exhibited no hesitation in demonstrating knowledge of all of the skills and concepts involved in the session. These observations of the participant's mental model confirmed the path taken during the sessions. Had the participant experienced more fear or frustration, the team would have needed to revise the training strategy.

At times, the progression of a session changed based on the interests of the participant. In one case, as a result of the participant's interest in producing comedic videos for his YouTube channel, the next appointment agenda was changed to include a review of a YouTube software product called Xtranormal. This product takes text and transforms it into a fully animated cartoon.

One indicator of the success of the sessions is what the participant does with the skills after the training session has finished. On his own one evening, this participant wished to embed a video into a presentation. The video was on his hard drive, but Prezi would not allow him to embed the video directly into the presentation. He noticed that YouTube videos could be inserted into presentations. He uploaded the presentation to YouTube and added text, overlays and transitions. Then he made the video public and embedded it into his presentation. He also set the video to be the featured video, ready to play automatically upon visitor arrival to his channel.

The notable item about the participant's experience is that he had no knowledge of either YouTube or Prezi before his sessions began. Not only did he learn the skills required to work with both programs, he demonstrated the ability to find workarounds in order to overcome obstacles. The entire video embedding experience occurred outside of a regular session, with no assistance.

7. CONCLUSION

Technological tools are essential for success in today's business environment. Plan driven training has been moderately successful, yet it yields variable results. Methods must be devised to make technological training more effective in unconventional educational environments, such as the microenterprise. The Informing Science Framework suggests that "[i]deally, the knowledge skills, and abilities that are being learned must be packaged, sequenced, and delivered in response to each learner's unique needs" [6]. The agile training method seeks to provide such learning through techniques that emphasize highly dynamic and flexible interactions between trainers and microenterprise participant; frequent iterations involving planning, instruction, practice, evaluation, and critical reflection; and close attention to mental models.

The approach described above is currently being employed in a study involving twenty microenterprises in the Nebraska/Iowa region.

Appendix

I. 12 Underlying Manifesto principles.

Agile Manifesto Principles	Agile Training Principles
Customer satisfaction by rapid delivery of useful software	User empowerment by rapid learning of useful IT skills/concepts
Welcome changing requirements, even late in development	Welcome changing learning scope, anytime in development
Working software is delivered frequently (weeks rather than months)	Useful IT skills/concepts are learned frequently (weeks rather than months)
Working software is the principal measure of progress	Demonstrable IT skills/concepts are the principle measure of progress
Sustainable development, able to maintain a constant pace	Sustainable learning, able to maintain a constant pace
Close, daily co-operation between business people and developers	Close cooperation between user and teacher
Face-to-face conversation is the best form of communication (co-location)	No Change
Projects are built around motivated individuals, who should be trusted	No Change
Continuous attention to technical excellence and good design	Continuous attention to the learning environment
Simplicity	No Change
Self-organizing teams	No Change
Regular adaptation to changing circumstances	No Change

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Basement on Value Creation of Study Programs as Highway to Integrate Academic, Business and Public Interest as well as to Shape Research Directions

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ABSTRACT

The object of this article is the process of studies, seeking the sources and factors of this process effectiveness in the stage of study programs preparation and highlighting the necessity of interests' compatibility of process participants – entrants (students), university (academia), business and nation (public interest). Plus, already in the program of study process should be estimated risks of discrepancy between the purposes projected in the program and process of the reality. The prevention of the mentioned risks or the education of students' abilities to qualify the subsequences of possible risks is necessary requirement for study process and its organizers. The hope is flattering that commanding requirement to follow the principles of interests' compatibility, to do reasoned estimations of mentioned values and to publish its results openly will eliminate the base for unreasoned or even demagogical discussions about the advantages, disadvantages or necessity of the one or other program. Moreover, objective information would be useful for choice of entrants. They could see the receivable benefit from program, possible risks and, finally, have the guaranty that the liabilities established in the program will be fulfilled.

Keywords: Value Creation, Study Programs, Academic, Public Interest, Information Systems, Study Program Management.

1. INTRODUCTION

Nowadays there are a lot of discussions about value creation. What do we mean by value creation? For the customer, it entails making products and providing services that customers find consistently useful. In today's economy, such value creation is based typically on understanding unique customer needs with ever-increasing speed and precision. Involving in the discussion the value creation of study programs, first the understanding that there is potent relationship between the participants of study process - for the university – values of the service supplier, for the student – values of the consumption (knowledge eater), for the business – surplus values, for the nation – public values, should be taken into account. All these values should be defined as symbiotic model. It is necessary to know where all the integrate values come from to the process and understand the strategic factors that build or erode the value. Every strategic decision we make affects general value of the whole process creation. To assess and manage these strategic decisions we have to understand all the process, its components and environmental factors.

2. GENERAL REMARKS ABOUT ASSESSMENT OF STUDY PROGRAMS EFECTIVENESS TODAY

Study program is production of intellectual activity and has long evolution period. For this reason study program instead original musical composition often reminds folk musical composition useful for conversation about music, amateurish training and, finally, for professional concerts. Truly, study program having the same modules set and references could be found in the programs digest of both most progressive world university and ordinary college.
On the other hand, in the face of studies and science management monopolization, if it would happen in any country, we should say that science and studies also study programs is not just public resource or public good about which should care just government of particular country.

In order to develop mentioned programs features first of all the interests of all interested parties – future specialists, business, universities and nation – should be deeply realized and to know how to estimate receivable value. Dirk C. Moosmayer (2010) identified the paradox of value-free science and the need for value- oriented management education. Freeman and Soete (1997) explain that science has emerged as an alternative engine of economic growth in addition to the classic triumvirate of land, labor and capital. Under the influence of a knowledge-based economy, academic research institutions are no longer simply the location of education, research and public services. Academic research institutions play a vital role in regional economic development and employment creation [6, 8]. The description of ‘‘entrepreneurial universities’’ has increasingly been used in relation to the partnership of technology commercialization in academia [5, 9].

Talking about competitiveness of studies programs as a single product of institution of studies services it would mean the ability of that program to attract more students going to get particular speciality in particular institution and in this way giving bigger financial benefit. Academic discussion has primarily focused on the changed environment, exemplified in an increased internationalization process and changing styles of management in academic institutions [14, 11, 3, 15]. In order to implement program goals especially important attribute is economy of program. Economy of program should be a direct component of the competitiveness of program, but regarding to nowadays reality demand – to look for saving possibilities in any activity, we should to assess whether knowledge and practical skills got from program, i.e. value for specialist, business and nation is got with the minimal inputs. Doubtless that estimation and practice of value of the study programs as creation giving intellectual product and service should become imperative. Probably it will become impulse to unclose the benefit which exploiting and projecting study program should bring to every participant of the study process [17, 7, 10, 4, 13, 16, 1].

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3. ABOUT INFROMATION SYSTEMS AS INTEGRATE COMPONENT OF STUDY PROGRAMS AND NECESSITY TO INVOKE ADEQUATE INFORMATION SYSTEMS

Taking into consideration that there is general need of description of the study programs rendering knowledge and practical skills, set of the program modules and digest of the important literature, potential indicators of the methodical and material equipment should be complemented by generally known or by program authors' created knowledge entirety or information system, which has expanded information about possible challenges for particular speciality from both practical skills allowing professionally deal with activities tasks, inadequacy and know uncertain ledge of decision methods viewpoints. These are most common species of study program risk and the readiness of the students to buffer the subsequences is an important attribute of study program quality. Also it is a means for students who independently seek to increase the benefits from study program.

Naturally, that mentioned knowledge and its conversion to the practical skills, as rule, cannot become direct object of the academicals and practical lectures or practical exercises because the credo of the studies is preparation for particular speciality. Preparation for the possible risk challenges is separate problem requiring several decision approaches and methods. Thus, also according to the constantly shortening duration of studies, especially important is to create information system or to use already existing one in order to see particular speciality in the risk challenges context.

With regard to creation of programs from both general value and separate value species, should take very important place in specialists' preparation for possible risk challenges. Thus, programs organizers and administrators also users and assessors should understand, that student's ability to work self-dependently should be complemented by students' ability to overtake him as "programmed" professional answering to risk challenges. Most effective this problem is tackling involving students into science-research activity and giving for them knowledge about riskiness of the future possibilities and possibilities to manage this riskiness.

The force of the study program express not just the abilities of students education to go deep into processes they are interested in, but also by unclosing new possibilities of the processes development and giving abilities for future professionals to use those possibilities. This is especially effective search way of the studies and science research synergy.

The implementation of the last three paragraphs of this section is not possible without functioning of study programs infrastructure information system, principles of which are discussed in the next section (Fig. 1).

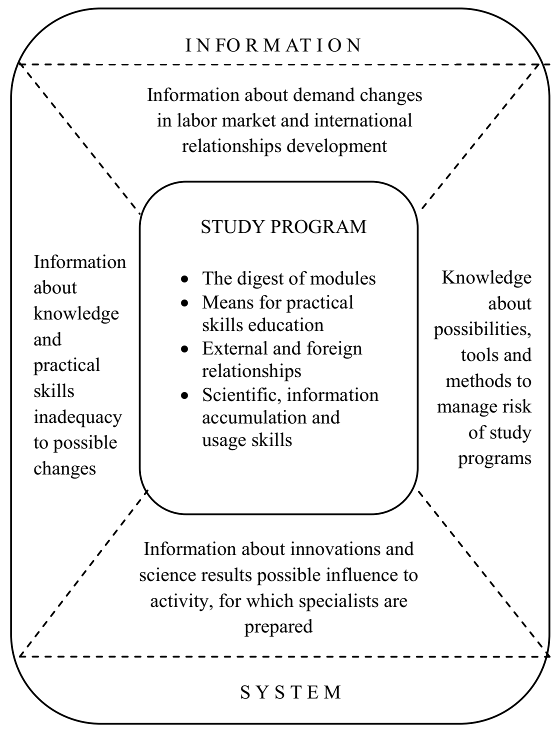

Fig. 1. The scheme of the general possibilities of interactions between study programs and its information system

4. VILNIUS GEDIMINAS TECHNICAL UNIVERSITY'S BUSINESS MANAGEMENT FACULTY'S OBJECTIVES AND POSSIBILITIES TO HARMONIZE INTERESTS OF STUDENTS, SOCIAL DEVELOPMENT AND BUSINESS

The definitions used in this text (SUDIS - Sustainable development information system, SETDIS - Social, economic and technological development information system, BUDIS - Business development information system, INNVIS - Investment information system, REGCDIS - Regional competitiveness development information system, REGDRIS - Regional development risk information system) should not be understood as linkups of paganism or other mystical powers of invisible environment. However it is just acronyms of definitions every day used in auditoriums and business or politics environment. The main part of these definitions is IS – information system.

In many cases, information system is understood as an entirety of definitions, opinions and consistent patterns formatted in base system together with hypothesis of characteristics of base system and generated information needful for decisions, which are necessity for achieving purposes. In our case information system is a digest of knowledge entirety about base system, for example investment processes development requirements, goals and its achievement possibilities based on most important factors – knowledge and intellect power of coming professionals and real activities estimated with possibilities requirements' investments. It should be together with seeing how to train mentioned power and to estimate demand and possibilities.

In order to concretize the principles of study programs preparation as the object of the research the complex of study of Business Management Faculty of Vilnius Gediminas Technical University (VGTU BMF) is chosen. Which is pointed to create knowledge and skills entirety, which, from one side, lets to meet students' interest to get package of knowledge and practical skills giving competitiveness advantages in labor market for a long time and to preserve an ability to refresh competitiveness knowledge and practical skills in the perspective, from the other side, guarantee that business, which will become the user of graduates' knowledge and skills, would be ensure about creation of added value and graduates' flexibility reacting into changes of environment and work processes.

Teaching institution, which aims to achieve all goals perfectly, needs to attain students having proper preparation and intellect and who also aims their goals reasonably. Business, in turn, using the great asset of country – intellectual potential should be responsible for its efficient practice and future development guarantee. To see this and to promote is the obligation of every government.

Great loss for country could be when young people, requesting largest investments, are wrong identified, when intellectual career education is prosecuted by having not enough competences teaching institutions, when supply of specialists is not adequate to real demand, when it is incapable to use created valuables – young specialists.

Presumptions and resources of implementation of BMF study programs

The main resources of BMF, giving knowledge and skills, are high qualification of lectures, plenty of knowledge what is necessary for every specialization or profession, high international mobility of students during studies and, most important, very purposeful accumulating and also generating knowledge in faculty, which creates the crown of graduates' knowledge. Accumulating and generating knowledge usually has double mission. First, it is oriented into high performance of graduates' knowledge and skills. Second, it is oriented into promotion of business development possibilities in the sphere, for which faculty is preparing specialists. In the case of success a strong synergetic effect is received also storing and generating knowledge brings on in the knowledge base or information system formation [2].The main moments of interaction between study programs and its information system are shown in Fig. 1.

The particularities of organization of VVF study programs complex implementation

Further we will represent real information systems serving as study programs' information systems in order to educe the requirements for students entering to bachelor and master studies and also to define skills of those, who work after BMF studies graduation.

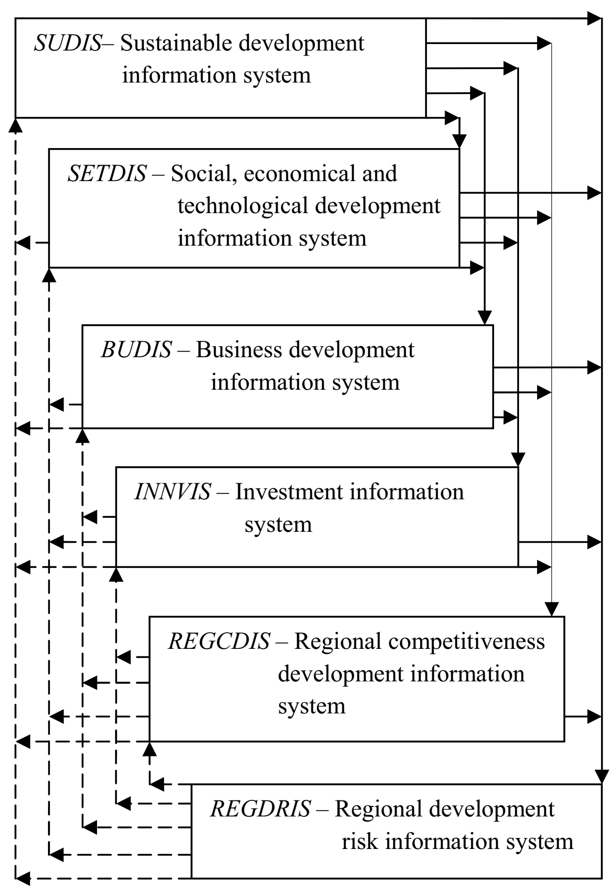

Fig. 2. Hierarchical interaction scheme of information systems during detailing (⟶) the rising demand and preparing also integrating the feedback (– – ►)

From Fig. 1 we can see that decision about demand of necessary knowledge and practical skills is taken analyzing macro economical, social, integration and other macro goals in their interaction with solution of social problems, search and implementation of business development strategies, investments as most active and unique means in order to impact development of Lithuania and, maybe, its' survival, also to ensure national, technological, intellectual, organizational maturity and its' dynamics.

Fig. 2 let us understand in which goals' and interests' hierarchy level the necessary knowledge is accumulated and guaranteed for concrete study program or for specialization and also pursuing scientific researches, which, from one side, are necessary for modern and long-lasting knowledge formation for future professionals and, from the other side, to stimulate of business development in spheres where BMF graduates should and could be in the lead.

The principles of individual program (specialization) selection

BMF maintains limited number of programs at the same time – two of bachelor and two of master studies. In order to ensure the flexibility of these programs large number of specializations, which are prepared on the base of information system and gives particular knowledge, is prepared.

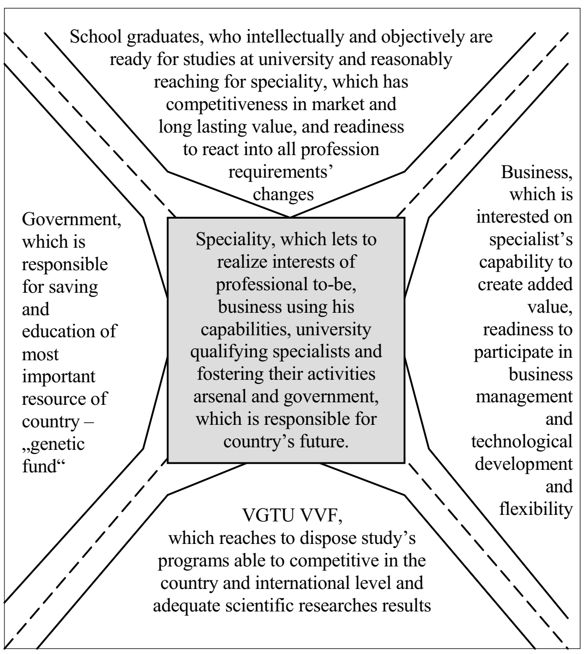

Fig. 3. VGTU BMF forming specialization as a result for future specialist, educating faculty, business, which use the knowledge and skills of specialist and realization of government's interests

The selection of specializations in concrete period usually proceeds following special procedure (Fig. 3):

- according to forecast of specialities and professions dynamics made in EU, Lithuania and other countries with analogical or reachable social-economical development, the list of most expected and popular professions in Lithuania is formed;
- according to current knowledge systems and it's refreshable possibilities, operated specializations are selected;
- the competitiveness of specialists prepared of BMF operated specializations in labor market is estimated;
- the levels of readiness, intellect and motivation of entrants' for selected specializations are forecasted;
- the decision about concrete specialization operation is made;
- The team, which should implement programs and specializations beforehand refreshing information systems and other required means, is formed.

This procedure is prosecuting according to requirement, that with the help of fostered speciality maximally meet all in the process participating parties – future specialist, business, university and government (Fig. 3).

5. PROGRAMS MANAGEMENT

In order to develop the quality of studies, to look for economically optimal study process development ways, to enshrine relationships of today's market in science and studies sphere the important attention should be given for creation and management of the study programs for both fundamentally of management and timeliness viewpoints.

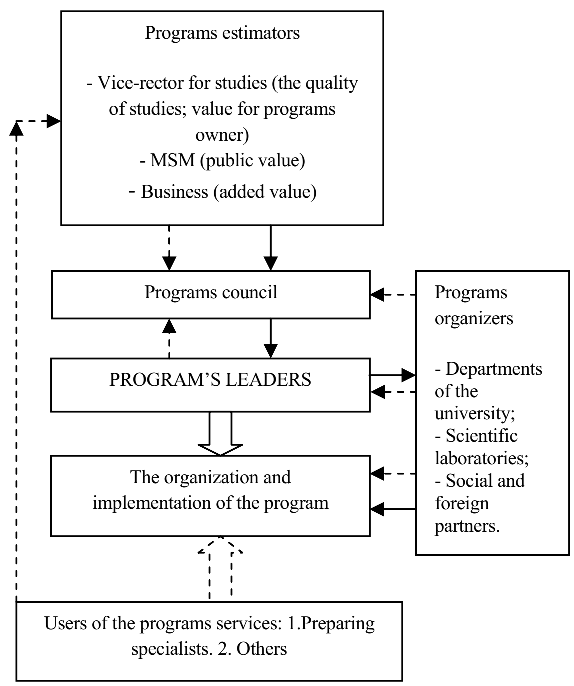

Fig. 4. Aggregated management structure showing necessary to implement decisions (⟶) and notifications (- - ►). Double cursor shows plurality of requirements and information

It is necessary to guarantee that the interests and decisions of all interested parties would influence the existence and development of the study program.

In the aggregated management structure of the program (Fig. 4) the actions of the subjects of direct programs process and its perspective development – programs council and leader are unclosed together with the interests and actions of programs organizers, users and assessors.

According to Fig. 4 the main duties and rights of the participants of study programs in the programs management process could be formulated:

1) The main functions of the operative programs management and monitoring of the implementation quality and the strategic management belongs to the leader of program, which:
   - is responsible for the study process adequacy to the declared programs goals and quality;
   - is operatively balancing the interests of programs users, assessors and organizers;
   - is responsible for programs succession and resumption. He is the main strategist of quality and marketing;
   - is responsible for programs council.
2) Programs council (scientific-methodical commission in the case of department programs or directorate of studies in the case of interdepartmental programs) is responsible for the coordination of interprogramical and interdepartmental interactions and accumulation of the information got during particular programs process supervision and its representation for the leader.
3) Programs users are fully responsible for their readiness and attempts to master knowledge and practical skills giving to them in particular way. If they unreservedly follow liabilities they have the right to require a partial compensation for departed from declared services and to make restitution of subsequences during some time.
4) Programs assessors assessing and informing programs council about programs adequacy to programs users (in the broad sense) and about created value for the owner (for the university), public value (for the nation) and added value (for the business). It should become as a base for assessment of programs generated value as whole.
5) Theoretical basics and estimation practice of the intellectual product or activities value estimation already is in the mature state period but this practice for the estimation of generating value of study programs is not large. But it is doubtless that this method based on science and progressive experience should safe programs from incompetent "fighters" for the saving of interests of nation, business and university.
6) Programs organizers should be professionally and financially free choosing services in one or other program and to have the guaranty of activity's succession if the services meet the requirements of quality and contract conditions.

Further we will discuss the selection one of the programs and the preparation for its implementation.

6. BUSINESS MANAGEMENT study program INVESTMENTS MANAGEMENT specialization

The necessity of the specialization.

The grounding of the specialization necessity could be started saying that before becoming a person, human being had to learn to invest. Actually investment is that economical factor which is building the way to the future by creating it. Investment is taking part in the all spheres of society activities and person individual life and for this socially and economically based decisions are needed. These are the decisions which require knowing about compatibility and mutual influence between social and technological processes development and about the importance and value dynamics in time perspective of human, reproduce and not reproduce nature resources. Doubtless, that the nation's survival, as the base of economically competitive region of the Europe, is the ability of nation and all its citizens to invest. The vision of the competitive state of nation and its single regions should be based on the adequate investment strategy.

The goal of the specialization.

Is to prepare professionals highest qualification of the able to understand integrally consistent patterns of the development of social, technological, ecological and valuable processes, knowing and generating investment methods, principles and strategies, ready to divert the investment forces of Lithuania's citizens and business subjects for nation welfare and competitiveness secure, knowing how to prepare projects of competitive business, enterprises reorganization, personal investments, able to prepare real time investment strategies for currency and capital markets.

In the case of the investment management specialization clear unclosing the compatibility of interests of all study process participants – entrants, business, nation and university, the possibility to estimate created total value and value for every participant and to do estimations and optimization of the studies input as value effect.

Methodical and material equipment of study programs.

According to the assessment done by international experts' group methodical and material equipment of the BMF study programs including investment management specialization is good and should stay good in the future.

Together we should pay attention that traditional attitude towards methodical equipment is not unclosing liabilities implementation possibilities of study programs to programs participants, and, first of all, to entrants when it is not considered risk of knowledge and skills got from studies inadequacy to real needs and not obtaining standards of the practical skills needed for work in the global market.

Mentioned problems in the case of BMF investment management specialization are solving using data and knowledge basis of INNVIS (Investment information system). The possibilities of the INNVIS are complemented by possibilities of REGCDIS and REGDRIS (Fig. 2). As exclusive possibility of INNVIS we should to highlight historical data basis and data about financial conditions of many global corporations, data about these companies' stocks prices dynamics and using forecasting methods. This let to form information necessary for decisions taking without wasting time and abilities. In turn, INNVIS has information about investment in global and local markets strategies created during scientific experiments. The effect of those strategies practice points about regularity of the giving investment knowledge. This is especially important material for high professional skills formation.

Information system of study program.
This is structural prognostic information about possible activities or specializations requiring services of specialists prepared by program and about those needs possible changes challenged by globalization processes innovations. Also this is information about alternative activities treats to preparing specialists demand and rival programs challenges.

This is information about amount and depth of the fundamental knowledge and practical skills of speciality and informatics needed for preparing specialist and about possible scientific discoveries, challenges of the activities inovatization to the competitiveness of this program giving knowledge and practical skills.

The creation of the study program information system is very susceptible to intellectual activity and economically expensive creation. If there is possibility general information systems should be used or cooperated for information system of branch of studies preparation (branch $\in$ direction $\in$ sphere).

7. CONCLUSIONS

1) Academic study program is the plan of knowledge giving and practical skills formation. In the results of this plan are interested not just university as the owner of the intellectual capital – program and student as recipient of programs direct result, but also particular activities as users of programs prepared specialists, services helping in added value creation and nation as upholder of public value creation.
2) Success of the study program depends on both compatibility of the mentioned above interested parties and created spreads of owner, user, added and public values. The base of programs utility and acceptability should become integral, i.e. the value inclusive all the mentioned values.
3) The factors related between each other by program potential utility are not just program competitiveness, economy, adaptively and flexibility but also growing importance of program's riskiness, the management of its subsequences is constructive ability of the future specialist.
4) The participants of the study program process – university, student, business and nation have their commitments and rights: for the university – to get nation support, for the business – to get services of specialist understanding local business peculiarities, for the nation – to see the creation of the value for users and investors and, finally, for the students – to have rights for the compensation if the owner of the program not guaranteed promised quality and amount of the knowledge and skills.
5) One of the success preconditions of the study program is its programmed management.

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Developing an Agribusiness Management Module for Farmer Organizations[1]

Integrating Research, Learning and Consulting/Teaching in Agribusiness for a Lifelong Learning Process.

The report of this study provides an overview of the process for designing a course module on Agribusiness Management for Farmer Organizations (AMFOs).

The module development was based on several interdisciplinary field case studies along with provision of consultancy services to participating farmers as part of the "AgShare" Open Education Resource (OER) project. The purpose of the study was to develop a pedagogical model and a pilot module for teaching farmer organizations such as community based organizations to change their **attitude**, gain new **knowledge**, and acquire agri-business management **skills** (ASK) for transforming farming from a livelihood practice to a business enterprise. In other words, *transforming the farmer's mindset from perceiving a farm to a firm*.

The foundation of this cyclical process of research, learning and consulting is based on two philosophical pedagogical premises of learning at universities. First, is about the role of universities in society which highlights the significance of *learning through research*. Second is the way of learning which elicits the role of general education at universities as a means of *integrative learning*. Ultimately, the fundamental pedagogical role of universities is to create opportunities that nurture learning as a lifelong process

Learning by Research

The role of research at universities is very critical for learning. Thus, the debate over the role of research at universities has been with us for over 200 years since Humboldts 1810 dichotomy between "university" and "school" (Elton, 2008)[2]. According to Elton, in Humboldt's view;

…..a university treats scholarship always "in terms of not yet completely solved problems, whether in research or teaching, while school is concerned essentially with agreed and accepted knowledge." The consequence, …., is that in universities "the teacher is then not there for the sake of the student, but both have their justification in the service of scholarship".

1 Francis Wambalaba, Maina Muniafu, Gidraph Nduati, Walter Wanyama, Dalton Ndirangu and Akosa Wambalaba are the module developers and case study research faculty at the United States International University (USIU). They were assisted by Mark Odhiambo of Moi University, a team of student interns, Sustainable Development Initiatives Center (SUDIC) secretariat, Open Education Resources (OER) Africa and farmers from, Emali, Kajiado, Kapsabet, Kiambu, Nakuru.Tigania, and Sikulu. The study was funded by Michigan State University's AgSgare Project.

2 Lewis Elton, Recognition and Acceptance of the Scholarship of Teaching and Learning, International Journal for the Scholarship of Teaching and Learning Vol. 2, No. 1 (January 2008), http://www.georgiasouthern.edu/ijsotl

In other words, the role of both faculty and students is to enhance scholarship which according to Elton has also been defined by Ashby (1958, p. 22) as '*the empirical approach to knowledge*'. However, fear has been expressed about positioning scholarship on teaching and learning within the disciplines (Weimer, 2008)[3]. This has been the most common trend at universities as opposed to Ashby's empirical approach to knowledge which is interdisciplinary and integrative in nature. For most universities in the American system of university education, this process is founded on the platform of General Education (or other similar programs).

Role of General Education

In his discussion of "What is a Generally Educated Person", Jerry Gaff refers to the late Joseph Katz who defined general education as "the knowledge, skills, and attitudes that all of us use and live by during most of our lives - whether as parents, citizens, lovers, travelers, participants in the arts, leaders, volunteers, or Good Samaritans". (Gaff, 2004) He further argues that general education is relevant today "because the United States has moved from an agrarian economy, through an industrial economy, to a knowledge-based economy". He supports this contention by indicating that labor economists have determined that, for a knowledge-based economy where many people work on solving unscripted problems, a liberal education is excellent preparation for the best careers (Carnevale and Strohl 2001). And according to White (2004), one of the key goals for general education is "to help students develop the tools essential for constructive participation in civic affairs - the social, political, professional, and artistic environments we inherit and then, leave for others".

One area of interest and debate typically revolves around the approach to teaching General Education. Indeed, Gaff (2003), has equated the development of general education to the "original sin" by highlighting the demands on educators to overcome their academic pride and sacrificing the focus on their own discipline, research interest and autonomy. Thus, in most cases, educators at colleges and universities come from specific disciplinary backgrounds. However, general education requires an interdisciplinary integrative approach to teaching. A review of disciplinary perspectives and approaches includes concepts such as disciplinary, cross disciplinary,

[3] Maryellen Weimer, Positioning Scholarly Work on Teaching and Learning International Journal for the Scholarship of Teaching and Learning Vol. 2, No. 1 (January 2008), http://www.georgiasouthern.edu/ijsotl

multidisciplinary, interdisciplinary, and integrative approaches.

1. A *disciplinary perspective* involves teaching a specific subject matter within a discipline by an expert in the respective discipline using specialized disciplinary theories and methods. But while most college and university programs have been designed around their disciplines, all the models for teaching general education need to go beyond a disciplinary coverage.

2. On one hand, a *cross disciplinary approach* tends to teach a subject matter in one discipline by taking on ideas from another discipline such as by borrowing of concepts, models, theories etc in order to provide a rich understanding or a comparative context of ones own discipline. A *multidisciplinary approach* on the other hand puts emphasis on involvement of multiple disciplines, especially in problem solving situations where input is collected from a wide variety of view points. In both cases, a teamwork approach to teaching is not only encouraged but is expected. While these two approaches enrich student learning, they are still done along disciplinary boundaries and therefore not fluid enough.

3. An *interdisciplinary approach* tends to melt these boundaries. According to Heidi Hayes Jacobs (1989), interdisciplinary learning is a "*knowledge view and curriculum approach that cautiously applies methodology and language from more than one discipline to examine a central theme, topic, issues, problem or work*". According to Erickson (1998), interdisciplinary learning is said to have become active in the United States in the 1890s until the 20th century when it gained considerable attention from an education theorist John Dewey and boosted during the 1960s "open classroom" concept and Hilda Taba's research works when educators began collaborative teaching units and creativity became the most important element in curriculum design. While the process experienced some setbacks in the 1970s anti-open classrooms, the education community had started to shift so that by the 1980s, emphasis was already being placed on the teaching of higher order thinking skills.

Integrative Learning

However, this was not without concern from those who viewed interdisciplinary approach as a threat to the integrity of the disciplines and thus "upsetting hundreds of years of educational theory" (Jacobs, 1989). Jacobs' initial concern was about the earlier attempts that resulted in the so called the "*potpourri effect*," instead of true interdisciplinary design. She therefore argued that it was the works of researchers such as Ackerman and Perkins who helped expand horizons by suggesting that “educators align the teaching of thinking with the teaching of content, to ensure that students developed higher-order thinking skills and discipline-based knowledge in an integrated way” (Jacobs, 1989).

While an interdisciplinary approach has in many cases been treated as synonymous with an *integrative approach* to learning, in practice, the former tends to put emphasis on the presentation from multiple perspectives while the later tends to focus on the integration of ideas covered previously and synthesizing them from an interdisciplinary perspective. For example, Schneider (2003) talks of integrative learning in form of culmination of learning. She points out that starting with: *“today’s students now have multiple, structured opportunities to make connections across disciplines and fields, to connect theories to practice, and even to engage their own lived experiences in the context of what they are learning in general education and in their majors. This commitment to integrative learning helps ensure that students will learn to take context and complexity into account when they apply their analytical skills to challenging problems”.*

And according to Rothblatt (1993), integrative learning focuses on educating the "whole" person by encouraging "breadth of outlook, a capacity to see connections and hence an ability to make fundamental decisions and judgments". It requires deliberative and reflexive stance towards knowledge acquisition and typically considers differing dimensions or perspectives of the problem and making links among the perspectives or dimensions such as contextual learning. According to the Center for Excellence in Teaching (CET) at the University of Southern California, “Contextual learning occurs when teachers relate subject matter to real world situations. Students are motivated to make connections between knowledge and its applications to their lives as family members, citizens, and workers”. According to Rothblatt (1993), the focus of integrative learning is on: “*discovery and creativity, integrating and interpreting knowledge from different disciplines, applying knowledge through real-world engagements, or teaching students and communicating with the public…..disciplines are now less bounded, with new areas of scientific knowledge emerging on the borders of old ones”.*

Based on the context of the disciplinary perspectives, and best practices, it is therefore the *interdisciplinary integrative approaches* that have been viewed as representing the “whole” and therefore more realistic for general education purposes. An interdisciplinary integrative learning is thus the foundation of an effective lifelong learning.

Project Design and Methodology

The project involved research and consulting activities to cultivate a process of learning among all the three key stakeholders, i.e., faculty, students and farmers. The project developed a pilot course module by combining concepts with regard to the structure of the agricultural sector and policies, context of the economics of a firm, behaviors of an entrepreneurial mind set, sustainable farming and applications of information technology. The framework was based on five key outcome objectives as outlined below.

1.Form Community-wide Partnerships: The goal here was to enable and facilitate community-wide partnerships (CWP), networking opportunities to support the project's vision and exploration of policy and strategy issues. This include partnerships with both farmer organizations and other relevant stakeholders, i.e., partnerships among USIU faculty and at least one university in Kenya with agriculture faculty, one producer organization and one NGO involved in women and agricultural / rural development and arrangements for feedback loops among those partners for information sharing for OER development and use and reuse.

2. Build Capacity: The framework was tailored towards facilitating advanced business management and organizational skills development of farmers and producer organization to increase their overall ability to transform their members' farming practice from a livelihood to a business enterprise. Similarly, in partnership with a local agriculture university (AgShare Partner), the module was to be used for training masters level students as a field work seminar. This included creating capacity for awareness of OER platform and understanding of creating information, using and reusing OER materials among all USIU AgShare project partners.

3. Create Learning Materials (OER): The team worked in partnerships with Moi University to co-create an OER environment and associated learning materials. USIU faculty developed syllabus content, teaching and class activity content, and case studies for teaching. They also taught the course in collaboration with each other from an interdisciplinary perspective. USIU internship students participated in the module development and case study process. They developed case study scenarios through interview data collection, writing of farmer stories, and captured farmer experiences through films and pictures. The completed draft was shared with the AgShare partner universities for feedback, input and possible adoption. All USIU AgShare project partners agreed on Open Access Licencing of AgShare project materials. This was a non credit module except that participants were to receive a certificate of completion.

4. Create an AgShare Fellows Program : The AgShare Fellows Program (AFP) constituted both faculty, students and farmers who championed the concept of OER within their respective universities. USIU coordinated with internship and community service programs to recruit student Agshare fellows who would capture local stories that could be used as illustrations, examples and even case studies. Four student's were recruited including three USIU undergraduate students from journalism, entrepreneurship, and IT and one agriculture masters student from the AgShare partner university.

5. *Assess the Impact*: During phase two of the project, the team embarked on project assessment with the dual quantitative and qualitative goals of determining the level of output as well the effects of the project. The output levels included; assessing the level of partnership and networking; development of modules for Farmer Organizations; and generating a variety of OER materials produced (modules, cases and video. Determination of impacts included; the impact on farmers, impact on faculty and students; and desirability of modules at universities.

Issues of sustainability and ethics were embedded in the module. Agribusiness issues to be covered included green business development, sustainable supply chains and a focus on development of socially responsible ventures. The farmer organization issues also included concepts of green farming practices, carbon footprint minimization, economically sustainable planting and harvests methodologies, and sustainable and just labor practices. This was accomplished through participating faculty's selection of appropriate books, articles, case studies, experiential exercises, facilitated discussions and lectures which make reference to sustainability and ethics or provide a format for their use as one of many analytical tools.

Concluding Observations

The process of course development is in itself a research process that imparts learning for the developer. The consultancy outcome solidifies that learning process. This is further enriched by not only a process of integrative learning, but also when the teacher, student and practitioner and all involved in the process of creating knowledge, developing skills and changing attitudes through research and learning from each other. This project was a demonstration of this integrative and collaborative process of learning.

Using different Research Paradigms to test Self-Directed Learning readiness in 4th year Information Systems students

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ABSTRACT

Self-directed learning is a concept introduced by Malcolm Knowles in 1975. Key to this concept is moving the responsibility of learning away from the teacher to the learner. The learner should take control of the learning experience and the teacher should only facilitate this process. However, self-directedness in a learner develops in stages. Learners need to be guided to become more self-directed over time. In order to guide learners the lecturer or facilitator should understand the level of self-directedness also referred to as the readiness for self-directed learning of the students. This paper reports on the process of understanding the readiness for self-directed learning of 4th year Information Systems students. Methods representing the positivistic and interpretive research paradigms are applied and compared to achieve this goal.

Keywords: Self-directed Learning, Self-directed Learning Readiness, Mixed Methods Research, Research Paradigms.

1. INTRODUCTION

The aim of this paper is to report on the Self-directed Learning (SDL) readiness of Information Systems (IS) students. In order to prepare students as life-long learners, one needs to develop their SDL skills. If the SDL skills of individual learners are understood it is possible to develop study material suitable to develop these skills. Blended learning where traditional face-to-face teaching is enhanced by electronic material provides the opportunity to provide different learning experiences for learners on different levels of self-directedness. Methods from two different research paradigms are used to gain a better understanding of the SDL readiness of the students.

This paper contributes in the understanding of SDL readiness of 4th year IS students. It also contributes to the discussion on using mixed methods in IS education research. The paper starts with a motivation of the study followed by a brief literature review of SDL. The empirical part of the study is introduced with a short discussion of different research paradigms. This is followed by reports on the positivistic and interpretive studies. The results of the studies are compared from a paradigmatic perspective. The paper concludes with reflections of the SDL readiness of the students and the suitability of the research methods used.

2. MOTIVATION FOR RESEARCH

Many IS lecturers complain that their 4th year students cannot think for themselves and do not know how to solve problems. As lecturers we are often amazed by our students' knowledge of the latest electronic gadgets, but the same students do not know where to start to investigate the problems we give them. This problem may be related to the fact that we give our students problems to solve for which they do not feel ownership. They are only attempting to solve the problem because the lecturer is telling them to solve it. Should we then rather give our students more control of their learning environment? Should they gather their own learning material? Should they decide how their progress will be evaluated? Should they decide what to study and how to study new IS technology? This might seem like extremes but in the fast changing world of Information and Communication Technology (ICT) we have an obligation to our students to equip them with life-long learning skills. The question investigated by this paper is: Are our students ready for self-directed learning?

In South Africa the National Qualification Framework (NQF) of the South African Qualification Authority (SAQA) puts 4th year (honours) study on level 7. In their description of level 7 under problem solving the skills required by the learner includes the ability to:

> ”[...] identify, analyse, critically reflect on and address complex problems, applying evidence-based solutions and theory driven arguments.” [11].

Further in terms of management of learning, the ability to:

> ”[...] identify, evaluate and address accurately his or her learning needs in a self-directed manner and to facilitate collaborative learning processes.” [11].

In order to demonstrate these skills our students should be intrinsically motivated to learn and to solve problems to achieve this learning process. In this respect it is the responsibility of educators of this level to equip learners with SDL skills. This can only be done effectively if educators understand their learners' SDL readiness.

3. RESEARCH METHODOLOGY

The term "research" as used in this paper corresponds to the description given by Mingers [9] as:

> "A construct that specifies a general set of philosophical assumptions covering, for example, ontology (what is assumed to exist), epistemology (the nature of valid knowledge), ethics or axiology (what is valued or considered right), and methodology."

Three major research paradigms are discussed in IS literature: Positivism, Interpretivism and Critical Social Theory (CST) [8]. The aim of methods used from a positivist paradigm is to measure aspects of reality, often referred to as variables [1]. Positivistic questionnaires are developed to be reusable in different environments to measure specific variables. Quite often the same measurement tool (questionnaire) is used in very diverse situations. Interpretive studies, on the other hand focuses on specific situations. The researcher is transformed from objective observer to subjective learner, who aims to understand the situation from the point of view of the participants in the study [3]. In CST studies the aim of the researcher is to identify oppressing structures in the problem environment and to facilitate change in order to emancipate the oppressed.

Recently there is a trend in combining methods from different paradigms in one project. The main advantage of such an approach is that methods from different paradigms provide different perspectives on the problem environment [9]. In other words we use different methods from different paradigms to better understand different aspects of the reality in our problem situation. A mixed method approach was followed in investigating the readiness for SDL of the 4th year IS students at a university in South Africa.

As this paper focuses on the investigation of the readiness for SDL of the students, a CST study is not applicable as it is not the aim of the research team to influence the SDL readiness in this phase of the project. When confronted with the choice between using a positivistic SDL readiness tool and an interpretive case study, this research team decided to perform both types on a pilot group of 4th year IS students, in order to get the best possible understanding of the SDL readiness of these students.

The positivistic tool of Guglielmino was used [5]. This tool is available at cost from the SDLR website. An interpretive questionnaire was also developed from SDL readiness literature, incorporating literature on positivistic readiness tests. Students were asked open ended questions to explain their perceptions, fears and aspirations on SDL. Before the detail of the empirical work is discussed, a brief literature review of SDL is provided to guide the reader.

4. SELF-DIRECTED LEARNING

Few people have ever defined self-directed learning with precision [4]. Different terms are used interchangeable with self-directed learning, for example individualized instruction, prescriptive learning and contract learning [10]. One possible definition is that self-directed learning takes place when the learner takes control and accepts the freedom to learn what he or she view as important [2]. Another definition is that self-directed learning is a process in which learners take the initiative for analysis and diagnosis of their learning needs, formulation of personally relevant learning goals, identification of how to achieve them, and reflection on their achievement [7]. For the purpose of this research self-directed learning will be defined as learning where the learners control the process with the guidance of a facilitator, including the analysis of learning needs, formulation of goals, and decisions on how to achieve these goals.

According to Grow the goal of the educational process is to produce self-directed, lifelong learners [4]. Knowles believes that self-directed learning is the best way to learn [7]. He states:

> "[I] don't think it is healthy – or even humane – for a person to be kept permanently dependent upon a system or upon another person".

Self-direction is partly a personality trait, and the degree of control the learner is willing to accept depends on their attitude, abilities, and personality characteristics [4]. Self-directed learning is also unfamiliar to most students [10]. Many students entering into a new situation feel the need for a structured plan and teachers who are in charge, and they become anxious when this is absent [7]. Teachers also find it difficult to change from being a teacher to being a facilitator of learning [4,7].

Stages of self-directed learning

Grow developed the Staged Self-Directed Learning (SSDL) model [4]. According to this model, there are 4 stages to self-directed learning. During stage 1 the student is a dependent learner who has to be taught by lectures, drilling, and coaching. The stage 2 learner is interested and can be taught by inspired lectures, guided discussion, and goal-setting. During stage 3 the student is ready to explore, as long as he or she has a good guide. The student can be taught by way of discussions, seminars, and group projects. In the final stage, stage 4, the student is self-directed, the teacher is a consultant, and the teacher uses internships, dissertations, and study groups to teach.

Preparing students to become more self-directed

The good news concerning self-directed learning is that it can be learned [4]. It is very important that teaching is matched to the self-directed learning readiness of the students. What is 'good teaching' for a student in one stage of development may not be 'good teaching' for another student in another stage of development. Good teaching does two things: it matches the student's stage of self-direction, and it empowers the student to progress towards greater self-direction [4]. When the teaching style is not matched to the student's degree of self-direction, problems arise. The students can be prepared for the next stages by gradually giving them more freedom and responsibilities. During stage 2 it is important to begin training students in basic skills such as goal setting, as part of preparing the students to becoming more self-directed. Students need to, at this stage, recognize their different personality types, life-goals, and styles of learning [4]. The students have to be sold on the advantages of self-directed learning [10].

Measuring the students' readiness for self-directed learning

To be able to match the teaching to the students' self-directedness, and guide the students through the relevant stages, it is of course very important to measure the readiness of the students for self-directed learning. The Self-Directed Learning Readiness Scale (SDLRS) was developed in 1977 by Lucy

Guglielmino, and has since been tested and revised. The self-scoring form, called the Learning Preference Assessment (LPA) was developed in 1991. Based on numerous literature reviews the SDLRS / LPA has for some time been the most valid and widely used quantitative instrument in the study of self-directed learning. Although there has been some criticism of the SDLRS / LPA [2], the vast majority of studies have supported the reliability and validity of the instrument [2]. As the SDLRS is the most widely used instrument, it was decided to use it in this study, in combination with an interpretive study.

The following section reports on the empirical part of the study. A discussion of the positivistic study is followed by a discussion of the interpretive study.

5. MEASURING SDL READINESS POSITIVISTICLY

The discussion of the positivistic readiness test of the 4th year IS student starts with a brief introduction on the background of the students. This is followed by sections on data collection and analysis, and findings.

Background information

In South Africa most Bachelor's degrees are completed in three years. A follow-up fourth year degree, called an Honour's degree, is done in preparation for Master's study. The students investigated here are Honour's students and have therefore completed a Bachelor's degree. Most of these students completed their degrees at other universities from the one where they are enrolled for their IS Honour's degree. The students' backgrounds are vastly diverse from an academic and social perspective. Some students studied previously at traditional academic state subsidised universities, while others are from technical state subsidised universities and other still are from privately managed universities who present courses accredit with mainly British universities.

Their preparation to deal with module content, in this case Data Mining, differ substantially. It is therefore required to present module content to individual students differently.

Data mining is presented as a year module. For the first five months students had to do assignments as preparation for lecturers. This was done to ensure that students have a solid foundation in basis data mining skills. After five months the students had to propose topics in data mining they wanted to study using SDL techniques. It was at this time that the students completed two SDL readiness questionnaires, one positivistic and one interpretive questionnaire.

Data gathering and analysis

The SDLRS of Guglielmino was used from the SDLRS website [12]. The questionnaire was completed by 17 students. The students completed the questionnaire on the Internet and their answers were then downloaded together with the descriptive statistical analysis and results.

Findings

The SDLRS measure the current level of readiness for self-directed learning. According to Guglielmino the average score for adults completing the questionnaire is 214, as can be seen in figure 1 [6]. The standard deviation is 25.59.

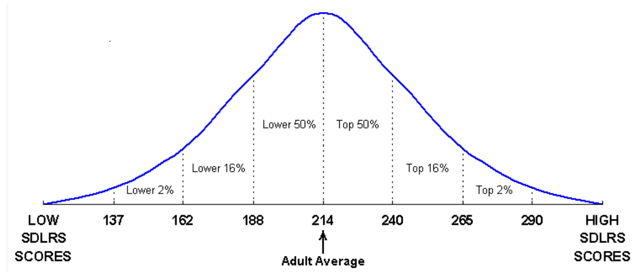

Figure 1 SDLRS scores [12]

The group that participated in this research had an above average mean (221 compared to the average of 214), as can be seen in table 1. The standard deviation is 22.11. The maximum is 266, which is high above average, and the minimum 189, which is below average.

Mean	221.0588235
Standard deviation	22.10619423
Minimum	189
Maximum	266
Range	77

Table 1 Group statistics

In table 2 the different levels of self-directed learning [6] can be seen in column 1. In columns 2 and 3 the results for this group can be seen. There were no students with a low readiness for self-directed learning. There were 3 students (17.65%) with a below average readiness for self-directed learning, while 9 students (52.94%) had an average readiness. There were 3 students (17.65%) with above average readiness, and 2 (11.76%) with a high readiness. This means that 82.35% of the students scored average and above average.

Score	**Level of readiness**	**Number of students**	**% of students**
58-176	Low	0	0
177-201	Below average	3	17.65
202-226	Average	9	52.94
227-251	Above average	3	17.65
252-290	High	2	11.76

Table 2 Statistical results

People with high SDLRS scores usually prefer to determine their learning needs and plan and implement their own learning. People with below average scores prefer very structured learning options. If the scores of students are known, the lecturer can adapt teaching to the readiness of the students. In the group that participated in this research, the lecturer will have to allow for the fact that all the students are not on the same level of readiness for self-directed learning, and the variance is high (varies from below average to high). Steps will have to be taken to guide the students with low scores, while not frustrating those with high scores.

6. MEASURING SDL READINESS INTERPRETIVLY

This section reports on the interpretive part of the empirical work in terms of data collection and analysis, and findings.

Data collection and Analysis

The same group of students completed interpretive questionnaires on SDL readiness, although 24 students completed the questionnaire compared to the 17 in the previous section. The questions were compiled from SDL literature incorporating questions on aspects found in positivistic questionnaires.
The results of only 5 of the questions are discussed here to illustrate the understanding achieved from interpretive analysis. Content analysis was used and codes were identified to describe the answers of the students.
The first question presented in this paper was:

> "What was your first reaction to the change of the module? Positive / Negative and why?"

As described earlier the first part of the module was presented using a lecturer centred model and it was changed to a SDL model. Codes were developed for (number of responses):

- Anxious mixed (2);
- Mixed (gave positive and negative reasons) (3);
- Negative (enjoyed previous methods) (2)
- Negative (against teamwork) (2)
- Negative (time management) (2)
- Positive (13).

From these one may group codes together. All the negatives add up to about 6 students, mixed 5, and positives 13. To illustrate the riches of information gathered a few of the answers and their codes are given here:

Anxious: "Never have I done this before! Scared and excited. Scared because of this huge change. Excited because of this huge change. This is a good opportunity to see if I can learn independent of any course material and study guide. I can choose these myself."

Negative (time management): "Negative, because it seemed like a lot of work to be done in a short period of time. And also the confusion of where to start, how to start, and to look for"

Negative (enjoyed previous methods): "Negative. Is easy to just settle at one's comfort zone, lecture coming prepared, lecturing and I just sit there and do what she told me."

Positive: "Positive because we are now applying the concepts more practical to the field in a real world than having assignments from the textbook only which are pre–prepared questions from a certain environment and difficult to imagine"

From this it is clear that special guidance on time management and teamwork should be provided to students. In a blended learning environment students can choose how much guidance they use in terms of how many optional resources on non-content related topics they study.

Another question was: "Do you view yourself as a curious person?" All the students except one answered positively. Only one student answered negatively to a question on their ability to evaluate their own examination performance. Only one student indicated that he thinks that he will not pass the module stating the following:

> "No, to be honest the time I spend on my studies is too minimal. My responsibilities at home where not permitting me to concentrate on my school work. As a father I had to give full support at home. This worked against me at all costs."

The final question reported on in this section was: "Do you do a lot of research on your hobbies? Explain." After coding, 9 students indicated that they often don't do research on hobbies while 13 indicated that they do. Two explained that they would rather form interest groups to investigate their interests.

Findings

Most of the students were positive towards the idea of SDL. Those who were negative mainly expressed time management, negative teamwork experiences, and resistance to change as motivation. All of this can be addressed by providing reading material to the students on the electronic learning management system.

Students view themselves as curious but only 13 of the 24 would actively research a topic associated with their hobbies.

A very encouraging result is that almost all the students are able to predict their mark or evaluate their success in examination papers. This might be due to the fact that all of them completed a Bachelor's degree successfully prior to enrolling for this module.

7. COMPARISON IN FINDINGS FROM DIFFERENT METHODS

The specific scores for the individual students are available for each question in the positivistic questionnaire. However the motivation for the selection of the option is unclear. It is the motivation of the few negative or low SDL readiness students that may assist the lecturer in providing solutions that may also assist other students who might not have been able to articulate their feelings.

For interest sake the answer on the question on the reaction of the student to the change towards SDL of the module given by the student with the lowest score on Guglielmino's SDLRC was:

> "My first reaction to the change of the module was negative. For me, it was a challenge that I was not sure I could be up to. Generally students are lazy. So self-directed learning could be useless for some students because of the time management and the commitment of the students. Not seeing a lecturer or getting explanation from him/her could affect the performance of the student learning."

On the hobby research the answer was:

> "It is very seldom. I must admit. I don't even remember if I did it once."

Both methods of investigation identified this student as somebody with a low level of SDL readiness. The interpretive answers might provide more insight on how to guide him/her to improved SDL skills.

Further analysis will be done to compare the results of specific students for related questions in the questionnaires.

8. CONCLUSION

The aim of this paper was to investigate the readiness for SDL of 4th year IS students. It was decided to do two studies in parallel. The students completed the SDLRS of Guglielmino, which is a positivistic measurement tool. The average score of the students is slightly above average which may be contributed to the fact that all of them have completed a Bachelor's degree successfully. The students also completed an interpretive questionnaire. Only a small number of the questions were reported on in this paper, but it demonstrated the richness of information contained in these answers. Specific fears and negative sentiments towards SDL could be expressed by students and could be understood by the lecturer. These may now be addressed by the development of a blended learning environment accommodating different levels of SDL capabilities of students.

Interpretive data analysis is time consuming and it is difficult to get an instant overall view of the concept that was investigated when compared to positivistic data analysis. It does however provide a better understanding of specific participant's motivation for their answers. The authors of this paper support the view of Mingers [9] that when methods from more than one paradigm are applied to the same problem a greater richness of understanding can be achieved.

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Experiences from Implementation of National and International, Collaborative, Virtual Universities

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ABSTRACT

Pressure from society and a growing need for education and specialised knowledge require new ways of facilitating access to learning and documentation of qualifications. Traditional universities do not have capacity to meet these challenges at their own premises. The use of ICT and Internet seems to be a possible way to increase access and capacity. In order to keep costs and efforts at a reasonable level without lowering study quality or staff qualifications, collaboration and sharing of material and competence may be the best option. This has been tested over the past 20 years in different plans and projects. Experiences from three projects are presented in this paper: NITOL (Norway-net with IT for Open Learning) as a national project in Norway, MENU (Model for a European Networked University) at a European level, and UNU-GVU (Global Virtual University) with students and partners around the World. The analysis of positive and negative findings leads up to certain recommendations that may be of value for future attempts to exploit the full potential of collaboration between universities. Hopefully the establishment of *collaborative virtual universities* can meet some of the global needs for higher education.

Keywords: Higher Education, Collaboration, ICT, Virtual Universities, National and International Projects

CLARIFICATION OF CONCEPTS

Universities have been operating more or less in the same way for centuries; with students staying at the university for a period of time, getting their degrees and diplomas and then leaving. This has been the typical pattern until the last couple of decades.

Terms like networked university, e-learning institution or a virtual university, are new terms that indicate universities offering distance or flexible education. Previously it was difficult to find a definition of the term *virtual university*; now it is defined in a way that suits our purpose well. *Wikipedia* explains:

> A ***virtual university*** provides higher education programs through electronic media, typically the Internet. Some are bricks-and-mortar institutions that provide online learning as part of their extended university courses while others solely offer online courses. They are regarded as a form of distance education. The goal of virtual universities is to provide access to the part of the population who would not be able to attend a physical campus, for reasons such as *distance* - where students live too far from a physical campus to attend regular classes; and the *need for flexibility* – some students need the flexibility to study at home whenever it is convenient for them to do so.. - - - [1]

Some universities are dedicated to distance learning only, for instance Open University in England [2] and the Open University in the Netherlands [3]. Both OU-UK and OU-NL allow students to enrol regardless of formal qualifications and still offer bachelor and higher degree studies.

Other universities are dual-mode institutions, offering education at distance as well as on campus; examples: the Finnish Virtual University [4], Canadian Virtual University [5], and the Open Universities in Australia [6]. All these virtual universities are networks of universities, e.g. the FVU is a partnership of 21 Finnish Universities. It is based on collaboration, division of labour, shared knowledge and the expertise of the member universities. "It is not a new university in itself and does not provide university education. For virtual studies you have to enrol in one of the member universities" [4].

In this paper the term *virtual university* is used for universities that offer online education on the *Internet*, accessible to students both on and off campus, but not necessarily their own courses. Terms like open universities, net-universities, networked universities, e-universities etc are in this respect treated as synonyms to virtual universities.

However, a *collaborative virtual university* (CVU) is defined to be a network of universities which collaborate in developing and offering courses and educational programmes online. Some of the above mentioned examples are of this kind. In a CVU the institutions join forces to develop and offer online education to students, either at distance or as blended solutions. Three such models will be presented below.

NORWAY-NET WITH IT FOR OPEN LEARNING, NITOL [7]

Representatives from the ICT departments at four Norwegian higher education (HE) institutions,

- Teacher Education, at Stord/Haugesund University College (SHUC) [8]
- Institute of ICT at University of Agder (UiA) [9]
- Engineering, at Sør-Trøndelag University College (STUC) [10]
- Institute of Informatics at Norwegian University of Science and Technology (NTNU) [11]

- joined forces in a proposal for the NITOL project. The proposal was awarded with a governmental grant for 2 + 2 years, 1994 - 97. NITOL was initially an open learning R&D project offering ICT related courses for students, teachers, ICT professionals and others. Research questions particularly focused on learning environments based on collaborative development and distribution of course material.

During the first years large efforts had to be devoted to technical solutions. As Internet and PCs gradually stabilised and became more user-friendly, pedagogy and subject content came more to the foreground of the work. The timely introduction and rapid development of World Wide Web (www) meant a major breakthrough for ICT-based Open and Distance Learning (ODL). NITOL happened to be there “just-in-time” to exploit the technology and to meet demands from the public.

An important principle was the *free flow of material* between the four NITOL partners. Of course, copy rights and the academic property rules applied equally well to electronic products as to printed material. At the start of the project, however, a partnership agreement was signed, stating that partners were free to “borrow” material from their colleagues, use it in their own courses, develop it further and offer it to the whole team of partners. The condition was that the name/institution of the author - and further developers - should be visible to everyone who was exposed to the material. During the project period this free exchange of competence and material was one of the major assets of the project. All partners had great advantages from it.

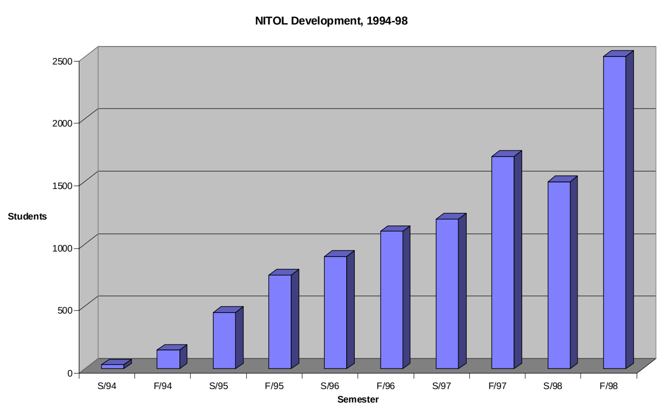

Fig. 1 [12]

The fast growth in student enrolment (Fig 1) required serious thinking about daily routines for running the project. In 1996 some systematic work was done to develop “The Administrative Concept of NITOL” [13], covering the central issues of the project organisation. To keep the administrative work at a minimal level, and to reduce parallel work as much as possible, the daily chores from the individual institutions were transferred to a joint secretariat. This secretariat took care of e.g. student registration, collection of course fees, organising exams, editing and printing course catalogues, providing technical support for students, assistants and staff etc. Students then had the advantage of dealing with only one point in the network when registering, paying and asking for practical information. The four institutions benefited from receiving both preliminary and final student lists for each course they were responsible for, and by receiving their respective sums of money earned through course fees without having to track each individual student.

NITOL exchanged ideas and evolved in close relations with projects funded by the European Commission under different framework programmes and specific initiatives. Joint experiences through these projects have supported and inspired new developments, both on the R&D side and more practically for courses and study programmes that were offered. Despite that NITOL already operated as a *collaborative virtual university*, it turned out to be great challenges for other higher education institutions, both in Norway and internationally [14].

Transition to a national networked university

The course activities in NITOL grew too large for ad hoc administration. Leaders of the four partner institutions were approached for institutionalisation and a more official status of the activities. In early 1998 an agreement for establishment of a national networked university, NettVerksUniversitetet (NVU) [15], was worked out. In December 1998 the partnership agreement was officially signed by the four NITOL institutions - plus five other Norwegian partners. A board and a steering committee for NVU were appointed at the institutional administrative level.

The Networked University (NVU) was meant to be a network of HE institutions in Norway, not a new, independent Norwegian university. For a start they should take over the course activities from NITOL and develop it further. After a few years, however, the NVU board decided to skip most of their joint course activities, like the common course catalogue, central enrolment of students, marketing etc.

The development of NVU did not live up to expectations of the NITOL group. NVU joint activities ended up being only the establishment of special interest groups (SIG) and the arrangement of an annual conference on e-learning. Joint activities for marketing of courses etc were abolished, the total course enrolments went down and there were only minor exchanges between the partner institutions. The major mistake is suspected to be that the new NVU administration distanced themselves from the professionals, the founders and enthusiasts that created and developed the NITOL principles.

The initial NITOL group remained active through 2008, after the establishment of NVU mainly with R & D work, engagement in national and international projects, and less with daily services to students and practical administration. A final project report was worked out, printed, handed over to the four institutions and made available other for interested parties [7].

Going International

Internationally the NITOL group kept up the activity within joint networks and e-learning projects also after the NVU was established. During the total of 15 years (1994 - 2008) the idea of openness and collaboration was promoted through several projects, most of them at a European level [16].

Some of these projects may still be of interest for understanding of the different ideas behind the final model for an international collaborative, virtual university. In particular the following five projects were central for gaining experience and developing competence at the four NITOL institutions:

- MECPOL - Models for European Collaboration and Pedagogy in Open Learning (1995-98) [17]
- Do ODL Dissemination of Open and Distributed Learning (1996-97) [18]
- EuroCompetence (1998-2000) [19]
- MENU – Model for a European Networked University for e-learning (2001-03), with a clear intention to create a European NITOL, or a European Virtual University EVU [20]
- QUIS – Quality, Interoperability and Standards in e-learning (2005-06) [21]

The MENU project was particularly interesting for continued work on *international, collaborative virtual universities.* It was responding to an initiative taken by the European Commission in 2001 [22], aiming at mobilising existing resources for designing tomorrow's education. This project also constituted the basic idea behind a *global virtual university.* Both of these concepts will be explained and analysed in the following two sections of this paper.

A EUROPEAN, COLLABORATIVE VIRTUAL UNIVERSITY

Based on priorities from the European Commission the MENU project [20] set out to develop a model that could be implemented into a sustainable consortium. The project was running from December 2001 till December 2003, intending to establish the virtual ENU (European Networked University) - or EVU (European Virtual University) in 2004.

The aim and objectives of the MENU project were stated in the proposal that was submitted (2001) to the *e-Learning Initiative*, a programme launched by the European Commission [23]. The aim was to develop a model that provided guidelines for developing collaborative virtual universities.

More precisely the main objectives were to:

- Activate the political principles stated in the Bologna and Sorbonne declarations, in the e-learning action plan, by establishing the 'business plan' for an ENU, accepted and integrated into national educational programmes
- Demonstrate the possibility of developing joint study programmes across institutional and national borders
- Establish a model for management and services for a virtual university. Options for scalability (up/down) for ENU as an independent organisation or as a virtual network.

  [24, p. 20]

The objectives were demanding and a real challenge for a project period of only 2 years.

There were four main stages in the project

- Establishing the partnership and agreeing on principles, goals and methods
- Creating the necessary documents/plans for the model
- Testing the model by running real courses on the net; quality assurance
- Finalising the model, based on plans and experiences; dissemination of results

  [25, p.6].

The first task was to formulate a partnership agreement which could be signed by the partners involved. Further activities should include the establishment of joint study programmes across institutional and national borders, exemplified by a masters programme. [26, p.4].

A European master degree programme must have academic as well as political acceptance. The MENU project, therefore, was to provide the structure for a generic study plan and for the quality assurance needed. The pilot test, however, was meant as a first step for a more sustainable networked university.

Anticipated outcomes from the project were:

- A sustainable European Networked (virtual) university, with an array of study programmes, available throughout Europe, in various languages
- A common quality assurance system for general acceptance of credits and degrees obtained through ICT-based studies
- An operational study plan for a European Master Degree programme, based on contributions from several countries and institutions, a model showing
  - o Subject content and method
  - o Learning material and environment
- A net based support system
- Management plan for scalable studies
- Publication of experiences, results and guidelines for the establishment of a permanent ENU.

[25, p.4]

This was an extensive list, but every item of it was fulfilled during the project period and all documents can be found at the project's website: http://www.hsh.no/menu

During the 2 year project period representatives of the 11 partners from 7 countries worked intensively together through discussions, draft documents and testing of ideas to come up with a complete description of a model that was likely to be implemented. In the final report lists the structure and visions:

Principal ENU goals

The primary goals of an ENU may be expressed as follows:

- To enrich the portfolio of the programmes offered by each of the ENU institutions today. New programmes should be collaboratively designed, directed and delivered within ENU. All programmes should use human resources and learning content from ENU institutions
- To fulfil demands that exist in the market for programmes covering new topics due to technological and cultural

evolution, or not available yet due to lack of human and other recourses at a single university

- To guarantee high quality of the ENU programmes through pooling of ENU resources, instructors, course material etc. and a strict control applied to each programme following a Quality Assurance System (QAS)
[27, p. 4]

In order to obtain these goals several measures must be taken.

Organisation

The organisation of the network to master the challenges of the strategy was proposed in the following manner.

Organisational Entities

a) ENU should have a **Board** with members at institutional level to ensure the anchoring of ENU in each partner institution, to have access to resources in the institution and to bring political power to ENU.

b) A **Board Working Group** should be appoint as a sub-group among the Board members, consisting of people who are specialists in one or more tasks related to the operation of a virtual university.

c) The **ENU Secretariat** could be hosted by one of the legal institutions, or the services could be bought externally, for the daily operation of ENU. The size of the secretariat would depend on the finances of ENU, but should be kept at a minimum.

d) An **Administrative Group** should work on overcoming differences between administrative systems and practices at the institutions. There could also be an **Academic Group**, taking care of quality assurance, and development of new curricula, a **Research Team** to work on questions related to the use of ICT in education.
[27, p. 5]

Agreement and services

An agreement between the institutions collaborating in ENU must be established and signed, stating the role of the ENU both as a virtual and as a physical organisation. An example of such an agreement is found attached to the organisational plan for ENU. [28, p. 23-25]

Offering distance e-learning courses requires both a pedagogical and a technical platform. ENU should not enforce particular pedagogical approaches or a common learning management system (LMS). ENU consists of several institutions with different traditions in teaching and e-learning. There should be plans and provisions for services to the public, the users, internal services, technical services, and measures for security.

Committees or task groups could be set up for particular purposes like pedagogical methods, marketing of ENU programmes, business strategies, and in particular a forum for information and discussions about e-learning standards (e-learning environments, LMS, learning units etc.)

Quality of studies

Students and society demand educational systems of high quality - the students because they spend time and money for the education, and the society because educational quality is the best insurance for future welfare and development. Reasons for implementing a comprehensive quality assurance system (QAS) stems from the competition with a growing number of institutions offering courses through the Internet, and that institutions all over Europe are urged to offer joint study programmes. A QAS that could be applied and accepted across all partner institutions would be of particular importance. This would have to define parameters and assessment methods for several factors, like administrative systems, study programmes, courses, staff qualifications, student assessment and qualifications. [29]

Plans and development of study programmes and courses

In order for collaboration between institutions to take place, it was necessary to develop a joint approach to the description of programmes and courses in order to have a common working vocabulary, before designing the template. An explanation of the key terms used, were as follows:

- A *study programme* consists of a number of *courses*, and awards a formal qualification or a degree
- A *course* can be part of more than one *programme*, and is awarding credits
- A *course* is made up of a number of *modules* or *study blocks*
- A *module* or a *study block* can be part of more than one course.
- A *module* or a *study block* consists of a number of *learning objects*
- A *learning object* can be used within more than one *module* or *study block*
[24, p. 64]

The *mENU* project adapted the structure from the first two levels as a starting point for designing the demonstrator, testing some courses of two different study programmes.

Credit Transfer

An already existing and specified European Credit Transfer System (ECTS) was appropriate for the creation of transparency of the study programmes, for “building bridges” between institutions and widening the choices available to students. The system made it easier for institutions to recognise learning achievements of students through the use of commonly understood measurements - credits and grades - and it also provided means to interpret national systems of higher education. But it needed adaptation in order to accommodate procedures related to the net based learning (NL) nature of study programmes.

A modular approach to construction of courses, applying the ECTS-NL, would enhance flexibility, cooperation and sustainability of dynamic study programmes. Clear advantages here can be stated as follows [24, p. 70-73]:

- *Standardisation*: Those designing a course or a module know in advance the exact amount of workload the total course shall have, and are guided in implementing it with a set of learning objects

- *Flexibility*: It is rather easy to develop interchangeable courses and modules that can be assembled, disassembled and re-used easily

- *Distributed development of courses* and *modules*: More than one institution can collaborate for the design, development and delivery of a study programme, a course or even a module

- *Adaptability*: a course or a module can be localised to diverse student populations or special target groups

Economy

ENU was meant to be a consortium administrated at the location of one of the ENU partners. Even if the experiences of models with rotating administration have not usually been very encouraging, this seemed to be a realistic first step [24, p. 86-88].

Funding

The financing for the ENU work would basically consist of the following sources:

- Annual remunerations, i.e. annual fees paid for the participation in the ENU network; may be paid as service fees between the HEIs etc.
- Membership fees on an annual basis
- Public subsidies from governments, EU projects, national / regional projects etc.
- Revenues from brokerage and fees, generated income, partially channelled back to the partners for their courses and services
- Other income, e.g. specific infrastructure project funds

One of the motives for joining the ENU would be to offer courses for a larger market, and perhaps make more revenues.

Costs / expenditure

This will consist of e.g. board costs, board working group costs, the ENU secretariat which includes

- personnel costs; leader, study administrator, technical support etc.
- office costs
- operational costs

Further on there would be development costs, where each institution is responsible for its own courses. Each institution must therefore cover these costs. Costs for joint development should be agreed upon in advance.

Concluding remarks

In the mENU project there was developed a lot of tools that would be helpful in constructing an ENU. To some extent the tools were used to create a demonstrator i.e. master programmes and courses. The programmes were still at the end of the project period running with students from around the World and with courses delivered by several institutions. The testing was then at an early stage, but has during the following years been further developed. One of the programmes, the *ICT in Learning*, is still running as a permanent, mainly net based, study at Stord/ Haugesund University College in Norway, now announcing its tenth intake of students in 2012.

In the process of *designing tomorrow's education* and *to foster the European dimension*, the MENU partners strongly believed that *virtual European universities, based on partnership and cooperation with other universities*, represented a possible way to move forward. The above description outlines some of the main principles for a network model to create an ENU. More details and background for the suggestions can be found in the full report. The hope was that the work of the mENU team would be of benefit to the community and to institutions that embark on the development of a collaborative, virtual university.

A GLOBAL VIRTUAL UNIVERSITY

A Global Virtual University, UNU-GVU [30] was established as an online network of universities for sustainable development, and had a particular objective to meet the educational needs of the third world. GVU was officially launched in September 2002 at the World Summit on Sustainable Development in Johannesburg, SA, where the Norwegian Government, the United Nations University, UNU, [31] and the United Nations Environment Programme, UNEP, [32] pledged their support and partnership.

The United Nations University - Global Virtual University, UNU-GVU, [33] offered courses from different universities, e.g. a course on global environment issues based on the UNEP report "Global Environment Outlook", GEO [34], as part of a master degree programme, Global Environment and Development Studies, GEDS [35]. This was part of the MENU demonstrator, involving students and tutors from around the World, actually following the NITOL principles of joint development and collaboration for net based learning.

One of the most popular courses offered through the GVU network, was e-Teaching, actually a sequence of two courses, E-teaching I [36] and E-teaching II [37], both based on structure and content ideas from the NITOL course on Pedagogy in Open Learning, PiOL [38]. The main idea behind these courses was to qualify professors and teachers to develop and tutor e-learning - or net based - courses within their own subject areas. This was particularly important for the partners of GVU that should provide higher education for students in developing countries, in remote areas and at universities lacking capacity and competence in certain disciplines.

The concept and principles of open collaboration, mutual trust and joint efforts are fragile, but still a key issues for success at local, national and international levels. They turn out to be hard to carry over from the initial NITOL partnership to other HE institutions. Even at the founding institutions, most of the basic principles in NITOL have suffered shifting support.

SUMMARY AND RECOMMENDATIONS

Brief summary of experiences

Experiences from the above described projects seem to indicate that the Millennium was too early for most academic environments to accept all the new concepts that made up the foundation for a collaborative virtual university:

1. Net based higher education, students not necessarily on campus
2. Sharing of knowledge, material and students
3. Acceptance of competence, courses and credits from partner institutions

The maturity within the institutions, regarding the use of ICT in education, implementation of ECTS and the willingness to create courses to be used over the Internet, varied considerably. There was still a way to go. Now, nearly 10 years later, experiences show that this maturing and readiness improves. But still there are hurdles to overcome.

Past experiences indicate that Collaborative Virtual Universities face serious challenges: e.g. in the following areas:

- Establishing and implementing a detailed and mutually acceptable partnership agreement
- Setting up an organisational framework for
  - recognition of competence, courses, credits etc.
  - similar or compatible technology and learning environment,
  - a common quality assurance system, a QAS
  - economy, including fees, common expenditures
- Resolving national and institutional differences related to degrees, credits, grades etc.
- Sharing and allocation of responsibilities

The demonstrator, or user trials, with joint master study programmes in MENU, revealed that local and national regulations prevented some of the partner institutions to participate. Even though the institutional leaders had signed partnership agreements that included this kind of joint practice, some institutions were bound by own or national regulations that did not e.g. allow participation in courses by students who were not present on campus, or they could not accept exams or credits obtained from other institutions. In a few cases the project was able to over-rule this kind of objections by referring to the signed partnership agreement.

Based on the experiences from NITOL, MENU and GVU there seem to be some central items that should be adhered to. These are presented as point of advice below. We still believe that the idea of collaboration between institutions for better quality, more efficient and sustainable net based study programmes with simpler access, particularly for people who are not in a position to stay on campus to obtain higher education.

Recommendations

For academics and leaders who may embark on new projects and attempts to implement a collaborative virtual university, CVU, a list of hints to avoid the most obvious stumble blocks, will hopefully be of some help. These are a few observed recommendations along the road.

Setting up the framework:

- Choose partners whom you already know as professionals, preferably making up a team with complementary competences
- Start with few partners and do not involve all faculties and departments from the very beginning. Let the network expand gradually within your own institution
- Make sure that every partner understands what you are planning to do together
- Define area(s) of content, professions, target groups etc that you are going to serve within your CVU
- Have important principles and regulations settled in a partnership agreement, signed at both administrative and project level

Running the CVU:

- Keep focus on the learning environment, e.g.
  - Allow for varying and different pedagogical approaches
  - Facilitate for efficient & deep learning
  - Learning is an active, individual process – also in groups and on the net
  - Blended learning may be a relevant alternative in some cases, with physical seminars if possible
- Training of personnel is important, both professors, tutors and service personnel
- There may be extra costs involved, particularly at early stages. Try to allocate extra funding. Internally or externally, to help transition to new methods
- New technology appears all the time. So be careful not to commit yourself or your partners to only one set of technology or software, but have open discussions about changes.

Taking these - and other - pieces of advise into account, it should hopefully be possible to implement more CVUs for the benefit of future learners.

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EFL Learners' Willingness to Communicate: The Interplay between Language Learning Anxiety and Language Proficiency

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ABSTRACT

Since willingness to communicate (WTC) model integrates psychological, linguistic, and communicative variables to predict L2 communication, and a few number of studies have tested the model with EFL students, the current study is an attempt to shed light on the examination of Iranian EFL university students' WTC and its interaction with their language anxiety and language proficiency. By helping the students to decrease language anxiety and increase a willingness to use the L2 inside and outside the classroom, we direct the focus of language teaching away from merely linguistic and structural competence to authentic communication. The purpose of this study is to understand whether WTC model could explain the relationships between psychological and linguistic variables in Iranian context to predict students' WTC. Forty nine university students participated in this study, they took TOEFL first and then filled out two questionnaires of WTC. For data analysis, Repeated Measures ANOVA and Spearman correlation were run and the results have revealed that Iranian university students' WTC is directly related to their language proficiency but not language anxiety. Therefore, linguistic variables appear to be more predictive of WTC for Iranians, and language instructors should work on their students' English proficiency.

Keywords: Willingness to communicate, Language anxiety, Language proficiency, EFL context, Iranian students

1. INTRODUCTION

Willingness to communicate (WTC) has been proposed as both an individual difference variable affecting L2 acquisition and as a goal of L2 instruction (MacIntyre, Clement, Dornyei, & Noels, 1998) [20]. To process WTC, the interface between two disparate approaches, linguistic and psychological, in EFL context has been overarching such a sustained commitment to engage in communication. The tendency to communicate with a specific person emanates primarily from affiliation and control motives as potent forces to propel individuals to be involved in interactive discourse. Unlike the previous studies in EFL context (e.g., Kim, 2004 [11]; Clement, Baker, & MacIntyre, 2003 [5]; MacDonald, Clement, & MacIntyre, 2003 [13]; MacIntyre, Baker, Clement, & Conrod, 2001 [16]; Peng, 2007 [27]; Peng & Woodrow, 2010 [28]; Yashima, 2002 [30]), the behavioral intention to use the language has been examined among Iranian EFL university students to eliminate the demarcation between language anxiety as a psychological structure and language proficiency as a linguistic structure. Regarding the success of using the second language, the dialectical relation between being able and being willing to successfully communicate and use the L2 requires further investigation. In situations where a proficient learner is unwilling to communicate, high motivation for learning and high anxiety about communicating may appear to have a direct influence on L2 use (MacIntyre, 2007) [15].

1.1. Purpose of the Study

Those who are generally capable of communicating and get high scores in the proficiency test are more willing than those who are not capable communicator and get low scores. The interaction between the influences of language proficiency and language anxiety on WTC in an L2 learning context among Iranian EFL learners has gone rather unnoticed. To this end, the relation between language proficiency and WTC has been subjected to investigation among Iranian EFL learners. Furthermore, it seems to be found that no studies have as yet dealt with the relationship between willingness to engage in communication and language anxiety in the context of Iran. If effective communication is an important skill for academic success, studies have examined the factors affecting the development of this skill among EFL learners are increasingly become important for fostering the communicative ability of language learners. Hence, communicative effectiveness may have a cumulative impact on language learners' ability to initiate communication and maintain social interactions.

The resulting affective state might be considered to address the following research questions in the current investigation:

1. Does language proficiency influence Iranian university students' WTC?
2. Does language anxiety influence Iranian university students' WTC?
3. Is there any relationship between language proficiency and language anxiety for Iranian university students?

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2. METHOD

This study examined MacIntyre et al.'s (1998) [20] WTC model and measured L2 WTC with the scale adapted from MacIntyre et al. (2001) [16]. The participants were freshmen university students in the EFL context at Sharif University of Technology in Iran. This study targeted the students' WTC in English as their foreign language.

2.1. Participants

The participants for this study were 49 engineering freshmen who were taking a three credit General English course which was compulsory at Sharif University of Technology. These students had recently graduated from high school and were 18 years of age or older. There was no opportunity for the simple random selection of the participants and they were in intact classes, which were selected by the researchers, and filled out the questionnaires. From among this number, six students who did not participate in all stages of data collection were omitted consequently.

2.2. Instruments

The data collected and used for the further analyses was gathered via TOEFL (2003) with reliability index of .88 and two questionnaires of language anxiety with reliability of .80 and WTC with the total reliability of .85. The latter was a four-part questionnaire which was in English. The different parts of this questionnaire were as follows:

Willingness to Communicate in the Classroom: The first two parts of the questionnaire were adapted from MacIntyre et al. (2001) [16] to measure WTC in each of four skill areas. It contained 27 items to tackle the learners' willingness to communicate in their EFL class while being assigned the communicative tasks. A 5-point Likert scale was employed to ask the learners to rate their willingness to communicate (with 1=almost never willing, 2=sometimes willing, 3=willing half of the time, 4=usually willing, and 5=almost always willing). The categorization of the items in each section was based on the type of language skill (alpha levels were calculated for the reliability estimates of the items of each skill): speaking (8 items, α=.58), comprehension (5 items, α=.44), reading (6 items, α=.55), and writing (8 items, α=.58). The reason for the inclusion of the four L2 skill areas was to determine which of the skills are the more active (like speaking) and which are the more receptive (like reading) with respect to L2 use. The receptive usage is also related to the concept of WTC because authentic usage of the L2 in form of the receptive skills and tasks may increase the learners' WTC in other domains of language use. The present study was then an attempt to focus on the correlation between the four skill areas.

Willingness to Communicate outside the Classroom: In this section, a total of 27 items written by a graduate from the immersion program in MacIntyre et al. (2001) [16] were used in the present study; however, these items referred to the willingness to communicate of the student out of the classroom context. The respondents were to rate their WTC with the application of the previously used subscales ranging from 1=almost never willing to 5=almost always willing. So, the rating scale was the same used in the previous section, but with different reliability estimates of four language skills: speaking (8 items, α=.70), comprehension (5 items, α=.57), reading (6 items, α=.74), and writing (8 items, α=.72).

Orientations for Language Learning: The items employed in this section were adopted from the ones used by Clement and Kruidenier (1983) [7]. Students were to choose the extent to which each of the reasons for learning English was true of them using a 6-point Likert scale (where 1= strongly agree, 2=moderately agree, 3=mildly agree, 4=mildly disagree, 5=moderately disagree, and 6=strongly disagree). It enjoyed a reliability of 0.91. There were also five proposed orientations, each with four items: travel (α=0.76), knowledge (α=0.67), friendship (α=0.80), job related (α=0.77), and school achievement (α=0.75).

Social Support: There were 6 yes/no questions and students were to answer these questions with regard to the source of support for their L2 learning. This procedure was similar to Ajzen's (1988) [2] method for testing subjective norms. The participants were to answer "yes" or "no" to the questions about whether these people provided them with support for learning the L2: mother, father, teacher, favorite sibling, best friend, and other friends. The items used in this section were not on a scale, but individually given to respondents. Consequently, reliability estimates cannot be estimated for the individual responses.

Language Anxiety: It was taken from Horwitz, Horwitz, and Cope (1986) [9] and modified and decreased to 10 items. It enjoyed a good reliability estimate of .80. A 5-point Likert scale was used for this 10-item questionnaire, including 1= strongly disagree, 2= disagree, 3= neutral, 4= agree, and 5= strongly disagree. The examples of the items are: "In English classes, I forget how to say things I know" or "In English classes, I tremble when I know I'm going to have to speak in English". The items tackled general English language anxiety of the learner in an English classroom.

2.3. Data Collection Procedure

To categorize learners in terms of language proficiency, reading and structure section of TOEFL (2003) were given to the learners. The test enjoyed an acceptable reliability index of 0.88 for 45 items (reading section Alpha = 0.85; structure section Alpha = 0.82). This indicated learners' consistency in responding the questions of the test. Then the students were asked to complete two questionnaires during the time of their regularly scheduled class. They were assured that any information that they would provide would be used anonymously and their names would remain confidential. Answering the items took those who agreed to answer around 30 minutes. The questionnaire, also, enjoyed an acceptable reliability index of 0.80. Table 1 shows the descriptive statistics of the anxiety questionnaire. As is shown in this table, it seems that the students in the present sample are not very anxious (M= 28.59, SD =7.21), they are less than half standard deviation above mean of anxiety test (M=14). Finally, the data was given to SPSS to calculate all reliability of and correlation among different parts.

Table 1
Descriptive statistics of the anxiety questionnaire

	Min	Max	M	SD
Anxiety	14.00	43.00	28.59	7.21

3. DATA ANALYSIS AND RESULTS

To answer the questions addressed in this study, different statistical procedures were employed.

3.1. Analysis One: Language Proficiency and WTC

To answer the first question of this study as "Does language proficiency influence Iranian university students' WTC?" data was subjected to Repeated Measures ANOVA. Language proficiency was used as fixed factor in this analysis and WTC inside and outside the classroom as two within-subject variables and skills as four between-subject variables. Firstly, the total score of TOFEL was changed into standardized Z score. Secondly, learners were classified into two groups in terms of language proficiency according to the Z score of their total score in the TOFEL they took. Then those students with negative Z score were considered as lower proficient and those with positive Z score were considered as higher proficient learners. The data, then, was subjected to Repeated Measures ANOVA through SPSS. The result indicates that the interaction between WTC and language proficiency was significant, $F (1, 47) = 5.560$, $P < 0.05$. This suggests that learners' willingness to communicate outside and inside the classroom is different across language proficiency.

Looking at marginal estimates of the measures, we found out that there are mixed results concerning the location of WTC across language proficiency. As is shown in Table 2, those with lower language proficiency have higher willingness to communicate outside the classroom, whereas those with higher language proficiency have higher willingness to communicate in the classroom. This might indicate that language proficiency functions as barrier for Iranian students in this sample. Interestingly, learners with higher language proficiency are more communicative inside the classroom than those with lower language proficiency, whereas they are less communicative than those with lower language proficiency outside the classroom. That is, those learners with lower language proficiency are afraid to get evaluated. Or maybe, those with higher language proficiency get more supports from the teacher inside the classroom and that is why they are more communicative and confident in communication. Pedagogically speaking, this indicates that we need more supportive teachers who encourage learners to be more communicative in class.

Table 2
WTC location across language proficiency

LG group	WTC	M	SD
Low	Inside	79.68	2.75
	Outside	86.16	3.34
high	Inside	87.83	2.80
	Outside	77.54	3.41

Willingness to communicate can function as both trait (MacIntyre et al., 1998) [20] and state construct (Cao & Philip, 2006 [3]; Kang, 2005 [10]; MacIntyre, 2007 [15]; Peng, 2007 [27]). In the present sample, it seems that language proficiency has manipulated learners' state because in different situations learners with different language proficiency showed different amount of willingness (see Table 2 and Figure 1). According to McCroskey and Baer (1985), we have extended the trait-like conceptualization of WTC (cited in McCroskey, 1997) [12]. Following the two underlying constructs proposed by Clement (1986) [4], perceived competence and lack of anxiety are two comprising elements of self-confidence. In particular, it is also probable to draw a distinction between the trait-like and momentary feeling of confidence, which is known as state self-confidence (MacIntyre et al., 1998) [20].

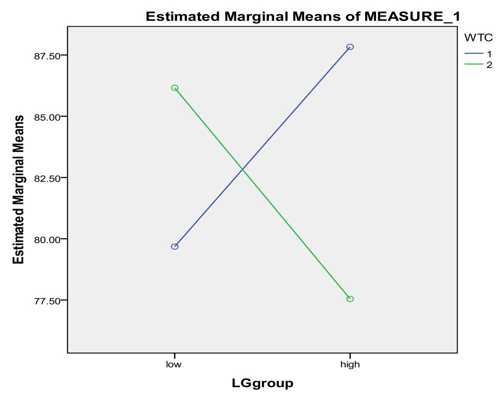

Figure 1: The interaction between language proficiency and WTC

3.2. Analysis Two: Language Anxiety and WTC

To answer the second question of this study as "Does language anxiety influence Iranian university students' WTC?" another Repeated Measures ANOVA was run. Language anxiety was used as the main factor in this analysis and WTC location (inside vs. outside) as two within-subject variables. First learners' Z score of anxiety was estimated, and then learners were classified into two groups in terms of their levels of anxiety; those with positive Z score were grouped as highly anxious and those with negative Z score were grouped as lowly anxious. ($Xz = 1.53$, $SD = 0.50$). The result is shown in Table 3.

Table 3
Frequency of learners' standard score on anxiety

	Frequency	Percent	Valid Percent	Cumulative Percent
Low	23	46.9	46.9	46.9
High	26	53.1	53.1	100.0
Total	49	100.0	100.0	

To check the influence of anxiety on learners' WTC, the data was subjected to Repeated Measures ANOVA. The result indicates that there was no significant within-subject effect (WTC $F (1, 47) = 0.237$, $P = NS$) nor any significant effect was seen for between-subject factors (anxiety F (1, 47) = 1.115, P = NS). Moreover, the interaction between WTC and anxiety did not turn out to be significant (F (1, 47) = 0.172, p= NS). This shows that in the present sample anxiety would not affect the way learners might decide to participate in communication (WTC). This finding is interesting because in previous research, MacIntyre, Baker, Clement, and Donovan (2003) [18], Yashima, Zenuk-Nishide, & Shimizu (2004) [32] found that there are correlational relationship between perceived competence, language anxiety, and WTC. It should be noted that L2 anxiety has been studied both as a distinct individual factor and as a contributing variable (Papi, 2010) [26]. Considering its interaction with willingness to communicate (e.g., MacIntyre, 1994 [14]; MacIntyre, Baker, Clement, & Donovan, 2002 [17]; MacIntyre & Charos, 1996 [19]; Papi, 2010 [26]), a negative association between these two variables has been confirmed.

3.3. Analysis Three: Language Proficiency and Anxiety

To answer the last question of this study as "Is there any relationship between language proficiency and language anxiety for Iranian university students?", then, Spearman correlation was run between TOEFL score (interval scale by nature) and Anxiety score (ordinal scale by nature). As displayed in the Table 4, anxiety and language proficiency have a negative relationship which means that with higher language proficiency the amount of anxiety decreases. This is not surprising and is fully supported in the literature (MacIntyre & Gardner, 1991 [22], 1994 [23]; MacIntyre, Noels, & Clement, 1997 [24]; Steinberg & Horwitz, 1986 [29]). This is also true for TOEFL components. This finding is revealing that anxious people are generally less communicative in comparison to non-anxious ones. This might be due to the fact that they are not able to communicate well in terms of output quality. In this regard, anxiety affects both what the students say and how they say it (MacIntyre & Gardner, 1994 [23]). The close connection between self-perception and self-expression in authentic communication makes a significant departure from the postulation of other academic anxieties (MacIntyre & Gardner, 1989 [21]; Horwitz et al., 1986 [9]).

Table 4
The relationship between anxiety and language proficiency

	TOEFL	Structure	Reading	Anxiety
TOEFL	1			
Structure	.88**	1		
Reading	.86**	.57**	1	
Anxiety	-.61**	-.66**	-.45**	1

**Correlation is significant at the 0.01 level (2-tailed)

4. CONCLUSION AND IMPLICATIONS

Willingness to communicate is offered to account for the individuals' differences in their first and second language communication (Zakahi & McCroskey, 1989) [34]. It is believed that WTC is an indicative factor of whether the individual will turn into an L2 speaker. Then there are a number of factors contributing to the quality and quantity of WTC in the EFL context (Clement, Dornyei, & Noels, 1994 [6]; Peng, 2007 [27]), naming communicative competence, language anxiety, risk-taking, learners' beliefs, classroom climate, group cohesiveness, teacher support, and classroom organization.

Research on WTC is not very old; it has originally developed in first language acquisition (McCroskey & Baer, 1985; McCroskey & Richmond, 1982; all cited in McCroskey, 1997) [12]. The core issue of WTC is that there is a dialectical relation between being able and being willing to communicate through L1 and L2 language. The factor contributing to WTC is then highlighted when other impeding factors such as anxiety and language proficiency are taken into account. The purpose of this study was to investigate the relation between language proficiency, language anxiety, and WTC among Iranian EFL learners. To this end, the following questions were posited:

1. Does language proficiency influence Iranian university students' WTC?
2. Does language anxiety influence Iranian university students' WTC?
3. Is there any relationship between language proficiency and language anxiety for Iranian university students?

As displayed in the current study, there were mixed results concerning the location of WTC across language proficiency. Lower proficient learners indicated to have lower WTC inside the classroom in comparison to those with higher language proficiency who exhibited higher willingness to communicate in the classroom context. Contrary to our expectation, the higher proficient learners showed to be less communicative than those with lower language proficiency outside the classroom. This proves the state-like nature of WTC in the present sample. WTC as one of the necessary components of becoming fluent in L2 inevitably functions in correspondence with the "situated" model which varies over time and across situations. In favor of the proposed model by MacIntyre et al. (1998) [20] to account for individual differences in the willingness to communicate, then, WTC is closely tied to the situational factors that determine one's intention to engage in communication. The result of this study is supported by Matsuoka and Evans (2005) [25] who, through structural equation modeling, found that language proficiency, along with motivational constructs are indicative factor of WTC. Also, it is supported by Yashima and Zenuk-Nishide's (2008) [31] research who found that the development of proficiency and frequency of communication are fully entangled with the active participation in the community of practice through content-based approach. This implies that having self-confidence in communication is crucial for affecting how one is willing to be engaged in L2. Moreover, this suggests that success will come to those who are more willing to initiate in L2 communication, likewise, WTC may function as a situated construct or situated model (MacIntyre et al., 1998) [20] where contextual fluctuations and modifications like language proficiency might have different results on learners' WTC. As Cao and Philip (2006) [3] note, WTC varies in terms of factors associated with the specific situation, topic, interlocutor, and the confidence of learners to accomplish the task.

It was found to be that neither significant within-subject effects nor significant between-subject factors contributed to L2 WTC. Moreover, the interaction between WTC and anxiety did not turn out to be significant. This shows that in the present sample anxiety, the psychological aspect of the original WTC model, would not affect the way learners might decide to participate in communication. This has not gone along with previous studies where the correlation between perceived competence, language anxiety, and WTC was significantly high (MacIntyre et al., 2003; Yashima et al., 2004 [32]). Then it can be concluded that L2 anxiety has been studied both as a distinct individual factor and as a contributing variable (Papi, 2010) [26]. Considering its interaction with willingness to communicate (e.g., MacIntyre, 1994 [14]; MacIntyre et al., 2002 [17]; MacIntyre & Charos, 1996 [19]; Papi, 2010 [26]), a negative association between these two variables has been confirmed. The non-significant interaction between anxiety and WTC in this study might be due to some reasons. First, the number of participants in this study was not large enough to represent the magnitude of real difference among the variables under the investigation. Second, another moderator variable might be required for anxiety to affect WTC. Clement (1986) [4] and Clement and Kruidenier (1985) [8] proposed self confidence as intervening variable for both anxiety and perceived competence. According to MacIntyre et al. (1998) [20], L2 anxiety as an enduring personal characteristics results variations in L2 self-confidence; however, based on situations, the fluctuation may still exist in terms of the degree of anxiety and L2 use.

In the current study, the findings revealed that anxiety and language proficiency are negatively correlated. This indicates that, in the present sample, anxiety has a debilitative influence on WTC. This is not surprising and is fully supported in the literature (MacIntyre & Gardner, 1991 [22], 1994 [23]; MacIntyre et al., 1997; Steinberg & Horwitz, 1986 [29]). When applied to L2 use, anxious students communicate less in comparison to those who are non-anxious. In addition, anxious students are not able to communicate well in terms of output quality. In this regard, anxiety affects both what the students say and how they say it (MacIntyre & Gardner, 1994) [23]. In the specific anxiety-provoking contexts, there is a high degree of negative correlation between L2 anxiety and L2 performance. Typically, a lower level of anxiety and perception of L2 competence lead to a higher level of WTC (Yashima, 2002 [30]). The association between language learning experience and L2 anxiety has been confirmed in the results of the study conducted by Aida (1994) [1] and Young (1991) [33]. The results indicated that negative language learning experience leads to increase in L2 anxiety, while, positive language learning experience contributes to decrease in L2 anxiety. Concerning the location of WTC across language proficiency, the future directions in L2 WTC study and attempts to extend the construct of WTC inside the classroom to bring learners and outside the classroom to bring nations into contact receive considerable attention. Conceptually, according to MacIntyre et al. (1998) [20], generating a WTC lends support to the ultimate goal of language learning, that is, intercultural communication between persons of different language and cultural backgrounds. Moreover, the interactions between linguistic variables and WTC are the concluding remarks of the study. This study utilized language proficiency, the linguistic aspect and language anxiety, the psychological aspect of the original WTC model. However, the students' language proficiency appears to contribute to their participation in communication. To explain why some approach, whereas others avoid, communication then the linguistic variables should be taken into consideration in the EFL context. Therefore, language teachers should increase learners' language proficiency as a predictive variable of WTC and provide convenience for their learners' communicative behavior.

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Collaboration of Research and Teaching Produces a New Course of Study in Critical Thinking

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ABSTRACT

A lack of Critical Thinking [CT] skills in business school graduates has been linked to poor business decisions, which often lead to business failures. A senior member of the faculty of a Midwestern college of business was troubled by the poor thinking skills exhibited by her business students. She collaborated with a doctoral candidate in education, whose research interest was within the domain of Critical Thinking. Together, they developed a course of study combining the researcher's Critical Thinking pedagogy within the environment of a senior-level business administration course of study.

Quantitative analysis of chapter assessments and the results from a standardized assessment instrument demonstrated: 1. Student's acquired Critical Thinking skills; 2. Students' transferred these skills to the domain of the standardized CT assessment instrument's environment. Qualitatively, the senior member of the faculty of the college of business administration observed: 1. Students' transferred CT skills to business case studies, as demonstrated by their superior reasoning and analytical skills; 2. Students' transferred CT skills to a computerized simulation, as demonstrated by their superior performances and the lack of total failures within the simulation.

INTRODUCTION

In a series of proposals, the Secretary of Labor's Commission on Achieving Necessary Skills [SCANS] redefined the skills that would be needed by industry in the late twentieth and early twenty-first centuries, and the educational requirements needed for workers to achieve those skills [1, 2, 3] . Six Thinking Skills were identified, as follows [4]:

A. Creative Thinking — generates new ideas

B. Decision Making — specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative

C. Problem Solving — recognizes problems and devises and implements plan of action

D. Seeing Things in the Mind's Eye — organizes, and processes symbols, pictures, graphs, objects, and other information

E. Knowing How to Learn — uses efficient learning techniques to acquire and apply new knowledge and skills

F. Reasoning — discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem

These thinking skills had been previously defined by psychologists and educators as Critical Thinking. Six years prior to the SCANS report, the noted psychologist and educator, Diane Halpern, published *Thought and Knowledge: An Introduction to Critical Thinking* [5]. A definitive text on the subject of Critical Thinking, Halpern assembled the ten basic skills and capacities necessary to think critically.

She defined Critical Thinking as, "… the use of those cognitive skills or strategies that increase the probability of a desirable outcome" [6]. Reid defined it as, "The conjunction of knowledge, skills, and strategies that promotes improved problem solving, rational decision making, and enhanced creativity" [7]. Critical Thinking is recognized as an essential part of education and a valuable life skill [8, 9]. Yet, in spite of the recommendations of these significant reports, educators did not incorporate Critical Thinking into their curricula.

In 2007, the U. S. Department of Education published the Nation's Report Card [10]. This landmark report testified to the facts that the reading and mathematics scores of high school seniors continued a decades-long decline. Reading scores for literary experience, for information, and to perform a task, declined in the period from 1992 through 2005 (p. 10). In mathematics, almost 37% of graduating seniors were unable to perform even the most basic mathematical procedures, while an additional 40% of graduating seniors were able to perform only basic mathematics. Only one student in four was rated as Proficient, while only 1 in 50 was rated as Advanced.

Similarly, the National Science Foundation equated American's poor understanding of scientific principles with a lack of Critical Thinking skills. The NSF reported in *Science and Engineering Indicators* [11] that, although, "…Americans express strong support for science and technology, they are not very well informed about these subjects."

These data were further interpreted in The Nation's Report Card: High school seniors [12]. For instance, in the area of retrieving information, the authors related reading assessments to Critical Thinking and judgment as follows.

> Retrieving information from a highly detailed document is an example of the knowledge and skills demonstrated by students performing at the Basic level. Making a critical judgment about a detailed document and explaining their reasoning is an example of the knowledge and skills associated with students' performance at the Proficient level. (p. 1)

Based on these studies, the National Mathematics Advisory Panel declared,

> Instructional practice should be informed by high-quality research, when available, and by the best professional judgment and experience of accomplished classroom teachers. High-quality research does not support the contention that instruction should be either entirely "student centered" or "teacher directed." Research indicates that some forms of particular instructional practices can have a positive impact under specified conditions. NAEP [National Assessment of Educational Progress] and state assessments should be improved in quality and should carry increased emphasis on the most critical knowledge and skills leading to Algebra. [13, p xiv]

Yet, in spite of this expert testimony as to the state of American education, curricula in America's colleges of business administration were not modified to include Critical Thinking skills, as specified by the Department of Labor, the Department of Education, the National Science Foundation, or the National Assessment of Educational Progress. One major impediment to the incorporation of Critical Thinking into the curriculum was the lack of an established course of study leading to the acquisition, retention, recall, and utilization of Critical Thinking skills. Until such a course was developed, the lack of implementation could be readily explained as lack of a valid pedagogy for the teaching, learning, or use of Critical Thinking. Further, there was no evidence that the acquisition of Critical Thinking skills led to improved student outcomes or greater career success. In large part, this doubt was caused by uncertainty of the transfer of these skills between domains of knowledge or practice. Until this uncertainty of transfer was resolved, educators were hesitant to implement any form of Critical Thinking pedagogy.

In order to resolve this impasse, a pedagogical treatment in Critical Thinking was developed and implemented. This pedagogical treatment was implemented in two classes at a college of business administration. A third class in the same college served as the control. The purpose of the treatment was to assess the acquisition, retention, and transfer of Critical Thinking skills across domains.

THE CRITICAL THINKING TREATMENT

The research problem was to determine whether Critical Thinking could be taught, learned, or transferred between domains. This required the development and implementation of a course of study in Critical Thinking, since no such course was extant. Therefore, a sound theoretical foundation in Critical Thinking was the first requirement in the development of such a course of study. Secondly, an instructional design model was needed to provide the pedagogical content and structure needed to develop and implement such a course of study. Third, a validated and reliable assessment was needed to measure any acquisition of Critical Thinking skills that might occur. Fourth, a sufficiently large number of willing test subjects had to be located to participate in the course and research study. Finally, the results of this experimental course of study would have to be distinguished from the results one would expect from the extant course of study that did not include the Critical Thinking component.

Theoretical Foundation

The need for a strong theoretical foundation was satisfied by the extensive literature generated by Dr. Diane Halpern, Director of the Berger Institute for Work, Family, and Children at Claremont McKenna College, Past President of the American Psychological Society, and noted expert in the field of Critical Thinking. In 1989, she published *Thought and Knowledge - An Introduction to Critical Thinking* [5], describing in exquisite detail the technical parameters of Critical Thinking. However, this tome was not only large and intimidating, but was also ill suited for use as a textbook. Subsequently, Halpern published *Critical Thinking across the Curriculum: A Brief Edition of Thought and Knowledge* [14]. Her reasons for writing this condensed version were to have it serve as a "… companion text that can be used in virtually any course where Critical Thinking is valued. It can also stand alone for use by anyone who wants to know what cognitive psychologists and educators have found that 'works' to improve learning, remembering, thinking and knowing"[14, p. vii]. However, even a condensed version of *Thought and Knowledge* proved to be both dense and challenging. Further, she had provided no philosophical foundation or content structure for its use in a classroom. As such, even a college-level teacher might be challenged to master the intricacies of logic and pedagogy required to convert the text into a course of study.

In 1998, Halpern provided the theoretical content and structure of such a course of study, which she called "Teaching for Critical Thinking" [15]. Halpern defined the goal of "Teaching for Critical Thinking" [TCT] as "… to promote the learning of transcontextual thinking skills and the awareness of and ability to direct one's own thinking and learning" [15, p. 451]. Within this context, she proposed a "… model for teaching Critical Thinking skills so they will transfer across domains of knowledge …" consisting of four constituent elements. The first component of the TCT pedagogical strategy was the dispositional or attitudinal element. The second was instruction in and practice of Critical Thinking skills. The third component was structure training to facilitate transfer across contexts or domains. Finally, a metacognitive component was used to direct and assess thinking.

Instructional Design Model

Although Halpern presented both a construct and structure, it was essential to translate that into instructional content. Foshay, Silber, and Stelnicki [16] provided the needed instructional design methodology. Borrowing heavily from Merrill [17, 18] and from Clark [19, 20], Foshay, Silber, and Stelnicki wrote *Writing Training Materials That Work: How to Train Anyone to Do Anything*. In this book, they describe a five-step model of instructional design that provided a parallel construction to Halpern's model.

Assessment Instruments

The primary assessment instrument was the California Critical Thinking Skills Test, as recommended by Diane Halpern [21, p. 249]. This test derives from a pioneering effort by Peter Facione [22] in which he convened a Delphi panel of 46 scholars and educators to develop the principles upon which Critical Thinking assessment instruments were developed and implemented. One of these, the California Critical Thinking Skills Test [CCTST] has undergone vigorous testing, evaluation, and validation {23, 24, 25, 26]. This assessment instrument uses five scales to measure Critical Thinking Skills: Inductive Reasoning, Deductive Reasoning, Analysis, Inference, and

Evaluation. Individual and group results are reported both as numeric values and as histograms.

In this study, the CCTST was used in two different ways. In the first instance, the CCTST was used as a pre-test/post-test in both of the experimental classes to determine if Critical Thinking skills had been acquired. In the second instance, the CCTST was used to determine the difference between the acquisitions of Critical Thinking skills in the experimental classes relative to the CT skills possessed by the control class.

The secondary assessment instruments were 10-question, True/False, Chapter quizzes provided by Halpern and Riggio [27]. The tests were comprehensive for each chapter. They were intended to test the student's knowledge. They were designed by and obtained from Halpern and Riggio's text, which was intended to be used in conjunction with *Critical Thinking Across the Curriculum* [14], the main CT text for the author's pedagogical treatment.

Experimental Venue

The venue for the course of instruction was a senior capstone class in business administration at a Midwestern university. However, the instructor required that the course be integrated into the established course of study and reflect business problems and solutions. The author and the instructor worked together to add Critical Thinking content to the business course case studies, which were within the business class textbook.

BUSINESS COURSE ASSESSMENTS

The senior member of the business school faculty needed to determine the validity of the Critical Thinking pedagogical treatment. If successful, this treatment could be developed into a program of instruction that would improve students' outcomes. Yet, it was also important that the research program should not interfere with the students' fulfillment of the educational requirements of the capstone course of study.

Students in their final class prior to graduation performed two different types of assignments upon which their grades were based. In the first type of assignment, students analyzed case studies taken from the assigned textbook. Many of these case studies were mini-studies, used to emphasize specific information within the text. One was a major case study, also found in the same text. Students analyzed these case studies, reporting their analyses both in the form of written reports and in presentations to the entire class.

The second type of assignment involved student's participation in a business simulation as a part of a team. Students assigned to teams, became the operating officers of the simulated corporation. The teams competed against each other, developing, manufacturing, and marketing similar products.

This experienced senior faculty instructor had noted the capacities of the students to think, to analyze business situations, to develop rational approaches to business problems. Their decision-making skills were below her expectations for graduating seniors. Their poor thinking skills were reflected in their analyses of the case studies and in the computerized team simulations. It was this instructor's intention to incorporate Critical Thinking skills within the business course of study to improve the students' analyses of business case studies, and to improve their performance as teams within the computerized corporate simulation.

METHODOLOGY

The convenience sample was of three sections of a senior level, capstone course in business administration, two of which were experimental and one was the control. A total of thirty-nine students took part in the two experimental classes. Sixteen individuals took part in one or more of the research phases in the first class. Twenty-three took part in one or more phases of the research in the second class. The final sample (n=34) contained only those students who completed both the pre-test and the post-test of the CCTST. Twenty-one (n=21) students participated in the control class.

This unit of instruction consisted of 11 modules of approximately 1-1/2 hours of class time. This corresponded to one introductory module, nine book chapters of the Halpern text, and one wrap-up session. Each module, corresponding to a chapter in the Halpern text [14], contained a True/False quiz; a computer-aided, multi-media assisted lecture; a discussion of the previous chapter assignment; a new chapter assignment; a business case study.

To determine if the Critical Thinking component was transferred to the business course, CT skills were incorporating into the weekly case study analyses. Business case studies were a regular part of the capstone course in business administration. Case studies from the regular text were examined by the regular course instructor and the author for business content, which emphasized CT skills. A grading rubric was prepared to assess the combination of business and CT skills employed by the students in their analyses.

The students were also assigned a major case study of a corporation. The students were required to use all the knowledge they had gained in their business curriculum to analyze the corporation. In addition, they were required to use their CT skills to assess their case study corporation's tactics and strategies to determine whether they would have been different had CT skills been utilized.

Three separate assessments were performed in the Critical Thinking treatment. In the first set, the CCTST was administered prior to the implementing the course of study in the experimental classes. This test was also administered after the conclusion of the course of study in the experimental classes. Statistical analyses were performed to determine whether there was a statistically significant difference between the pre-test and the post-test scores of the seven CCTST parameters.

In the second set, the CCTST was administered to a similar capstone class, but one in which the CT pedagogical treatment had not been administered. Because of logistical considerations, only one test was administered at the end of the course of study. This test was considered equivalent to the CCTST post-test administered in the experimental classes. Analyses were performed to determine whether the seven CCTST parameters of the experimental classes were statistically different from those of the control class.

In the third set, chapter pre-test and post-test questionnaires were administered to the experimental classes. The individual student's pre-test and post-test results were obtained. The students' responses for each question were summed, providing a percentage of correct responses, as well as a total percentage for the sum of all students in the pre-test and post-test with percentages of correct answers. Statistical analyses were performed to determine whether a statistically significant difference between the pre-test and the post-test scores of the nine chapter quizzes existed.

RESULTS

Critical Thinking Treatment

Sample-Control Analyses: The results of the CCTST from the experimental classes were compared to those of the control class. As explained, only one CCTST was obtained from the control capstone class. This test was taken at the end of the capstone course of study, corresponding in time and business course content to the post-tests taken by the test subjects.

The values of the seven parameters of the CCTST were identical for the control class and the experimental pre-test classes, within the reporting error of the assessment instrument. That is, the results of the control class were within one-tenth of a unit to the corresponding experimental pre-test class for all seven variables. The researchers compared the results of the control test with the pre-tests of both the experimental groups, noting that the scores of the untrained students were all in the thirty-fifth percentile for graduating seniors. The researchers concluded that it highly improbable that environmental effects of the capstone course would have decreased the control students' performance in all seven of these tests. However, it was possible that the control group's performance could have either been unaffected or had increased. Yet, if their scores had increased, then they would have had pre-test scores below the thirty-fifth percentile, which is already low for groups of graduating seniors. Finally, the control group's scores were sufficiently similar to the experimental groups' pre-test results as to be deemed identical. The researchers concluded that these scores were typical of graduating seniors in this college who did not have the benefit of training in Critical Thinking skills. Therefore, for the purposes of this preliminary study, only the pre-test and post-test experimental values were used to derive the statistical significance of the experiment results.

Experimental Classes CCTST t-Tests: To determine the effects of the author's Critical Thinking pedagogical treatment, the students' scores of the pre-test CCTST from the experimental classes were compared to their corresponding post-tests. The students' scores in the pre-test and post-test CCTST were compared using a one tail, repeated measures, *t*-Test. In six of the seven parameters of the CCTST, the *t*-Scores were found to be significant. The Analysis parameter was shown to be statistically insignificant. The Evaluation parameter was found to be significant at the 99% confidence level ($\alpha<.01$). The other five parameters, i.e. Total Score, Percentile Score, Inference, Inductive Reasoning and Deductive Reasoning, were significant at greater than the 99.5% level ($\alpha<.005$). Based upon these results, the authors reasoned that the students had acquired the Critical Thinking skills, knowledge, and capacities taught within the pedagogical treatment. Chapter Pre-Tests/Post Tests

To determine whether the content of each chapter of the author's Critical Thinking treatment had been acquired, retained, and recalled, the results of the pre-test chapter quizzes from the experimental classes were compared to their corresponding post-tests. The students' scores in pre-test and post-test of the chapter-by-chapter modules quizzes were compared using a one tail, repeated measures *t*-Test. In each Module, the *t*-Scores were found to be significant. In Modules 2 and 9, the *t*-Scores were found to be significant at the 95% confidence level ($\alpha<.05$). In the other seven Modules, the *t*-Scores were found to be significant at greater than the 99.5% confidence level ($\alpha<.005$). The overall score for all the Module scores was found to be significant at greater than the 99.5% confidence level ($\alpha<.005$).

Business Course Studies

Case Studies: The Mini-Case Studies obtained from the textbook usually highlighted one or two specific business problems. Students submitted a one-page analysis of the business problem including a well-reasoned solution. As previously specified, the authors selected these short cases to correspond with the Critical Thinking topic being covered at the time. The instructor noted consistent attempts by the students to incorporate the CT topic into these case studies.

Semester Case Studies: The Semester Case Studies obtained from the textbook were extensive historical reviews of specific corporations, including their business strategies and the specific tactics used to address their business problems. Students developed a 15 to 20 page case analysis of the corporation, which included materials from other sources. These analyses included well-reasoned analyses of the corporation's strategies, tactics, and business solutions. The instructor observed that the results of the Semester Case Study analyses were more thoughtful and better reasoned compared with those of previous classes. Student grades in this area improved in comparison with previous courses in which Critical Thinking was not included.

Computer Simulation: The CapSim**®** simulation from **Capsim Management Simulations, Inc.® (Capsim®)** is an extensive computer simulation of complex, competitive business operations. Ideally, the student management teams have eight weeks of practice simulation rounds, and eight weeks of competition rounds. This simulation requires that student teams make business decisions in most operational business areas, against up to five competitive businesses. This requires in-depth evaluation of competitor's actions as well as decisions for their company concerning manufacturing, capacity and scheduling, product R&D, pricing, labor relations and contract decisions, product mix, accounting, and capital investments in a competitive environment. The simulation is intense, and tests the students' accumulated knowledge and integration of business concepts. Commonly, some student teams perform well in the simulation, while many teams fail to consider all of the variables, and, as a result, are forced out of business, or into bankruptcy.

The instructor observed that the results of the CapSim® analyses were more thoughtful and more reasoned compared with those of previous classes. Teams that had undergone the Critical Thinking regimen had no business failures. There were varying levels of success, but all teams performed satisfactorily. Student grades in this area improved in comparison to those in previous courses.

Summary: In the reasoned judgment of the senior member of the faculty, there is a strong indication that the Critical Thinking treatment significantly improved the students' analytical skills and student outcomes in the capstone course. However, since the purpose of this study was to determine whether the pedagogical treatment was effective in imbuing Critical Thinking skills, it was not possible to determine simultaneously the effect of the treatment on the business course of study. Since the pedagogical treatment appeared to be effective, a more formal study could be undertaken to determine whether Critical Thinking skills improve student outcomes.

RESULTS

The objectives of this collaborative study were to determine whether Critical Thinking could be taught, whether it could be learned, and whether Critical Thinking skills could be transferred among domains. A treatment was developed that was congruent with Halpern's Teaching for Critical Thinking model.

The treatment was taught to two capstone classes in a college of business administration. Emphasis was placed on reconstructing the regular business-class case studies to incorporate a Critical Thinking component to assess transfer. An independent, reliable, and validated assessment instrument was used to determine the acquisition, retention, and recall of Critical Thinking skills. Quizzes, designed by the author of the textbook used in the treatment, were used to assess chapter-by-chapter learning.

Statistical analyses showed that six of the seven parameters of the CCTST were shown to be significantly higher in the experimental classes than in the control class. These results were interpreted as evidence that the authors' treatment had been effective in increasing the CT skills of the students in comparison to the regular, business class program of study.

Statistical analyses of chapter-by-chapter quizzes showed that the student's scores of the post-tests were significantly higher than their scores in the pre-test. These results support and provide a rationale for the scores observed in the CCTST. These results were interpreted as evidence of the student's acquisition, retention, and recall of the information content within each chapter of the Critical Thinking textbook.

Statistical analyses of the CCTST showed that six of the seven parameters were significantly higher in the post-tests than in the pre-tests. These results were interpreted as evidence of the students' acquisition, retention, and recall of the Critical Thinking skills acquired during the authors' treatment. These results were also interpreted as utilizing the skills initially learned within the domain of the CT treatment and the transfer of those skills successfully to the domain of the CCTST.

The senior faculty member verified that the students had successfully used their CT skills in the analyses of their weekly business course case studies. The senior faculty member also verified that the students had used the CT skills they had acquired to assess the tactics and strategies employed in case studies of their assigned corporations. These results were interpreted as utilizing the skills initially learned within the domain of the CT treatment and transferred those skills successfully to the domain of business.

Therefore, the goals of this study were achieved. The results indicate that Critical Thinking can be taught. The results indicate that Critical Thinking can be learned. The results indicate that Critical Thinking skills can be transferred from one domain to another.

DISCUSSION AND FUTURE STUDIES

The Federal government and vast numbers of academic and business experts have recommended that Critical Thinking be incorporated into academic programs. A significant barrier to integrating Critical Thinking into the curriculum has been a lack of such a course of study. Research from a recent collaborative effort indicates that this obstacle may have been overcome. However, it is important to test this pedagogical treatment to ensure that the results observed in this research are valid and can be reproduced in other academic programs, colleges, and universities.

This collaborative research suggests that long-term studies are needed. In general, such research might address whether a graduate's success is affected by the acquisition of Critical Thinking skills. Specifically, such research might determine whether the acquisition of Critical Thinking skills produces measurably superior student outcomes in the capstone courses investigated in this research. Other research might inquire as to the relationship between the acquisition of Critical Thinking skills and improvement in a graduate's business skills, performance, or motivation.

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What Do Pre-Service Science and Mathematics Teachers' Views about Scientific Theories and Laws?

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ABSTRACT

This study aimed to investigate pre-service science and mathematics teachers' views about theories and laws and compare their beliefs about them. The participants were 75 pre-service teachers (32 science and 43 mathematics). Participants were engaged in different NOS activities through one semester that explicit reflective approach to improve their views. For data collection, Views of Nature of Science (VNOS-C) questionnaire [6] was used for pre and post tests to determine participants' initial views. Semi-structured interview was undertaken with 8 participants as post tests in order to help uncover the participants' views. Each of the participants' pre and post tests responses were analyzed and coded as "naïve", "have merit" and "informed". The results revealed that majority of both groups have naive view according to pre-test results. Meanwhile, the post test results indicated that science teachers' views were more informed than mathematics teachers' views after explicit reflective approach.

Keywords: Nature of science, Pre-service Science Teachers, Pre-service Mathematics Teachers, Scientific theory and law.

1. THEORETICAL FRAMEWORK

Scientific theories and laws have distinct characteristic of knowledge. Their roles in science are different and there is no hierarchical relationship between them [1]. Theories never become laws even with additional evidence. Laws are principles, generalizations or patterns in nature and theories are the statements of those generalizations [7] (e.g. The Law of Gravity). Scientific theories are the products of scientific logical processes like laws. They are inferences generated as a result of the relationship between the structures of the natural phenomena [5]. There is no possibility to test the theories directly (e.g. Big Bang Theory). Theories are only supported by the data and different evidences. Scientists proposed new theories only checking out these theories against the verified data. The reliability of the theories increase when there is such agreements between predictions, experimental evidences, and the data. Popper (1983) [8] concluded that a hypothesis, or theory is "scientific" only if it is, among other things, falsifiable. That is, falsifiability is a necessary (but not sufficient) criterion for scientific ideas. He also stated that unfalsifiable statements are non-scientific, although not without relevance. Differences between observations and inferences revealed the distinction between scientific theories and laws.

The nature of science concept has been proposed as an important learning outcome for science education; however, research studies have consistently shown that both students and teachers have naïve ideas about the structure of epistemological scientific knowledge [7], [5]. McComas (1998) [7] has listed mutual misconceptions on NOS made by both pre-service teachers and in-service teachers as hierarchical order between hypothesis, theory and law, certainty of scientific laws and ideas. The false statements from the books and other sources, the educators' lack of knowledge and insufficient opportunities to develop themselves cause the formation of these misconceptions. Irez (2009) [4] examined the conception of the nature of science in five high school biology textbooks. He reported that the books are generally inadequate in terms of their vision of NOS. Furthermore, fundamental aspects of the nature of science have been found to be deficient in textbooks.

The science and mathematics are two important courses in teaching nature of science and when compared with other disciplines, these two courses classified in the same class generally. However, the close relationship between math and science is a little bit ignored and when the subject is nature of science, this issue is considered only in terms of science lessons. Many detailed studies have done about the nature of science opinions of science teachers however, only a small number of studies have examined mathematics teachers' views on nature of science.

According to AAAS (2001) [2], science supports mathematics to create interesting problems, mathematics also supports science with its mathematical tools (numbers, symbols, graphics..). Mathematics defined as the language of science. Mathematics and science have many common features, for this reason, we must understand mathematicians NOS conceptions, beliefs and/or views of the relevant domains and topics. For that reason; one goal of this study has been to explore the views of pre-service science and mathematics teachers' on the scientific theories and laws aspect of NOS. A second goal was to better understand how pre-service science and math teachers' branch affiliations affect their own concept of the nature of science. A third goal was to compare NOS views of pre-service science and math teachers' which have similar mental structures and thought systems, constitutes the importance of this study.

2. METHOD

Sample and Data Resources

A total of seventy-five pre-service elementary teachers (32 science and 43 math) participated in this study. Data were obtained from the Views of Nature of Science Questionnaire-Form C (VNOS-C) developed by Lederman, Scharwartz, Abd-El-Khalick, and Bell (2002) [6]. The VNOS-C consists of ten open-ended questions which assessing NOS views of the students. This study has only three relevant questions about theories and laws within VNOS-C. Additionally, data were supported with interviews at the end of the semester. Eight participants were interviewed with questions derived from the VNOS-C.

The Context of the Current Study

Participants from both two groups were engaged in different NOS activities (e.g. black box, tricky tracks) that explicit reflective approach to improve their views through one school semester. According to this, VNOS-C was used as a pre-test to determine participants' initial views of theories and laws, and it was also administered at the end of the semester as a post test to determine changes in participants' views. Semi-structured interview was undertaken with 8 participants as post tests in order to help uncover the participants' views.

This study was carried out with the analysis of three questions which are related with theories and laws. In these questions, the students are asked to define theory and law, expected to give examples related with them, expected to describe how theories and laws are constituted and asked whether there is a relationship between them. Each of the participants' pre and post survey' responses were analyzed by a coding system which has three-category coding scheme "naïve", "have merit" and "informed". Chi-square statistic indicated statistically significant differences from pre- to post-test responses of teachers' views. Also, the examples of theories and laws were analyzed given at the pre-test and post test.

3. RESULTS

Generally, analysis of responses from pre-test and post-test indicated significant changes about theories and laws at the end of the semester. According to results of the analyses, it is established that 81.2% of pre-service science teachers (PST) and 81.4% of pre-service mathematic teachers (PMT) have 'naïve' view. The rest of the participants' (18.8% of PST and 18.6% of PMT) responses coded as 'have merit'. The most important result of this analyses is from both of the groups were not have responses about theories and laws coded as 'informed'. These results were constituted from the pre-service teachers' statements which defend that there is a hierarchical construct between theory and law. According to the responses of pre-test Chi-square analyses, statistically meaningful results were not obtained $\left[x^2_{(1)} = 0{,}000, p = 0.987\right]$. The pre-service teachers from both groups gave theory and law examples generally about physics, chemistry and biology. There are some examples given below about PST's and PMT's pre-test views.

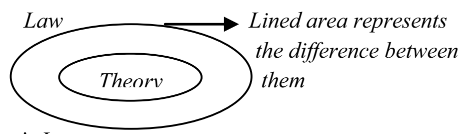
S(5): Scientific theory, is the version of the result which is not exactly turning into a law obtained from our experiments. Atomic theory.

(M25): A scientific reality (hypothesis) becomes scientific theory if it gains validity about 90 % from the authorities. Relativity theory.

After the instruction the survey results were analyzed 3.1% of PST, and 34.9% of PMT have 'naive' views according to the post-test results. Beside this, 15.6% of PST and 34.9% of PMT have 'have merit' views after the instruction. Also, none of the participants coded as 'informed' before the instruction according to the pre-test results; however, 52% of the participants coded as 'informed' after the instruction. Meanwhile, results indicated that PST's views (81.2%) were more informed than PMT's views (30.2%) about theories and laws. According to the responses of post-test Chi-square analyses, statistically meaningful results were obtained $\left[x^2_{(2)} = 20{,}409, p = 0.000\right]$. There is some examples given below about PST's and PMT's post-test views.

S(32): Laws are the descriptions of facts in nature and observed or perceived relations in nature, Gravity Law

(M5)



Gauss's Law

Surprisingly, interview results contradicted with VNOS results that half of participants stated that laws were more certain than theories and theories can be law if they prove. After the instruction some participants gave example of theories and laws relevant with math.

4. CONCLUSIONS AND IMPLICATIONS

Contrast to Bell, et.al. (2003) [3] this study emphasizes that the explicit instructional approach is effective in promoting improved student views about theories and laws. This study's results show that as Trembaths' (1972) [9] study, researchers who manipulated certain aspects of the learning environment in their attempts to enhance teachers' NOS conceptions will be success. One of the primary aims of science education is to train scientifically literate individuals for a healthy and developing society. To achieve this, science and math teachers must become scientifically literate. Therefore, educating science and math teachers with a contemporary view of scientific knowledge should become an important issue in teacher education.

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Cognitive Processes in Problem Solving: Bridging the Intersection of Cognition and Management Science

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Abstract
Decision making is vital to business and life. Management Science (MS) seems to help people make better informed decisions and thus could make a difference to the real world. However, solving MS problems need inputs from cognitive psychology and therefore require the bridging of both for a mutual coexistence. Many researchers acknowledged that decision makers are required to possess different problem solving skills to approach different types of problems, such as the solving of well-structured and ill-structured problems requires peculiar cognitive processes. Insofar, there is a need for deeper insights on how undergraduate business students, who will soon be the decision makers and leaders to make 'calculated risk' decisions, which are critical in our future society. The first part of paper is to present a review on the cognitive processes in problem solving based on Polya's 4-phase framework of problem solving, Schoenfeld's six problem solving strategies, the Constructivist Theory and the Information Processing Model (IPM). Using Malaysian undergraduate business students as a case study, the second part of this paper is to propose a 7-step problem solving algorithmic model in an attempt to improve the cognitive processes of students in solving MS problems and the quality of decision making.

Key words: cognitive processes, management science, problem solving, decision making.

1.0 INTRODUCTION

Problem solving is an omnipresent human activity. Leaders at all levels are constantly facing challenges of various types of problems. The domain of the problems ranging from highly structured to ill-structured in real life [1]. Effective problem solving and decision making are what leaders have to confront with almost everyday. However, making quality decision is highly dependent on the individual's skills and experiences. Many literatures documented that there is a distinguishing feature between well-structured and ill-structured problems [2]. Generally, solving the well-structured and ill-structured problems requires different cognitive processes [3] and learners were required to possess different problem solving skills to approach these two types of problems [2].

In the 21st century, problems are becoming more complex and difficult to solve, and the timescales available to solve the problem are getting shorter. Management Science (MS) is an emerging discipline that provides structured and logical approach to problem solving as well as to improve the quality of decision making [4].

It was noted that Polya was among the first proponents of on problem solving by adopting heuristics in mathematical problems in schools, but was slow to impact undergraduate mathematics teaching[5]. Furthermore, his work was criticized by Shoenfeld and others in that it was too general and could not develop the problem solving abilities. With his Six Problem Solving Strategies, Shoenfeld was able to plot the strategies on a time-line graph that could provide the concrete illustration of non-linearity of the problem solving processes [6].

In the 1950s, the information process theory (IPT) developed by George Miller in 1956 was then a dominant theory in cognitive psychology on problem solving. It featured two sets of processes: the understanding processes and the search processes[7]. Being criticized on its conceptual base, most of the cognitive psychologists, over the last two decades, have shied away from IPT[8].

The constructivist theory on the other hand, suggests that the ability for an individual to solve the problem is built upon the problem solver's knowledge and experiences [9]. In this study, it was found that the constructivist theory seems to be an appropriate theoretical framework in answering the research objectives and questions.

From the perspective of MS, problem solving is the cognitive processes of identifying the differences between the actual and the desired state of affairs and taking action to resolve the differences [10]. This paper is intended to investigate the cognitive processes of Malaysian undergraduate business (MUB) students (who will be the future leaders), in solving MS problems. As a result in the decision making, this study further investigates whether any particular algorithmic strategies exist in solving the well-structured and ill-structured MS problems.

The findings of this study is attempted to provide some insight to the effectiveness of problem solving and quality decision making. Hopefully, the implications drawn could also enhance our understanding in better designing the pedagogical strategies for MS and its related subjects.

2.0 RESEARCH METHODOLOGY

This study employed a qualitative approach by observing the participants in solving two different types of MS problems namely well-structured and ill-structured problems, and then followed by a semi-structured face-to-face interview. Well-structured MS problem is featured by as well-defined and give clear goals for problem solvers to assess them in a logical manner, while the ill-structured problem is referred to those without any particular hints on the patterns of approach and generate more than one solution[2]. Participants are encouraged to adopt the "thinking aloud" method during the problem solving session. The observations and face-to-face interviews were conducted to ensure that the researchers could obtain in-depth and comprehensive information, whilst at the same time participants could have freedom to respond and illustrate the cognitive processes involved in problem solving.

2.1 Design

The data sources included the observation, field notes, answer scripts of six participants solving the well-structured and ill-structured MS problems individually. These processes were video-taped and interviews were immediately conducted based on the 'solved' problems and were also audio recorded. Participants were encouraged to use the "thinking-aloud" approach during the problem solving session.

2.2 Participants of the Study

A purposive sample comprising six willing participants were selected from the BSc degree programme in Accounting and Finance cohort. The selection was based on their prior knowledge in Management Science, which happened to be one of their subjects in the degree programme, as well as their exposure to the well-structured and ill-structured MS problems and decision making models. The participants gave their consents to participate in this study.

2.3 Instruments

To solve a well-structured MS problem, the participant has to access his/her problem schema in order to obtain numeric solution as an optimal answer. The well-structured was adopted and adapted based on the course text, Beasley (2004) Students' Study Guide, as indicated below:

"*A company is involved in the production of two items (X and Y). The resources needed to produce X and Y are twofold: namely, machine time for automatic processing and craftsman time for hand finishing. The table below gives the number of minutes required for each item:*

		Machine Time	*Craftsman Time*
Item	*X*	*13*	*20*
	Y	*19*	*29*

The company has 40 hours of machine time available in the next working week but only 35 hours of craftsman time. Machine time is costed at RM10 per hours worked and craftsman time is costed at RM2 per hour worked. Both machine and craftsman idle times incur no costs. The revenue received for each item produced (all production is sold) is RM20 for X and RM30 for Y. The company has specific contract to produce 10 items of X per week for a particular customer.

Formulate the problem of deciding how much to produce per week as a linear program. Solve this linear program graphically."

For the ill-structured problem, the question was constructed based on the guidelines of problem structuring methods (or Soft OR) developed by Rosenhead (2001), which emphasizes on the importance of each individual's perception of the situation.

"You are the production manager in the ABC Paper Mill. You are responsible for the production output and quality of the paper.

The production planning in the paper mill goes like this:

The input to a paper mill is wood fiber and pulp; the output is finished rolls of paper. At the heart of the paper mill are its paper machines, which are very large and represent a significant capital investment (between 50 and 100 million dollars each). Each machine produces various types of paper characterized by their basis of weights, grades and colors.

Master production plans for these machines are typically drawn up on an annual basis. The projected schedules are cyclic with cycle times of two weeks or longer. A particular type of paper may be produced either every cycle, every other cycle, or even less often, depending upon the demand.

Every time the machine switches over from one grade of paper to another, a setup cost is incurred. During the changeover the machine keeps on producing paper. However, since the paper produced during a changeover does not meet any of the set standards, it is either sold at a steep discount or considered waste and fed back into the production system.

Determine what should be done to improve the production performance."

In terms of content validation, both the well- and ill-structured problems were validated by three experts who have been involved in teaching or practicing problem solving in MS.

2.4 Data Gathering Procedures

The data was gathered individually in an air-conditioned classroom setting where table, chair and stationery were provided. In carrying out the investigation, participants went through 4 steps: (a) understanding "thinking aloud" method; (b) personal data collection through a simply interview; (c) working on the 2 problems; and (iv) interview and provide feedback. The participants were given free hand to solve both well- and ill-structured questions with no hints or guidelines.

Step 1 : participants were requested to view the video on "thinking aloud" method and were later explained on how it worked in order to understand the reflection of cognitive processes in the problem solving session.

Step 2 : a structured questionnaire was used to solicit participants on their personal data as well as their background related to the level of mathematical skills and management knowledge in their undergraduate studies.

Step 3: observations were carried out while participants were working on the two MS problems, the processes were video-tapped and audio recorded.

Step 4: a semi-structured face-to-face interview was conducted based on the participants written documents.

A video camera was set up to record the entire problem solving session and an interview was also audio-recorded. Both recordings were transcribed, triangulated, analysed and coded.

3.0 RESULTS AND DISCUSSIONS

3.1 Cognitive Processes in Solving Well-Structured MS Problem

From the observations, it was found that all six participants (four females and two males) knew that the question was about optimization (either maximization of profit or minimization of cost). Only one participant indicated that she was not familiar with the well-structured MS question given. The other participants were able to identify the problem as Linear Programming which was part of their syllabus in the Management Science Methods course.

As participants proceeded to solve the problems, all of them indicated that at the beginning, they were unsure whether they should use maximization of profit or minimization of cost as the problem objective. This was due to the fact that the figures of cost and revenue were given in the question. All participants indicated that after reading the question for second time, they began to assume that the objective function was maximization of profit.

All the six participants were able to solve the problem. However, only four participants could successfully obtain the correct answer while the other two participants could not arrive at the correct answer. It was mainly attributed to making careless mistakes in the calculation.

Out of the six participants, five participants presented their answers with diagram, while one participant TZ did not. In fact, TZ drew the diagram at the beginning, but after drawing the axis, he crossed it out. The reason given was that he did not want to follow the algorithm of Linear Programming (LP) method which he had learnt before. Instead, he tried another way and could solve the problem by mathematical reasoning approach.

Table 1 provides two samples of transcripts (partial) from a successful solver and an unsuccessful solver which describe how the both participants approach to solve the well-structured MS problem.

Table 1: Samples of Transcripts (partial) for Well-Structured MS problem

Participants	Successful solver	Approach to solve the well-structured MS problem	Strategy
TZ	Successful	"At first, after I wrote the question, is to ask myself to determine how much the company should produce. So have to make sure to make an assumption like the company would like to maximize profit as it's a profit oriental company. And then accept the objective in order to maximize the profit. And then I'll look for the resources, the constraints of the resources that convert into the minutes, and then I'll look on the maximum amount that I would I can produce by producing X, and by producing Y. By using all the resources, and then I found out that the machine hours are always sufficient and what is constraining our production is the labour, we have the real binding constraint is the labour time. So that's one binding constraint that I found, so I just need to make sure which item will bring me more profit, then I just allocate all my resources to produce the item. So I calculated the profit the unit for X and Y, I found Y is more profitable to produce. And then but according to contract, we have to produce at least 10 units of X, so after deducting the RM10 of X then we'll have to produce according to the contracts. I'll use all the remaining resources to produce Y. They're the way find to maximize the unit."	• Reading • Planning • Analyzing • Exploring • Implementing • Verifying
CY	Unsuccessful	"I used the Linear programming approach and firstly I will define the factor X and the alphabet X and Y. X is stand for the number of product X, which is produced. And Y is the number of product Y, which is produced. After that, I set up the objective function, the main idea I used for the objective function is the total revenue minus the total cost. This is my idea, after that I reset up the constraint. Constraint 1 is the machine time, constraint 2 is the craftsman time, and the constraint 3 is the production constraint which the data that the company need to produce at least 10 items of X per week. Okay, after that I will draw the graph that I calculated, the	• Reading • Analyzing • Planning • Exploring • Implementing • Verifying

		production function in order to get the optimum production unit.”	

From the verbatim transcription above, it was noted that TZ used a slightly different approach. He did not follow exactly the algorithm of Linear Programming (LP) to solve the problem, but instead, he used his mathematical reasoning. He did it purposely as he mentioned that he was trying to use another way to solve this type of LP problem. CY followed the algorithm of LP and drew a diagram to help him found the answer. Unfortunately, he made calculation mistakes in the final step while substituting variables into the objective function. Figure 1 shows the answers from the two above-mentioned participants solving the well-structured.

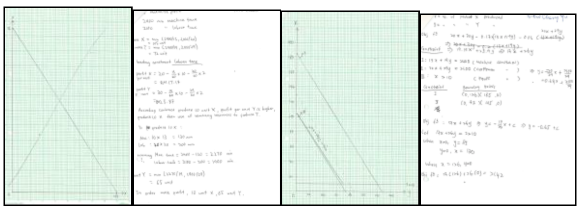

Fig. 1: Sample Answers from the Two Above-mentioned Participants

3.2 Cognitive Processes in Solving Ill-Structured MS Problem

All the participants except SJ had been exposed to the topic of how to formulate complex problem. However, all participants were able to attempt the problem and came out with the suggested solution, based on their interpretation. All participants indicated that they needed to read the question for the second time, in order to fully understand and tried to summarize the information. All participants commented that the objective of the question was clear to them. However, one participant commented that production plan was a bit confusing and ambiguous; it was quite tricky and needed time to analyze. Two participants indicated that they were not familiar with paper production. The suggested solutions indicate several variations in solving the problem. Table 2 provides the partial transcripts of the participants solving ill-structured MS problem.

Table 2: Sample transcripts (partial) for Ill-structured MS problem

Participants	Approach to solve the ill-structured MS problem	Strategy
CY	“After I read through the question, I think that the question is about how to minimize the production cost. In order to improve the production performance. And given the constraints, the purpose is to improve the current constraint in order to improve the production performance. .. Forecasting is one of the factors to improve the performance… maybe we can self-manufacturing the pulp and the wood fiber… we also can buy our land, then we can plant the wood ourselves… this one is about the long term investment… master production maybe I will suggest the company review quarterly… reduce the changeover period…,we can forecast the demand and the production more closely from the history data and the demand can supply… we can plan the production more efficient in the sense that we don’t often switch the production.”	• Reading • Planning • Analyzing • Exploring
TZ	“Firstly, I think of what the things I can do to improve the performance, then we can do some cost control, and then you’ll need a clearer way in doing it and what’s the result it will lead to. And then will lead the objective that we need is to improve the production performance… Mmmm… because they say they have industries to set up cost whenever we switching from one grades of paper to another. And then so we knew it should be reducing the switch to the machine, number of machine switches... Then will reduce the set up cost so we do a better planning… Maybe we have a fixed production cycle for each grate of paper, and then it will link to a less machine switch, the machine change over and then same thing it to less the wastage… production quality is quite important… should spend more time in the quality control… then we’ll receive less complain.”	• Reading • Planning • Analyzing • Exploring

The results indicate that the cognitive processes involved in solving well- and ill-structured MS/OR problems were to some extent similar. As an example, when participants attempted to solve both the well-structured and ill-structured MS problems, they had to first "read" the problems, "read" again for the second time to understand the objective of the problem, followed by recalling their prerequisite knowledge in planning stage. The first 4 stages of the strategies adopted were the same. i.e. Reading, Planning, Analyzing and Exploring. According to Polya (1957), these were the natural steps involved in problem solving.

In this study, the results also found that participants would go through the strategies of "implementing" and "verifying" when they were attempting the well-structure MS problem, but somehow this did not happen in the ill-structured MS problem. In the case of EJ, when she was drawing the diagram, she suddenly realised and said : "I did some mistakes here because I did not convert to standardized unit used…I think I made some mistakes in the calculation on that…" Then, she went back to cross the existing working and re-formulated the equations for constraints. This indicates that participants' cognitive processes were quite guided and trying to fit into certain patterns and attempted to figure out a "correct" answer.

On the other hand, regardless of whether the participants were familiar with the paper production or otherwise, they did attempt to solve the problem and came out with solutions. However, they did not verify if their suggested solution was right or wrong. On the contrary, they were confident that they had provided a reasonable and logical solution to the problem. In the case of TZ, when he was asked if he had come across this type (ill-structured MS problem), he said, "Maybe in movie.. quite normal question… I'm not really familiar with the paper production…not really sure what's the production performance what they are looking for." However, from the verbatim transcription mentioned above, apparently he had used his prior knowledge to assess the problem decomposition [11]. Figure 2 shows the sketches from the above-mentioned participants solving the ill-structured problem.

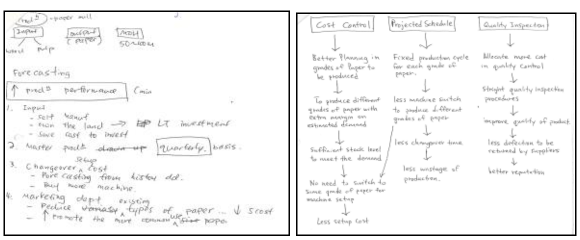

Fig. 2 : The sketches from the two above-mentioned participants solving the ill-structured problem.

4. CONCLUSION

It was noted that when participants approached the well-structured problems, their cognitive processes were found to be following several discrete steps, although prior knowledge was used. On the other hand, when they approached the ill-structured problem, their cognitive processes did not follow any particular patterns. They tended to draw upon their knowledge or experiences and tried to justify the situation.

Although the findings of this study are limited to a small sample size and might not be generalisable enough to a wider context, the findings however, may be able to contribute to the further understanding of cognitive processes in problem solving particularly related to MS problems. Linking the management science problems and using the constructivist view of problem solving, the study managed to uncover seven generic algorithmic steps participants used in solving both well- and ill-structured problems as displayed in Figure 3 and Table 3. It could be concluded that for both well- and ill-structured questions, the participants followed four common generic algorithmic steps namely, reading, understanding, planning, and doing. However, for the well-structured, the participants used three additional algorithmic steps such as analyzing, verifying, and improving. It is to be noted that the progression of the steps were not that linear as participants constantly flipped flop from one steps to another. Nonetheless, regardless of the questions, participants tended to read the questions several times to understand them better. With this framework, instructors could use these seven algorithmic steps as a guide to help their students construct their own ways in solving MS problems and hence in making effective decisions.

Fig 3: Proposed Framework for Effective Decision Making in MS Problems

Table 3 : Description of Steps for the Proposed Framework

Steps	Description
1.Reading	- Quick reading of the whole question once
2.Understanding	- Understand the problem by re-reading the question again, highlight any keywords or figures
3.Planning	- Planning what to do and recall relevant prior knowledge
4.Doing	- Extract (or write down) the relevant information; sketch or draw out the relationship
5.Analyzing & Measuring	- Identify necessary criteria
6.Verifying	- Refer back to the information given in the problem and do checking
7.Acting & Improving	- Implementing decision, review and refine the outcome

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Curricular and Programmatic Structures to Support Sustained Community Research and Action in a Large Undergraduate Curricular Student Leadership Program

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ABSTRACT

There are numerous models for turning research questions into action projects. Often, these models are implemented by professional researchers or practitioners in fields such as sociology, education, and social work. Among the terms for these are Action Research, Participatory Action Research, and Community-Based Participatory Research. There have been many attempts to integrate these models into service-learning and other forms of university-community engagement. This case study examines an undergraduate leadership minor program at a Midwestern, research one, university that has implemented such a model throughout its four-core-course sequence. Basic to most of these models, it trains college students to ask questions, conduct relevant and original research, and take action to create change on social issues. The program has been implemented on a large scale, serving over five hundred students each year with thirty adjunct, many community faculty, instructors. The primary focus of this paper is an analysis of the programmatic, curricular, and training structures that surround and enable work that moves theory into research, then into action, and finally, reflection, at this scale in this setting. It asks about what structures might be necessary for undergraduate university programs to support learning and education that encourages and teaches at the intersections of research and real-world social problem solving.

INTRODUCTION

The Leadership Minor at the University of Minnesota is an interdisciplinary, undergraduate, minor that focuses on the practice of global leadership. It developed in the late 1990's in response to student demand for curricular leadership education opportunities and was one of the first undergraduate minors in leadership in the US. Its theoretical foundation rests on Astin and Astin's [1] Social Change Model and the four core-course sequence reflects the Social Change Model's progression from self (the introduction to leadership course) to community (the second and third courses) to the larger world (the capstone course). In order to cultivate skillful leadership practitioners, the curriculum has developed over time to include numerous opportunities to practice leadership and reflect on successes and failures. Participatory forms of action research serve as a core element of the four courses and are integrated into each class in order to broaden and deepen students' skills in turning purposeful research into powerful action.

This paper outlines the multiple, layered, structures that are key to supporting the action-research learning processes with over five hundred students and thirty adjunct faculty each year. It does so recognizing that, though every context brings new and different challenges, some elements of this program may provide insights into context-specific challenges to implementing similar programming. The paper will explore (1) partnership and faculty, (2) core curricular models, (3) the curricular structures that support research and action, (4) the models of instructor training and support that enable this research, and (5) the use of course evaluations as an iterative process for the entire program.

1. PARTNERSHIPS AND FACULTY

Developed in response to student demand, this program was created as a tri-partite partnership between the Office for Student Affairs and two separate colleges within the university (The College of Education and Human Development and the Humphrey School of Public Affairs). The Office for Student Affairs office serves as the fiscal/managerial host for the program and provided the majority of the funding required to initially support the program. The colleges serve as the curriculum development and oversight board, help recruit faculty, and schedule the courses within the departments of Organizational Leadership, Policy, and Development (OLPD) and Public Affairs (PA). When these specific departments (OLPD and PA) originally joined the partnership, neither department offered undergraduate courses and the partnership offered the opportunity for access to undergraduate students for those faculty who were passionate about undergraduate education.

In order to provide a deep integration of theory and practice, and to pilot the initial curriculum, faculty members were paired with student affairs professionals to co-teach each class. After the pilot phase, new adjunct instructors were recruited from the community in order to meet the rising demand for sections. These new instructors were brought through a rigorous observation and co-teaching process. Eventually, this developed as a full program model, with a faculty supervision board that approves curriculum changes from both host colleges, the student affairs office serving as fiscal and staff host, and community faculty instructing most course offerings.

Community faculty often bring real-world experience and a willingness to try new pedagogical methods. This enables the curriculum to remain flexible and adaptive, changing in response to different students and instructors while holding steady to core readings and outcomes across all sections. It also means that instructors move in and out more frequently, allowing changes in the curriculum to propagate quickly, rather than encountering resistance to change.

2. CORE MODEL

The Leadership Minor curriculum is sequentially based on the Social Change Model of Leadership Development created by Astin and Astin [1]. At the core of this model are several key beliefs, including: leadership is concerned with social change, leadership is collaborative, leadership is a process rather than a position, and leadership should be based in values. Additionally, the model firmly asserts that anyone is a potential leader. In addition to encouraging students to create social change, the model puts great emphasis on students achieving a knowledge of self that includes an understanding of their values, strengths, and interests. The model asks students to consider leadership from the perspective of themselves (as individuals), then from the perspective of communities, and finally the broader global society [1].

3. CURRICULAR STRUCTURES FOR RESEARCH AND ACTION

In the Leadership Minor program, we differentiate between what Harvard leadership researcher and educator, Ronald Heifetz, calls technical and adaptive challenges [2]. Technical challenges involve solving problems for which a suitable formula or solution has already been developed. An example might be implementing an affirmative action program at an organization based on company policy and state and federal laws. Adaptive challenges involve changing the attitudes and behaviors of those involved. This might involve an organization-wide program to develop a more open, diverse and accepting workforce culture.

We use a Participatory Action Research (PAR) framework to offer students a real life laboratory to practice solving adaptive challenges [5]. PAR involves raising questions about problems and taking action on these problems in collaboration with stakeholders affected by the problem. It is different from standard research in two ways. First, it involves stakeholders as more than research subjects, but as a valuable part of the research. Second, it asks researchers and research participants to take action as a part of the research process. PAR comes in many forms, with various levels of collaboration between researchers and stakeholders. The particular model utilized in the Leadership Minor is the Civic Action Project model developed by VeLure Roholt [4]. This model involves the researchers (in this case, our students) in researching and acting on problems of compelling interest to them.

The four-course sequence of the Leadership Minor program develops students' ability to solve adaptive challenges, broadens the range of tools and skills they are able to address adaptive problems, and simultaneously deepens their abilities to practice problem-solving skillfully in a variety of diverse contexts.

Course 1: Leadership, You, and the University
With Astin and Astin's Social Change Model at the core, instructors guide small groups of students through a Social Change Project, wherein students collaborate to choose an issue they are passionate about, develop a strategy for, conduct research, and take action on to create change. The instructor asks students to organize themselves thoughtfully into groups based on group and teams theory learned during the course. Instructors also help students throughout the projects to reflect on the dynamics of their group activities in light of these theories and to develop effective interventions to improve group collaboration. There are eight elements of the Social Change Project: (1) Students determine and agree upon an issue that is of significant importance to them; (2) The students research this issue, including developing a map of the different elements relating to their issue; (3) The students develop a "power map" that identifies key stakeholders that have power over or within this issue; (4) Each group member meets with one of the individuals identified in the power map; (5) The group develops an action plan that is reviewed by the instructor; (6) The group executes at least a part of their action plan before the completion of the semester; (7) The group develops a presentation explaining their work and reflecting upon their group experience that is given to classmates and stakeholders.; (8) Individual group members write reflections on their role in the group, group dynamics, and their group work as related to course readings and in-class experiences.

Course 2: Leadership, You, and the Community
In the second course, students use research as a vehicle for understanding and applying the Adaptive Leadership model [2]. Students explore adaptive leadership in a community setting by conducting interviews with community leaders, mapping the complex community contexts in which leadership occurs, and use the Adaptive Leadership lens to analyze the data they collect. Students are not encouraged to identify solutions to adaptive issues at this point. Instead, they are encouraged to conduct thorough research, and to seek to understand the presenting problems in complex and rigorous ways.

Course 3: Leadership Minor Field Experience
Building upon this authentic experience with real and lived community adaptive issues, the third course allows students to continue their research, but to move toward action on the issue. Similar to a service-learning course, but nuanced with the task of making systemic progress toward a larger community-driven goal, this Field Experience course involves students in community work near campus. There are several options that students can choose from including grassroots community-organizing, coaching youth action projects, and developing a social entrepreneurship project. They key distinction between the Field Experience course and the first (introductory course) is that this class is developed within the context of sustained partnerships with communities and non-profit organizations. Students participate in the field experience for one semester, but they carry on work that was started before them and will continue after them. Students begin the class by developing their knowledge of the community they will be working with during the semester. This is accomplished through the use of course texts, news articles, speakers, observations, and site visits. They further this understanding through participation in community projects with non-profit organizations. At the end of the semester, they develop a final project that requires they make lasting change in the community. The instructor, through reflective writing and in-class discussions of field experiences, supports this process. Unlike the first two courses (which have 30 students per section), there are typically only fifteen students per section in this course in order to allow the instructor adequate time for personalized support.

Course 4: Leadership for Global Citizenship

In the final course in the sequence, students use the fields/majors they will graduate into as the global context for action research. Within their fields, they identify five people who are non-US citizens with whom to conduct interviews about the global issues facing their fields. In order to accomplish this task, many students start with U.S. professionals or professors within their majors who are able to connect them with people representing more global perspectives. After these interviews, students analyze the data to identify global issues within their fields. For example, an Information Technologies student may speak with people from all over the world to identify such global issues as intercultural communication within corporations, sustainable technology infrastructures for countries that have not been able to keep up with infrastructure at the same rate technological advances have occurred, or e-waste issues as they affect communities around the world.

Once students have identified these issues, they conduct literature reviews and professional organization reviews within their fields to understand how global practitioners' views connect to the professional literature and conference agendas worldwide. The data from interviews is overlaid with the data from their fields' literature to create a more complete picture of the global issues they will face upon graduation. The final step is to identify how, as a Leadership Minor student, they personally will contribute to the amelioration of these adaptive issues.

4. INSTRUCTOR TRAINING AND SUPPORT

The Leadership Minor trains and/or supports over thirty instructors per semester. There have been particular structures created to aid these instructors in navigating this non-traditional and demanding work. Unlike traditional teaching, which can operate more or less successfully with teachers offering engaging lectures and discussions, teaching that involves students in real-world problem solving requires a re-conceptualization of the roles of instructors and students in the classroom. The teaching pedagogy employed by the instructors within the Leadership Minor comes out of the adaptive Case in Point™ methodology used by Heifetz, et al [1]. However it has been adapted significantly for the undergraduate context (instead of the Harvard graduate school context in which it originated). This new approach to teaching research-infused leadership, called Intentional Emergent Context, requires instructors to serve as facilitators, challenge students to think in new ways, and to use the immediate context of the students' lived experience as the bridge between theory and practice. This kind of teaching requires a great deal of training and continued support over time. There are four phases each instructor goes through:

1. Instructor Observations New instructors observe at least ten classes in the course they intend on teaching;
2. Observation Meetings New instructors reflect on their observations in the context of other observers and with several seasoned instructors;
3. Mentored Teaching New instructors are paired with a seasoned instructor to co-instruct a course;
4. Individual Teaching New instructors teach the next semester on their own to develop a personal style of instruction; and
5. Mentoring Teaching Now seasoned instructors are asked to take on the additional challenge of mentoring new instructors.

If an instructor carried through this process from beginning to end in back-to-back semesters, they would be mentoring new instructors in their fourth semester of involvement in the program. By investing significant energy in developing new instructors, the Leadership Minor assists these instructors in doing the work of supporting students to take on real-world challenges in meaningful and exciting ways.

Throughout this process (and on-going as long as instructors are teaching), instructors also participate in continuously evolving program curriculum. Small groups of instructors evaluate and update pieces of curriculum on a regular basis. Instructors are supported trying new ideas, testing the efficacy of experimental new curriculum, and continuously looking for the leading edge of best practices. Once an experimental resource or concept is proven worthy, Leadership

Minor staff propagate successful curriculum throughout other courses in the program.

5. COURSE EVALUATIONS AS ANOTHER LAYER OF PRAXIS

Praxis, the coming together of research, reflection, and action, is a critical foundational component for the functioning and makeup of the Leadership Minor [3]. Students move through the praxis process each semester within all four core courses. Instructors engage in praxis through training, teaching, and shared reflection processes. Additionally, the course evaluations provide a meta-process of praxis for the entire program.

Program course evaluations collect information not only about the content of each course, the quality of instruction and materials, but also about the degree to which each course helps students reach the larger university Student Learning Outcomes (SLOs) and Student Development Outcomes (SDOs). Student ratings are correlated with the SLOs and SDOs each course asserts it meets to be sure that assignments and course materials are supporting the achievement of listed outcomes.

The rigorous evaluation process deeply engrains the value of Participatory Action Research and praxis at an instructor level as well as a programmatic level and ensures that the program is surfacing its own adaptive issues in a timely manner. The results of the process are then used to update readings and assignments on an annual basis through a reflective whole-instructor team process.

CONCLUSIONS

Leadership is a curricular area that is being widely adopted within colleges and departments from Liberal Arts to Science and Engineering. Whether leadership curriculum is taught in the context of these collegial lenses or as its own discipline, the study of leadership affords ample opportunities for the integration of research, leadership theory, and practice.

The process of research itself (identifying a problem, analyzing existing data to inform a new data collection plan, collecting new data, and analyzing new data) is an exemplary vehicle for teaching adaptive leadership theory because the issues that arise during the research process provide real-life practice in applying leadership theory to successfully carry out the research tasks.

In addition, using a robust framework, such as Astin and Astin's Social Change Model [1], allows a leadership curriculum to incorporate research into theory and practice in a stratified and developmental approach throughout the progression of the curriculum from one unit of study to another. Using such intentionally connected and layered approaches, gives undergraduate students the concrete application practice they need for their specific developmental stages of learning.

The structures used to create, support, and evaluate the Leadership Minor within this specific case study cannot be overlooked as to their importance in its success and replication within other contexts. The first key structure, the tri-partite collaboration among a student affairs unit and two separate collegiate departments, created a need for innovative navigation of complex systems. Within a research one, land grant, big ten university, it is rare for cross-departmental collaboration of this level of complexity to occur. As a result of this partnership, the oversight of and vision for the work within the Minor is held within the hands of many instead of few, which not only allows for, but requires conversations about the deep purpose of the Minor and its future. Within a context of such collaboration, decision-making often focuses on what would be best for the students, the program, and the larger community instead of other more financial or political considerations. This has led to the absolute financial stability and rapid expansion of the Minor and contributes to its political safety within such a large institution.

The second structure, the curriculum (its theoretical foundations and its continuous evaluation), is equally important to the specific context of this program and its success. Grounding the curriculum in the Social Change Model [1], not only supports the integration of research, education, and problem-solving in the classroom, but provides for a developmentally appropriate scaffolding of such skills within the four core-course sequence of the Minor. Selecting a civically engaged and scaffolding model for the foundation allows the integration of research in a seamless manner that bypasses faculty-resistance that sometimes occurs with time-intensive teaching methodologies.

The final structure, instructor training and support, is specific to this context in that by accommodating over 500 students annually, the process of instructor recruitment, training, and support has become central to the health of the program and the student experience. Although most contexts may not call for the rapid deployment of 30 or more trained and fully autonomous adjunct faculty within each year, for those contexts where expansion to more sections than fulltime faculty can accommodate, the use of adjunct faculty is imperative, and therefore so is their training and support. Integrating research, education, and problem-solving into any classroom (leadership or otherwise), calls for an instructor with diverse strengths and a great deal of programmatic support. Within the Leadership Minor, new instructors are recruited not only for their academic background in leadership or related field, but also for their ability to teach in and Intentional Emergent Context model.

No matter the scope of the programmatic context, the process used to create the Leadership Minor and support its expansion from one section of 20 students in its pilot year to its current student engagement level is replicable: 1) Collaborate across disciplines, 2) Select a solid theoretical foundation that supports the integration of research, education, and problem-solving, 3) Recruit and support talented/committed faculty, and 4) have a constant and iterative process of program evaluation in place.

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Integrating Research and Education to Promote Innovations

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ABSTRACT

This study presents typologies of learning to bridge the gap between learning inside and outside higher education institutions. The different types of learning can be found in higher education institutions to promote the learning outcomes. The study also presents the approach of innovation pedagogy and an example of how it has been applied to form a multi-disciplinary structure of the faculty. The results of this study are useful for those who want to improve the quality of education and promote innovations.

Keywords: Higher education, Pedagogy, Learning, Knowledge, University, Innovations

1. INTRODUCTION

Learning includes two integrated but very different processes. The learning can be an external interaction process between the learner and his or her social, cultural or material environment or an internal psychological process of acquisition and elaboration where new impulses are connected with the results of prior learning (Illeris, 2009a). Learning is constructivist in nature so that the learner actively builds up or construes his or her learning as mental structures, but the term of the socio-cultural theory of learning is also commonly used (Peck et al., 2009). Both of the processes mentioned above must be actively involved if any learning is to take place.

The purpose of this study is to present typologies to bridge the gap between learning inside and outside higher education institutions and find ways to promote innovations. Innovations are created in value chains or networks, which combine business, technology and other subjects, which combine different kind of knowledge needed in working life. Empirical evidence is presented from the Turku University of Applied Sciences, which does not have any business or technology faculties but the institution has created multi-disciplinary faculties and used the concept of innovation pedagogy to support the innovations.

Each higher education institution has its profile which differentiates it from other institutions. The Finnish Ministry of Education and Culture asked every higher education institution to define its profile. Therefore there is a need for a comprehensive and up-to-date understanding about the concept of learning that correspond the profile of the institution. The Turku University of Applied Sciences defined innovation pedagogy for its profile (Kettunen, 2011).

2. TYPES OF LEARNING AND KNOWLEDGE IN DIFFERENT CONTEXTS

The transfer problem of education psychology is concerned with the challenge of transfer the learned in one context to apply in a different context. The challenge is how the higher education institution can be more applicable outside the institution. Typically, education is too much oriented towards the reproduction of the subject matters of institutions. Illeris (2009b, 145) argues that the learning theories have been too narrow in their scope and at least in the English-speaking countries the learning theories have been dominated by the behaviourist approach up to the 1980s.

Table 1 collects the four types of learning and knowledge in the context of higher education. The types of learning and knowledge are extended and combined in this study with the context of higher education. Illeris (2009b) presents a typology of four basic learning types based on his earlier study (Illeris, 2007) and the earlier work by Piaget (1952). The concept of expansive learning can be found Engeström (1987) and the concept of transformative learning from Mezirow (1991). The different types of learning and knowledge can be found in higher education.

Originally the typologies of learning and knowledge are based on the different theoretical backgrounds and developed in different ways. They have come close to the understanding about education in higher education. In practice the four levels of transfer are not sharply separated as the typology may indicate. All of these typologies can be found in higher education and are necessary to build up the capacities and competence of an individual. The challenge of a higher education institution is to find variation and balance in the use of these levels.

Table 1. Types of learning, knowledge and context in higher education

Type of learning	Type of knowledge	Context
Cumulative of mechanical learning • Learning of concepts and facts • Learning is characterised by a type of automation	Replication of knowledge • Repetition of knowledge	Lecture, literature and memorization in examinations • No context of meaning or personal importance
Assimilative learning or learning by addition • New element is linked as an addition to a scheme • Learning is easy to recall and apply in the field in question	Application of knowledge • Use acquired knowledge under new circumstances • Follow the rules and procedures related to the knowledge	Problem solving and development • Gradual development of capacities • Incremental innovations
Accommodative or transcendent learning • Situation that is difficult relate to any existing scheme • One breaks down an existing scheme and reconstructs it in a new way	Interpretation of knowledge • Understanding involves personal perspectives or ways of seeing • Requires professional insight and an intellectual effort	Research • New idea has to be discovered and solved • Produces results which are significantly new or different • Radical innovations
Expansive or transformative learning • Personality changes or changes in the organisation of the self • Includes emotional and social patterns	Association of knowledge • A sense of purpose, appropriateness and feasibility	Personal growth and internships • Acquisition depends on a wealth of professional experience • Transformative learning can often be experienced physically in internships

3. COGNITIVE DEVELOPMENT

According to Mezirow (1991), development is at the heart of transformational learning and the link between development and learning is explicit. Merriam (2004) and Mezirow (2004) argue that one must be at a mature level of cognitive functioning to engage in the transformational learning process and be able to critically reflect and engage in rational discourse. Numerous studies (Taylor, 2000) offer support for the notion that development is an outcome of transformational learning. Fostering greater autonomy in thinking is both a goal and method for adult educators and achieving greater autonomy in thinking is a product of transformative learning (Mezirow, 2000, 29). A rather high level of cognitive functioning is a prerequisite for transformational learning (Merriam, 2004, 61). Feinstein (2004) notes that critical reflection and reflective discourse are used to facilitate transformative learning.

Criticos (1993) observed that valuable is not the experience itself but the intellectual growth that follows the process of reflecting on experience. Effective learning does not follow from positive experience but from effective reflection (Criticos, 1993, 162). Critical reflection, or premise reflection on assumptions, involves examining long-held, socially constructed assumptions, beliefs, and values about the experience or problem. Brookfield (2000, 139) concurred that an act of learning can be called transformative only if it involves a fundamental questioning and reordering of how one thinks or acts.

Reflective discourse is specialized dialogue devoted to searching for a common understanding and the assessment of the justification of an interpretation or belief (Mezirow, 2000, 10-11). Critical reflection and reflective discourse assume a certain level of cognitive development, but studies find that many adults do not operate at higher levels of cognitive functioning (Merriam, 2004, 63).

Mezirow (2000, 21) has acknowledged the possibility that critical reflection may not be necessary for transformational learning to occur, but the transformations through assimilative learning occur “our situation changes, and, beyond our scope of awareness, we make a tacit judgment to move toward a way of thinking or behaving that we deem more appropriate to our new situation (Mezirow, 1998, 191). Mindless assimilation seems quite a different process from “critical reflection and rational discourse”.

Mezirow (2004) and Merriam (2004) recognize that the fully developed learner moves through a series of development form to arrive at the highest potential for understanding to engage in transformative learning. They recognize that this occurs only in adulthood but not in all or even most adults. This view is rather a limited view of higher education and development. Mezirow (2004) concludes that there is a need for a theory in the process of development.

Paloniemi et al. (2010) recognise individual, collaborative group-based and networked learning even though they do not emphasise the role of transfer and the learning inside and outside the higher education institution. They emphasise the role of socio-cultural learning, where the individual learning has been extended to learning in different contexts, situations and cultures. They present evidence that collaborative learning is able to produces better results than individual learning. It has been stipulated that the applied research and development of the universities of applied sciences support the regional development.

Multidisciplinary activities are appealing to increase the effectiveness of research and development and economic growth. The challenges of interdisciplinary include according to Kirjonen and Satka (2010) the definition of the research task, language and communication, the various limitations of research, the difficulties of research career and to become qualified, the sufficiency of know-how and motivation. On the other hand, they list the many benefits of interdisciplinary activities such as the opening of thinking, broader views, better effectiveness, the effective use of data and the development of new ideas. They do not emphasise the role of applied research and development which is based on the customer needs, which are responded with multidisciplinary projects.

4. INNOVATION PEDAGOGY FOR THE UNIVERSITIES OF APPLIED SCIENCES

Education at the Finnish universities of applied sciences includes internships which are at least half a year, applied research and development which in integrated with education to create capabilities for students participate in the projects of working life. Education also includes project work and the thesis planned to support the companies and public sector in the region. The integration of research and development requires, however, the multidisciplinary education of activities to understand the customer needs and solve the problems in an innovative way.

Education at the Finnish traditional research universities includes lectures, literature and examinations to create the strong intellectual and informative basis of learning and knowledge. Collaborative and networked learning is not systematically used in every subject, which is perhaps due to the fact that teacher training is not required as at the traditional universities.

Internships are included only in a few subjects where it is necessary.

The typical procedure of project work is that a group of students selects a relevant problem counselled by a teacher, plan the project, investigate the problem and write a report and present the results of the project. The presentation together with the report forms the basis for a grade or approval. In this form, the project work is group-based collaborative learning inside the institution and it does not outreach and engage with the external customers and partners outside the institution.

The alternative form of project work is that the teachers apply funding from the European union, other funding bodies or directly from customer organisations, look for partners to the projects and integrates the project with education so that students are able to find a useful role in the project and achieve real work experience in project work, study in networked collaboration and create capabilities that can be used after graduation in working life.

Innovative projects can be created at the third level of learning and knowledge. There must be some kind of innovative element in the project application which is solved in the project using the networked collaboration. A radical innovation is a new product, service or re-engineered process, but typically the innovations are incremental in applied research and development (Tidd et al., 2001). Radical innovations are close to re-engineering of processes which produce new products or services (Hammer & Champy, 1993). Incremental innovations are improved products, services and processes and hence close to the concept of continuous improvement in quality assurance.

The universities of applied sciences aim to be valuable institutions in regional development. The customer needs do not typically follow the subject, the degree programme or field of study. Therefore the project teams have members from many backgrounds. Multi-field faculties and operations across the faculties support the projects of applied research and development, which have shown their ability to respond the needs of working life. This is different from the creation of new universal knowledge which is an ideal of traditional research universities which have discipline-oriented faculties and subjects.

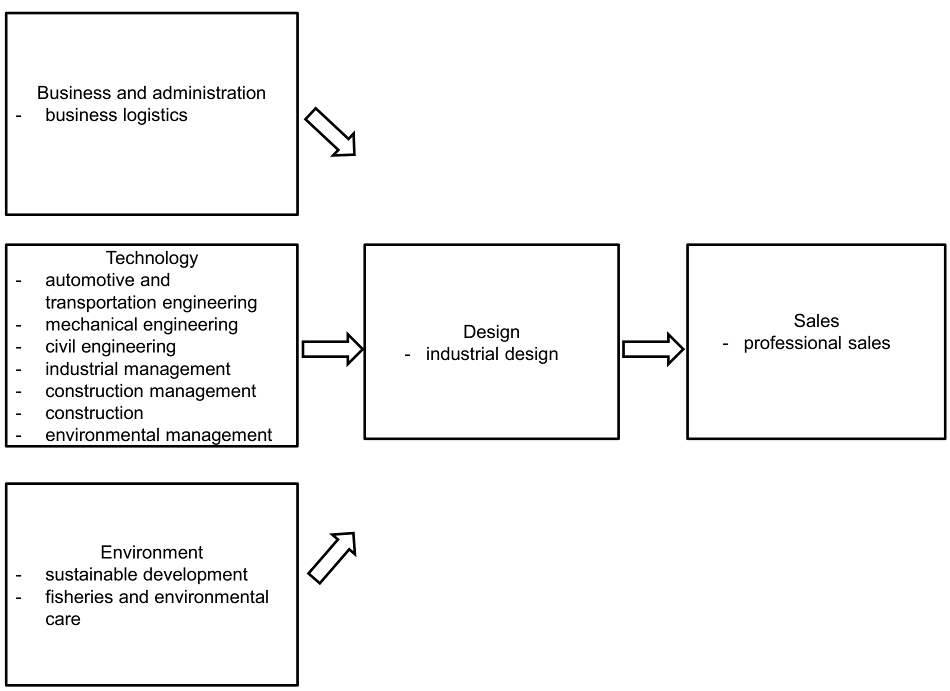

Figure 1. Innovative faculty in higher education

Figure 1 depicts the innovative faculty of higher education. The Faculty of Technology, Environment and Business of the Turku University of Applied Sciences have been planned to combine business, environment and technology. The next steps in the innovation process are the design and sales education. Many other faculties of the institution have been planned in a similar way to combine business, technology and some other knowledge.

5. CONCLUSIONS

Learning is not mechanical or isolated formation of knowledge that can be recalled and used in situations mentally similar to the learning context. Typically, this type of education learning is based on lectures and literature and includes concepts and facts which are memorized in examinations with no context of meaning or personal importance. A more advanced learning includes gradual development of capacities and problem solving, where the new element is linked as an addition to a scheme or pattern. This type of learning can produce incremental innovations. A new step is taken in learning when the learner breaks down an existing scheme and uses the knowledge in a new situation. This kind of learning may take place, when the learner accepts something that is significantly new or different. Learning may also produce outcomes which change the personality or the identity of the learner. That can be characterised as professional growth.

When education is integrated with development projects assimilative learning may take place. In assimilative learning, problems are solved and new elements are linked as an addition to a theoretical model or the framework. Assimilative learning takes place also when knowledge is applied in practice so that it develops the products, services and processes and hence produces incremental innovations. Accommodative or transcendent learning takes place when education is integrated with projects so that they produce new products, services or processes. These can be called radical innovations.

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Teaching Geometry and Research on Fractal Tilings

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Abstract

In this paper, we demonstrate how our research findings regarding fractal tilings arose through the teaching of a geometry course, and describe the mathematical relationships between the content of the geometry course and our research results. We share this delightful experience and demonstrate how research can be closely related to teaching activities in university.

Keywords: Geometry Course, Linking Teaching and Research, Fractals, Fractal Tilings, Maple, Reptile.

1. Introduction

The geometry course at the National Kaohsiung Normal University covers Euclidean and fractal geometry. Because these students will eventually become teachers in high school, a number of interesting subtopics of Euclidean and fractal geometry are also taught, including tilings, polyhedra, the Golden ratio, and fractals. Students are provided the opportunity to explore the properties of geometry using dynamic geometry software, such as GSP and GeoGebra, as well as computer algebra systems, including Maple. After teaching the above content for two years, the author sought to expand the curricula with new materials related to tilings using fractal shapes. This opened a door to the newly develop field of fractal tilings.

The internet provides many sources of information related to the topic of fractal tilings; however, this new field is scarcely touched upon in textbooks on geometry or fractals. The research results of the author include a rigorous definition of fractal tilings in [1] and an algorithm with which to generate self-similar forms in [2]. The exploration of research questions in this geometry course has proven highly rewarding, both for instructors and students, particularly with regard to the invention of new fractal shapes using Maple by students. In this paper, we share this delightful experience and demonstrate how research can be closely related to teaching activities in university.

About the relationship between research and teaching, in [3,4] McNay, Healy et al. indicated the trend of separation of research and teaching in university "Structural changes: research centres housed staff freed from teaching responsibilities; graduate schools became the arenas for research, leaving department to organize undergraduate teaching. Each of these [developments] was particular and peculiar, but the trend was gradually of a separation, structurally of research from teaching".

More recently, one of the topics to study linking teaching and research is called "The Research informed Teaching (RiT)" introduced in the homepage of Staffordshire University in United Kindom as "...recognise the importance of the reciprocal relationship between teaching and research in enhancing the students' learning experience In the University Research and Enterprise Strategy, for example, it is stated that applied research activity will underpin the student experience through its support of learning and teaching, and many staff already make good use of their research in the teaching context ." It shows that the trend of linking research and teaching is obvious.

In [5,6,7] the typology of teaching-research links was developed as 1.Teaching can be research-led 2. Teaching can be research-oriented 3. Teaching can be research-based 4. Teaching can be research-informed. In the geometry course, we conducted students to understand the processes by which fractal knowledge is produced and learn how to simulate fractals by Maple programming. So our course should fall on the second category of this typology. It was the teaching experience in this course that made the author invent new results about the fusion topic of tilings and fractals. The remainder of this paper is organized as follows: Section2 describes the main ideas of tilings and fractals, and the computer simulation of fractals with Maple by students. Section 3 describes our published research results about fractal tilings. And the conclusion is given in Section 4.

2. Geometry Course Teaching

The geometry course is taught three hours per week for two semesters. The first part of the second semester is devoted to the geometry of tilings and fractal geometry is covered in the second. The need to make these topics comprehensible to students led the author to develop a novel fusion of tilings and fractals. In the following subsections, we outline the main ideas of these two topics in detail.

Tilings

We review here some definitions of tilings in the book by Grünbaum and Shephard [8].

Definition 1. A *plane tiling* T is a countable family of closed topological disks $\mathrm{T} = \{T_1, T_2, \cdots\}$, which cover the plane without gaps or overlaps. More explicitly, the union of the sets $T_1, T_2, \cdots$ (which are known as the tiles of T) spans the entire plane, and the interior of the sets T_i are pairwise disjoint. A closed topological disk means a set homeomorphic to a closed circular disk.

Definition 2. A *monohedral tiling* T is a tiling whose tiles are all the same size and shape, i.e.,

$$T_1 \overset{congruent}{\cong} T_2 \overset{congruent}{\cong} \cdots .$$

Fractals with Maple Simulation

We see in the sequel that students presented their Maple codes to simulate their own designed fractals in the computer room.

At first we need review some notations and terminology for fractals. As an example, if we want to generate a von Koch curve we assign proper mappings $\{\phi_1, \phi_2, \cdots, \phi_n\}$ to constitute an iterated function system (IFS) [9]. We define the initiator and the generator as in [10].

We denote $H(A,k)$ to be a scaling with center A and scaling ratio k, that is, $H(A,k)(B) = C$ means that A,B,C are collinear and $\dfrac{AC}{AB} = k$. $T_{AB}(C)$ is defined to be a translation so that if $T_{AB}(C) = D$ then $CD \,//\, AB, CD = AB$. $R(O,\theta)$ is a rotation with center O and angle θ.

Let $\{\varphi_1, \varphi_2, \varphi_3, \varphi_4\}$ be such that:

$\varphi_1 = H(A, \frac{1}{3})$,

$\phi_2 = R(C, \frac{\pi}{3}) \circ T_{AC} \circ H(A, \frac{1}{3})$,

$\phi_3 = R(E, -\frac{\pi}{3}) \circ T_{AC} \circ H(A, \frac{1}{3})$,

$\phi_4 = T_{AE} \circ H(A, \frac{1}{3})$,

and define

$\Phi(B) := \bigcup_{i=1}^{n} \phi_i(B)$. Then the von Koch curve is: $A = \lim_{n\to\infty} \Phi^{\circ n}(U)$, see Fig. 1.

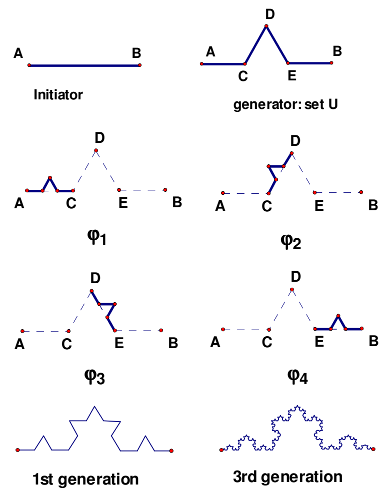


Fig. 1

We showed at first the Maple codes of Sierpinski carpet in [11] to students then explain the meaning of the codes in brief to them in computer room.

```
> restart;
> serp3:=proc(L::algebraic, lev::integer,x0::algebraic,
y0::algebraic)
local i,j;
global p,s;
options remember;
if s=0 then
p[0]:=plots[polygonplot]([[x0,y0],[x0,y0+L],[x0+L,y0
+L],[x0+L,y0]],style=line):
fi;
s:=s+1;
p[s]:=plots[polygonplot]([[x0+L/3,y0+L/3],[x0+L/3,y
0+2*L/3],[x0+2*L/3,y0+2*L/3],[x0+2*L/3,y0+L/3]],c
olor=blue):
if lev >1 then
  for i from 0 to 2 do
     for j from 0 to 2 do
        if abs(i-1)+abs(j-1) >0 then
           serp3(L/3,lev-1,x0+i*L/3,y0+j*L/3);
        fi;
     od;
  od;
fi;
RETURN(plots[display]([seq(p[i],i=0..s)],scaling=con
strained))
# In fact s=(8^lev-1)/7.
end:
> s:=0;serp3(100,3,0,0);
```

$$s := 0$$

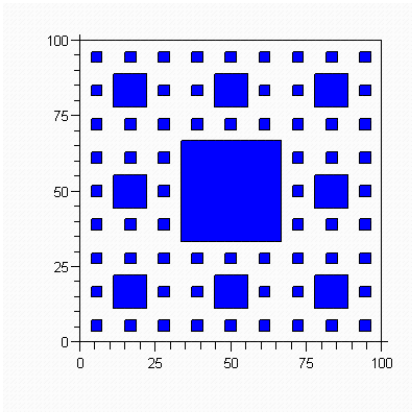


Fig. 2

Fig.2 is the running result graph of the above maple codes..

Then we showed the variant codes to get modified Sierpinski carpet as in the fig. 3 to let the students know more clearly how the codes work.

```
> serp2:=proc(L::algebraic, lev::integer,x0::algebraic,
y0::algebraic)
local i,j;
global p,s;
options remember;
if s=0 then
p[0]:=plots[polygonplot]([[x0,y0],[x0,y0+L],[x0+L,y0
+L],[x0+L,y0]],style=line):
fi;
s:=s+1;
p[s]:=plots[polygonplot]([[x0+L/3,y0+L/3],[x0+L/3,y
0+2*L/3],[x0+2*L/3,y0+2*L/3],[x0+2*L/3,y0+L/3]],c
olor=green):
if lev >1 then
   for i from 1 to 2 do
      for j from 1 to 2 do
         if abs(i-1)+abs(j-1) >0 then
            serp2(L/3,lev-1,x0+i*L/3,y0+j*L/3);
         fi;
      od;
   od;
fi;
RETURN(plots[display]([seq(p[i],i=0..(3^lev-
1)/2)],scaling=constrained))
end:
> s:=0;serp2(100,4,0,0);
```

$$s := 0$$

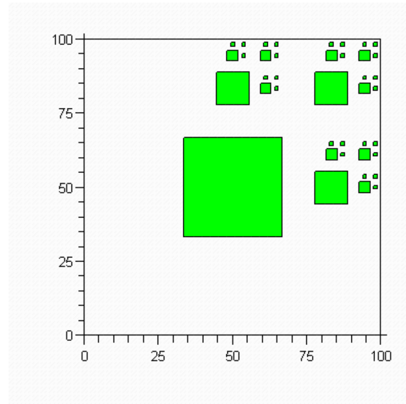


Fig. 3

Then we assigned homework to all student teams to design (invent) and simulate their fractals with Maple programming. We found the students could design their fractal shape by modifying the codes in [11] and by repeating computer simulating. The following Fig. 4-Fig. 7 are part of photos of students while presenting their homework in computer room.

Fig. 4 One team was presenting their Maple codes and designed fractal in computer room.

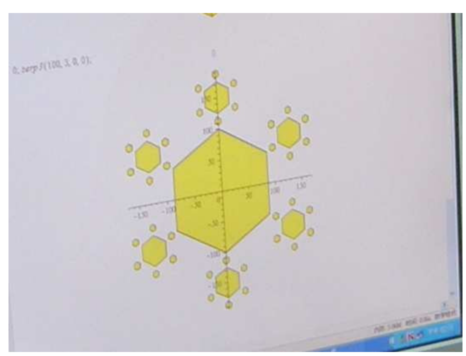


Fig. 5 The detail of the designed fractal in the above figure.

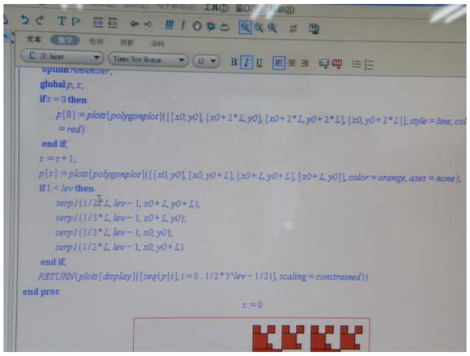


Fig. 6 The Maple codes of a designed fractal by another team.

Fig. 7 Another team was preparing the presentation.

3. Research Results

After teaching the above topics about fractals and tilings in Geometry course, the author presented some research results about fractal tilings in [1,2]. We state the results in the following in brief.

In [12] they suggested a way of generating a fractal tiling; they give the following intuitive definition for a *fractal tile*.

Definition 3. A *fractal tile* is a tile whose boundary is composed of fractal curves, or say, a topological closed disk with fractal boundaries.

In [1] we give a rigorous definition of fractal tilings. At first we review a prefractal [13].

Definition 4. A *prefractal* is the intermediate shape for generating a fractal using the IFS method.

Then we give the definition of prefractal tilings.

Definition 5. Given a tile with fractal boundary , we denote the tile by T and its fractal boundary by Γ. We define the (*kth*) *prefractal tile of* T to be a set (tile) with (*kth*) prefractal of Γ as boundary.

The following is a rigorous definition of fractal tiling presented by the author in [1].

Definition 6. A tile with fractal boundary can tile the plane if its every k th prefractal tile can tile the plane for every $k \in N$. If so, we call this tile with fractal boundary *a fractal tile*.

Another research results in [1] included five methods, including Escher's tiling pictures methods and the Conway criterion to create the fractal tilings. By the results in [1] it is easy to check the well-known fractal fudgeflake to be a fractal tilings see Fig 8. .

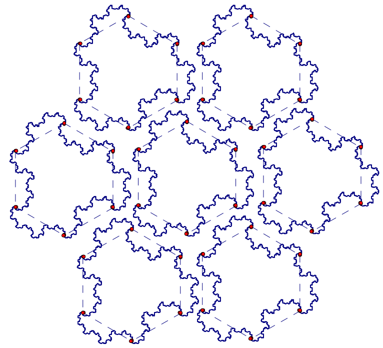


Fig. 8 The fudgeflake as a fractal tilings

Our another research result is an algorithm to generate fractal reptiles [2].

Definition 7. A *k-rep tile* is defined as any set T that can be dissected into k congruent parts T' each of which is similar to T . If the above T is disk-like, then we say that T is a *disk-like k-rep tile.* A fractal tile is called *a fractal k-reptile* if it is a k-reptile.

Sphinx is a famous example of a 4-rep tile. It is well known that the Sierpinski gasket constitutes of 3^n copies of small congruent one for any $n \in \mathbb{N}$. So the Sierpinski gasket is a non-disk-like 3^n -rep tile for any $n \in \mathbb{N}$.

We investigate a well known process to generate Gosper snowflake (Gosper island). With the aid of Escher-style rules we can realize more deeply why this process works. The investigation proceeds as follows. The 0th step we begin with a hexagon G_0 (Fig. 9). We can call it the initiator. Step 1. we use 7 congruent hexagons scaled from G_0 to form the new polygon called G_1 . For convenience we denote the scaled one also by G_0 in the figure. We can see that because G_1 is modified from a hexagon by the Escher parallel translation rule, it follows that G_1 can tile the plane well. We need the dashed hexagon attached to G_1 to indicate the relative position. We call it the *referenced hexagon of* G_1 (Fig. 10). Step 2. shrink G_1 as small as the scaled G_0 in G_1 and replace every small G_0 by scaled G_1 by coinciding the *referenced hexagon of* G_1 with small G_0 to form G_1. Here we can see that G_2 is modified from G_1 by the Escher parallel translation rule. So we know that G_2 can tile the plane as well (Fig. 11). Step 3 Similarly, we replace every small G_1 in G_2 by scaled G_2 to get G_3. Continue this process indefinitely to get the convergent shape which is the Gosper snowflake.

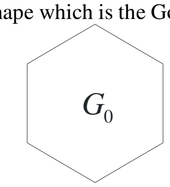
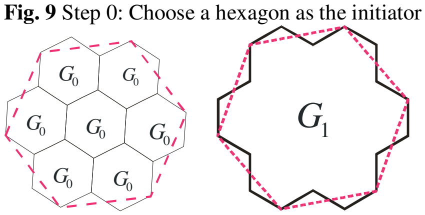


Fig. 9 Step 0: Choose a hexagon as the initiator



Step1: Find a generator which is satisfied with Escher rules.

Fig. 10 Find suitable initiator and generator of Gosper snowflake.

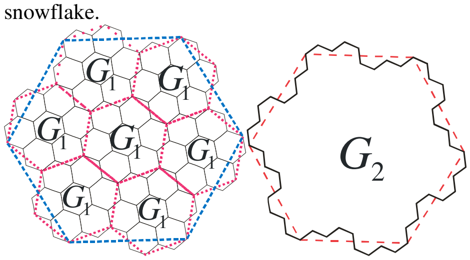


Fig. 11 Step 2: Replacing G_0 with G_1 to get G_2.

With the aid of the above investigation, we can provide an informal proof as follows. Let $G_{n,k}$ denote the scaled previous generation shapes in G_{n+1}. Because $G_{n+1} = \bigcup_{k=1,\cdots,7} G_{n,k}$ for every $n \in \mathrm{N}$, with no overlap and no gap. Taking limit on both sides to get

Gosper= $\lim_{n\to\infty} G_{n+1} = \lim_{n\to\infty} \bigcup_{k=1,\cdots,7} G_{n,k}$

$= \bigcup_{k=1,\cdots,7} \lim_{n\to\infty} G_{n,k} = \bigcup_{k=1,\cdots,7}$ small Gosper

For the no overlap and no gap union we get that the Gosper snowflake is a 7-reptile.

Base on the above investigation and Escher-style rules we can now present an algorithm to generate fractal reptiles. We find the key point is a criterion with which the polygon initiator P_0 and the polygon generator P_1 must satisfy.

Criterion 1. Several congruent scaled-down P_0 can be joined together to form P_1, i.e., $P_1 = \bigcup_{k=1}^{m} P_{0k}$ where P_{0k} is congruent to a scaled-down P_0, such that P_1 is modified from P_0 according to some Escher-style rule or Conway criteria.

Algorithm for generating fractal reptiles:

Step 1. Choose a polygon P_0 (initiator) and a polygon generator P_1 which satisfy criterion 1. Then we should attach a referenced P_0 on P_1 (as stated in the above Gosper example) to proceed the next step.

Step 2. Replacing every P_{0k} in P_1 by scaled-down P_1 to form P_2. The Escher-style rule promises that the union is no overlap and no gap. Also we need to attach a referenced P_0 on P_2 for the successive replacing process.

Step 3. Continue similar way in Step2 indefinitely to get a limit set which is a fractal m-reptile.

4. Conclusion

In this paper, we demonstrate how our research findings regarding fractal tilings arose through the teaching of a geometry course, and describe the mathematical relationships between the content of the geometry course and our research results. This experience is a poignant demonstration of the close relationship between research and teaching.

5. Acknowledgement

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Renewable Energy: An Interdisciplinary Problem Solving Course

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ABSTRACT

This paper describes a new intermediate course given in the Environmental Studies Program at The New School. It incorporates research activities by the class as a whole, in the process of which the class learns a great deal about the science and technology of non-fossil fuels, their promises and difficulties. Since ameliorating human influenced global climate change, educating and training students in the skills necessary to accomplish the necessary transition is essential. The course embodies a class project on which everyone works, entitled "Fueling America," whose purpose is to determine what technologies deployed in what manner and in what quantities can eliminate the use of fossil fuels in the United States by a date certain. Knowing that it was impossible, we nevertheless chose an early date, 2030, so that it seemed reachable for the students. The project resulted in a technical paper, which included an economic analysis. In addition to alternative energy technologies, the technologies of energy efficiencies were also included.

Keywords: fossil fuels, solar energy, energy efficiency, climate change, tidal energy, biomass, wind

INTRODUCTION

The Renewable Energy course in Environmental Studies was comprised of students from Environmental Studies, Integrated Science, and Urban Studies programs. A prerequisite for the course was an introductory one, Energy and Sustainability, which I have taught for six years. [1] That course laid the basis of understanding energy from a physics and chemical point of view, considered the first two laws of thermodynamics, and assured the students had certain calculation skills necessary for the work in the course.

The enthusiasm for the course was very high, due both to the commitment of the particular students in the course for building a more sustainable society, and because of the joint class project, in which every student participated. As one student said at the presentation of the final report to a group of students and teachers: "It was great because everyone worked together, and there was not the usual competition for grades that you find in many courses." Of course grades were given, but based primarily on class discussions and individual presentations from the reading. Students met out of class, on their own, to discuss their work, and one student started a blog for the course, which I had nothing to do with. It was fundamentally a student centered course, and it showed the benefits of constructing a course in this manner.

Energy is fundamental to our lives, and students learn how difficult it is to wean ourselves off of the intensive use of energy which characterizes modern economies. Although the date we chose to be free of fossil fuels, was totally unrealistic, the date was chosen as a forcing mechanism, so that we could really face the problems of a fossil fuel free society. Students were eager to adopt an early date, because they were learning that global climate change was occurring more quickly than experts had originally predicted. The lack of political action on combatting climate change also fueled their eagerness.

THE COURSE

The course started with consideration of basic concepts; we used a text for basic understanding of different energy concepts. The class was run as a true seminar; students made presentations from the text [2] as well as from supplemental reading posted on the on-line service we use, Blackboard. As well, students were required to search for their own supplemental material for the topic on which they were presenting. Although this meant a good deal more time preparing for each class hour than is usual, students ended up being very enthusiastic about this aspect. They felt as though they were being treated as serious researchers, which they were.

Although this part of the course went on for some time, after a few weeks the students felt they were ready to tackle the main project, "Fueling America." To be sure, in the beginning of this process they did not realize how hard a job it was going to be; one student said that one value of the class was to demonstrate how hard the job was, both of removing American dependence on fossil fuels and also finding adequate information about each technology. She said: "I used to say this is simple, just go to solar power. Now I think this is hard!"

There followed intense discussion of the various technical possibilities, after which the class discussed how to proceed. They decided that one person - there were only six students in the class - would deal with one technology or technique, and that each student, in consultation with others, could choose what he or she wanted, making sure there were no duplications. With such a small number of students, that meant that some promising technologies would not be covered, and we would have to acknowledge that in our report. In the end, one of the most promising technologies, the many ways of using biomass, was not analyzed in the report. Although this is obviously a significant deficiency, the class decided, and I agreed, that it was more important in terms of student enthusiasm to let students work on a technology of their own choice. This would not have been an issue with a larger class, and there is, of course, another way to proceed, to insist that the most promising technologies be considered. This is a pedagogical issue, and I am sure there are many who would have chosen an alternative scenario.

The six areas that were considered were: wind, tidal power, solar photovoltaics, nuclear, efficiency in buildings, and efficiencies in transportation. For both building and energy efficiencies, increasing the efficiency of buildings and automobiles, for example, were considered, as well as increasing the efficiency of the system, more mass transit, for example, and reorganizing where people live - more city and less suburban living, for one. The students working on efficiencies of the building and transportation sectors worked closely together, since housing patterns have much to do with automobile use and other transportation issues.

To coordinate the effort, a Google Doc was created, so that each student could see each other's work and comment on it. Each student had to report the basics about the technology, including its current state of development. Also necessary to include were cost - both current and projected future cost - land mass, and any environmental concerns about the manufacture or deployment of the technology. A portion of each class was devoted to a discussion of the data posted; as the end of the project neared, practically all class time was spent on this process.

Each technology or technique posed its difficulties, which the students soon came to realize. Wind, for example, was a very attractive option, until the student involved had to calculate the land mass necessary. Although there are a number of sites in the United States which are capable of supplying electricity from wind, the land mass they must occupy is significant. A similar picture is found in solar photovoltaics; the density of the energy from the sun, though large in absolute terms, is simply not high enough to sustain, for example, a solar car, at least one that has normal dimensions and weight. Even a small car would need a huge collector on top to propel it at any speed.

The basic problem, of course, is that with the exception of tidal power and geothermal, all non-fossil fuel energy comes from the sun. The power density of the sun is about 1 kW per square meter; the area of the United States is 9.8 x 10 to the twelfth power meters. On average, we can only obtain about 6 or 7 hours of sun per day; that gives us 7 kWh (kilowatt hours) per day per square meter. Assuming the 15% efficiency of current solar photovoltaic cells (redo calculations). [3]

In 2009, the United States used 94.6 Quads, or quadrillion BTUs per year, which is what the class used as our benchmark, even though we knew that energy use would increase every year as it has for the last hundred, though energy use per capita in the United States has remained roughly the same or even declined in the last few years. [4] It gave us a target to shoot for.

Nuclear power, to nobody's surprise, was the most controversial. Despite many arguments in the class, it was determined - I must admit, with some urging from me - that it had to be considered. After all the numbers came in, we and society could decide not to use it, but that it ought to be considered. It led to a very interesting discussion of the trade-offs that one inevitably faces in considering these issues. Although it is hard to find totally unbiased reports on the relative benefits of nuclear vs. coal, there is interesting information that can be found. [5] Almost everyone agrees that under regular running conditions, coal causes more deaths per unit of energy produced by orders of magnitude over nuclear. However, nuclear power makes many people nervous, partly because of its association with the atomic bomb, and partly because of the potential for very serious radioactive contamination. The poster child for this is Chernobyl, of course, Fukushima, both of which caused great damage and deaths; Three Mile Island while very serious, caused few if any deaths.

Thus, the decision ultimately depends on how serious one takes global climate change and environmental pollution. Everyone in the class came into it with a strong feeling that these were very important issues, and that both global warming and environmental pollution were serious threats. Particularly when the students realized how difficult it was to completely eliminate fossil fuels from the energy picture, and that nuclear energy could be necessary to fill in where solar and other alternative energy forms might fall short, they started to face the tough issues. More about this later, but one of the real benefits of this course was showing them that tough choices had to be made.

Tidal energy turned out to be an interesting choice. As I said, students could choose a source that was of interest to them. This continued to be true, even after the student who chose tidal quickly found out that tidal energy at most could supply one or two percent of our total energy supply. The class agreed that this should remain in the final report - even though if this were a realistic attempt to wean the nation off of fossil fuels, one would quickly abandon this and go on to something else - since there is a lot of talk in some circles about the benefits of tidal power and it was useful to make the point that some alternative energy sources are just not going to play a big role.

The class also considered, because it discovered that it had to, some rather radical changes in societal organization. The urban studies student, who was studying building efficiencies, included a large section on the energy wasting facet of suburban living. Working very closely with the student studying transportation, he (there were five men in the class, one woman) pointed out that the very design of suburban homes and their layouts required a great deal of energy to heat and cool, since they were all separate units, and also required cars and much driving, since many suburban layouts foreclose any notion of an adequate public transportation system, although many suburban areas have some kind of bus system. The difficulties of changing the system were obviously seen as very difficult, pointing out yet again what an enormous task we face.

The students finished with a report, detailing their research and their conclusions, and made the presentation previously referred to. The current plan is to use this report as the starting point for the next class - it is currently planned to offer this course every other year - and perhaps in three or four iterations have a complete report in publishable form.

BENEFITS

Although many of the claims I make about the benefits of this course are anecdotal, there is a good deal of research pointing to the value of this way of conducting a class. [6-15] We know that students learn best when they are engaged, and we know that creating a learning community in the classroom is important to retaining knowledge. All of these benefits have accrued to the students in this class. Student evaluations, both at mid-term and at the end of the class, were very high, with every student saying they would highly recommend the course to their friends.

But, of course, student satisfaction is not the only measure of success, although I think it is a necessary condition for success. What we really want to know, we cannot measure at this time; that is, what the students will remember about and what they will remember from this course in ten or even twenty years after graduation. However, there is research, in the references above, that tells us students are much more likely to remember from this kind of course than a traditional lecture or even seminar course. Time will tell.

CONCLUSIONS

In addition to the benefits, there are costs and risks to doing such a course. Its success depends greatly on the type of student who enrolls. One student who does not pull his or her own weight, or is difficult in class discussions, or who disrupts the class in one of any number of ways, will prevent the establishment of the good will that is necessary for the course to succeed. The students really have to be willing to help each other, and to contribute to the course in many ways. As noted above, one student started a blog, with which I had nothing to do; yet another posted results of the research on a web page she kept on sustainable development.

The students also need to come to the course with a minimum of calculation and research skills. Students at the university in which I teach are traditionally math-phobic - mirroring the large number of students nation wide who suffer thus - and some time had to be spent in class going over basic computational and especially algebra skills. [13] I would expect in other, more technically oriented schools, this might not be such a problem, but students certainly need to know how to perform elementary mathematical operations, including conversions of one unit to another and other such calculations.

Because a prerequisite was the Energy and Sustainability course - all truth be told not every student had actually taken the course, but were considered sufficiently skilled that they could take this course - they were well versed in the issue of global climate change, and so the motivation to switch to alternative fuels was strong. [16] This motivation was key in impelling to do the rather large amount of work necessary.

It was difficult to fit everything into the one hour forty minute class, twice a week for fifteen weeks. Time after time we would run out of time, and the students would be required to determine things on their own. Their work load was heavy; though remarkably nobody complained about it, they regularly said it was the hardest course they were taking that semester, and required the most work.

The lack of time led to another problem. Although sustainability contains within it issues of social justice - some solutions for energy efficiency, rising prices dramatically, for example, affect poor people much more than the well-to-do - and there is a large literature that speaks to such issues, there was little time to consider such questions. [17-24] I would hope to be able to find time in future editions of the course to deal with such questions, for in my mind they are key.

Finally, there is a good deal of research which is necessary to determine the effect of courses taught in this way. With such a small class, and with no control group, it was impossible to do a true assessment of the course, but such research is necessary. We think we know what effective teaching is, but in fact there are many surprises contained herein. It is my hope that by teaching such courses and by talking about them in conferences like this, we will be able to stimulate the necessary research.

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No Problem? No Research, Little Learning ... Big Problem!

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ABSTRACT

The motivation to carry out this study stemmed from the generalized perception that nowadays youth lacks the skills for the 21st century. Especially the high-level competences like critical thinking, problem solving and autonomy. Several tools can help to improve these competences (e.g. the SCRATCH programming language), but as researchers and educators we are mostly concerned with the skill to recognize problems. What if we do not find problems to solve? What if we do not even feel the ***need*** to find or solve problems? The problem is to recognize the problem; the next step is to equate the problem; finally we have to feel the ***need*** to solve it. No need? No invention. Recognizing a problem is probably the biggest problem of everyday life, because we are permanently faced with problems (many ill-defined problems), which we need to identify, equate and solve.

Keywords: intuition; curiosity; problem recognition; creativity; problem solving; critical thinking; research and education

1. RATIONALE

Youngsters seem to be more and more passive consumers, little autonomous and less motivated intrinsically for learning at school. The innate curiosity, imagination, creativity and the need that is the mother of invention all vanish in most pupils along 11 to 12 years of pre-university school. Therefore, youngsters do not develop high-level competences that can make them pro-active, autonomous, critical citizens, inventors and constructors in the future. In fact, most of our students even lack basic skills, which are needed to work, for instance, in a lab. They (male or female) do not know how to properly use a basic tool like a screwdriver. Even more worrying is the fact that most of the colleagues in the Geology department of a Faculty of Sciences have a very poor scientific production, and for one very simple reason: they cannot find problems to solve.

2. PREMISES

As basis of argument, let us assume that some very well-known sayings are true: (i) "*He who can no longer pause to wonder and stand rapt in awe, is as good as dead: his eyes are closed*" (A. Einstein); (ii) "*The intuitive mind is a sacred gift and the rational mind is a faithful servant*" (A. Einstein); (iii) "*The need is the mother of invention*" (old popular saying); (iv) "*To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science*" (A. Einstein); (v) "*The important thing is not to stop questioning*" and "*Imagination is more important than knowledge*" (A. Einstein), who also recognized that "*It is a miracle that curiosity survives formal education*", which seems to still hold.

These famous sayings illustrate the problems we recognize in Natural Sciences students. The problems are related to observation, intuition, need, (intrinsic) motivation, recognition of problems and problem solving. Because one of us travels regularly to many universities around the world, he has recognized these problems everywhere.

3. PROBLEMS

3.1. Observation

A basic and fundamental tool in sciences is observation. However, the present-day school does not teach the students to observe carefully and in detail, and to describe, in drawing and writing, with the rigor of science.

Our personal experience in the activities of teaching and scientific research has taught us that our eyes see what the brain is educated to see [e.g. 1-4]. This means that we first do a preliminary observation, then we use critical thinking to analyze the data, and finally usually come to the conclusion that the observation is insufficient or even irrelevant. Typically, we soon realize that we have problems to solve and so we need more observation and data. But now the brain is aware of what we need to look for (our eyes see what the brain is educated to see), which is the relevant data that will help to solve the problem.

3.2. Attitude

The ***need*** is the mother of invention. However, most kids nowadays have no needs, probably because parents in the so-called "first world countries" give them everything, especially the superfluous, and not as a reward to anything.

The present-day helping culture is eroding autonomy and self-reliance [e.g. 5-8]. Nowadays parents make life too easy to their kids, by removing every obstacle (however small). The result is that they are not being prepared for real life, which is full of obstacles at every step. Nowadays parents ignore a fundamental premise: "*Adversity builds character*" or "*What does not kill you makes you stronger*" (Nietzsche).

3.3. Where Is The Problem?

High-level skills like critical thinking, problem solving and autonomy are all inherent in Problem-Based Learning (PBL) [e.g. 9, 10]. PBL can very successfully teach us how to solve problems; however, PBL by itself does not teach us how to find/recognize problems. What if we do not find problems to solve? What if we do not even feel the ***need*** to find or solve problems? The problem is to recognize the problem; the next step is to equate the problem; finally we have to feel the ***need*** to solve it. No need? No invention. Recognizing a problem is probably the biggest problem of everyday life, because we are permanently faced with problems (many are ill-defined problems), which we need to identify, equate and solve (without recourse to a psychiatrist, who will try to help one recognize the problems).

Although experimentation and modelling are fundamental tools in basic Physics and problem recognition, experimentation at pre-university level is absent in Portugal. The school textbooks for Natural Sciences are misleading and ineffective, because all the so-called "*experimental activities*" (with no exception) are either physically wrong or no more than poor laboratory activities.

3.4. Intuition And Motivation

As recognized by A. Einstein, *the intuitive mind is a sacred gift*; it is indeed fundamental in science and in the recognition of problems. Children naturally and unconsciously develop intuition, which is our background knowledge of the way things work, gained from everyday experience [e.g. 11, 12]. When a child throws a ball vertically in the air, he intuitively (unconsciously) learns that the ball has some weight, that he has to spend some energy to throw it high (do some work), that the ball will slow down on the way up, come to a stop, and then accelerate downward back to his hand, where he will feel the impact. Without knowing a thing of Physics or Mathematics, he was introduced to many important concepts of Classical Mechanics. He does not know of them formally, but he knows how they work. So what should be a major objective of the School? Take this everyday life intuition of how things work and educate it [e.g. 13, 14]. However, it does exactly the opposite ("*It is a miracle that curiosity survives formal education"*, Einstein). Intuition may be wrong (e.g. it is not the sun that moves everyday from E to W, it is the Earth that rotates in the opposite sense) and must be corrected in a modern society. In a primitive society people did not care about correction or education of the intuition, because their main objective was the preservation of the species. Only later the human kind decided that this was not enough and started paying more attention to the intellect. We now live in an age of transition from primitive instinct/intuition/physical based society to a higher-level intellectual society. This time is dangerous because we are not as intellectually evolved as we often pretend to be. And this generates too many conflicts in the present human being, caught in a hybrid stage made of primitive instincts and higher intellectual development. But, paradoxically, the present-day school kills the most genuine high-level innate skills (curiosity, imagination and creativity) and does not promote the autonomy so necessary in the modern society and so basic in the primitive societies. An Einstein's quote pops to my mind: "*Only two things are infinite, the universe and human stupidity, and I am not sure about the former*".

Motivation is probably the biggest challenge: how can we trigger/develop intrinsic motivation, so critical to transform our pupils into students?

3.5. Critical Thinking

Most of our pre-university students, and none of our under or post-graduate students at the university question what we tell them, or what is written in textbooks or scientific papers. They do not even question the beautiful rocks we take them to observe in the field.

Many of our students, at any level, present, as the result of a problem, two values, one determined graphically and the other analytically, for exactly the same angle, without recognizing that one value is obviously wrong.

4. POSSIBLE SOLUTIONS

How can we improve students' observation skills? They should be taken more regularly outdoors to observe and describe large-scale and small-scale features. They should be taught how to collect relevant data according to different objectives.

How can we improve the students' ability to recognize problems? Scientific drawing, writing and experimentation are excellent ways. When we draw, we become aware of geometrical problems and what is relevant according to the objectives; when we write, we usually find that the data is insufficient or even irrelevant for the proposed objectives; when we experiment and model, we realize that we have mechanical problems to solve. When the students use a programming language like SCRATCH, they soon find problems that they immediately have (feel the need) to solve in order to advance with the project.

The roles of Science and Mathematics are growing fast in our society. Mathematics teaches us how to solve problems in a logical and rational way. If it is important to know how to solve problems, it is not less important to know how to recognize and formulate them. However, Mathematics does not teach us how to find or recognize problems. This is a major role of Science that urgently needs to be taught to our youngsters (at least). With experimentation, students learn the most basic and fundamental practice in Science. Students even learn how to use basic tools (e.g. hammer, screwdriver, pliers, ...) when they are faced with the need to build new apparatuses to realize the experiments. Students even learn how to properly use a modern basic tool like the computer (usually used by youngsters for games) when they use programming languages like SCRATCH.

5. CONCLUSIONS

Regarding observation, we should always keep in mind that the eyes see what the brain is educated to see. Otherwise we are blind to many relevant details and many problems.

We need to improve the student's innate

intuition and educate it. This is likely the easiest way to motivate students.

Ultimately Science and Mathematics can help us with everyday life, because we are permanently faced with problems, which we need to identify, equate and solve rationally.

We try to teach our students, in 12 years of pre-university school, the science that took humanity thousands of years to develop. This is absolute nonsense! The solution could be to work only a few fundamental physical processes with students, and use the most basic and fundamental tools – observation, experimentation and analysis – to understand them.

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Approaches for Multidisciplinary Research-Oriented Studies by Means of Joint Programmes: Cases, Experiences and Successes.

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ABSTRACT

Research-oriented joint programmes in the Division of Atmospheric Sciences at the University of Helsinki have been conducted for almost ten years, and cover both Master's and Doctoral degrees. These programmes are aimed at providing the students with multidisciplinary education, comprehensive curriculum, training in transferrable skills and networking opportunities. They cover a variety of subjects within the field of atmospheric and environmental sciences, and bring together both students and research/teaching staff from Nordic universities. The joint nature of the programmes is visible in two actions: e-learning courses and intensive field courses, both of which are attended by students from different universities. Courses given as part of these joint programmes are not only intended for pure scientific and learning purposes, but also for bringing students from different countries together and establishing international network connections. The chief goal is to educate a next generation of top-level scientists and experts with all necessary multidisciplinary skills to tackle the future challenges of climate change, air quality matters and environmental technologies. This is achieved by providing necessary facilities, knowledge and environment, and by the collaboration of a large group of specialists.

Keywords: joint programmes, multidisciplinarity, atmospheric research, master and doctoral studies, horizontal learning, participatory action research

INTRODUCTION

The shift from discipline-tied fundamental education towards multidisciplinarity is imperative for a successful career in climate and global change science [1]. Therefore, we have adopted the education of the next generation of scientists in a truly multidisciplinary way of thinking as the chief educational and knowledge transfer goal. Participatory action research has been acknowledged as the main tool to achieve this goal. We also emphasize the recognition of the research career as a whole, ranging from master-level studies to postdoctoral researcher level. Following the CBACCI (Nordic-Baltic Graduate School on Biosphere-Carbon-Aerosol-Cloud-Climate Interactions) Education Structure [2], dedicated work on the national and regional scale (Nordic and Baltic countries) has been carried out to develop the multidisciplinary training on all levels (master students, doctoral students, postdoctoral scientists, professors and other senior researchers).

Atmospheric research involves several fields of science, such as chemistry, physics, meteorology, mathematics, biology, agricultural and forest sciences, technology, and geosciences, combining observations, experimentation and modelling. In such a framework it is crucial that observations are based on unifying theoretical framework and are carried out with various measurement techniques supporting each other. Furthermore, observations should be tested against field and laboratory experiments, and process understanding should be tied to theoretical and modelling development work. Great importance is also given to the ability to up-scale the small scale processes to the regional and global level phenomena and dynamics. The research-oriented joint programmes described in this paper include all of these challenging components and bring them to the level of the student training.

MASTER LEVEL EDUCATION: JOINT PROGRAMME

ABS (Atmosphere-Biosphere Studies) is a Nordic Master's Degree Programme in Atmospheric Sciences and Biogeochemical Cycles. The aim of the programme is to educate environmental specialists, who are capable of independent and innovative work in the current and future challenges related to global climate change and environmental pollution. The approximate study period is two years. The ABS programme has been designed to be very multidisciplinary, involving a versatile education in atmospheric sciences, covering physical phenomena, atmospheric chemistry, meteorology, and ecosystem studies. The programme is a joint effort of ten Northern European universities, and serves as a forum for exchanging experiences and best practises concerning the European harmonization process and master level education in general. Each ABS programme student selects one major subject, and gets the main part of the two-year education in the selected university and department. The joint nature of the programme steps in after the introductory courses in the major subject are completed. Each year the partners jointly organize several intensive field courses as well as e-learning courses for the whole network. In particular, these courses address the multidisciplinary nature of the present-day environmental problems.

The programme started as an attempt to answer the global need for experts having multidisciplinary education in environmental issues. The governmental environmental agencies need people who are able to interpret the new scientific results as a base for future legislation. Close monitoring of scientific results, interpretation and action-taking is needed to combat the current and future global change effects on the environment. The industry, transport and commerce need to adapt to the new, stricter regulations.

From the educational point of view, the idea of a common European educational area was introduced in the Bologna agreement [3]. Harmonisation of the degree structure of European universities, as well as a common credit transfer system (ECTS) improving the student mobility between European countries, are both included in the agreement. The programme has attracted students interested in environmental issues from all parts of the world.

None of the units participating in the ABS programme could give such versatile education alone, but the ABS network enables the utilization of the highest environmental research in the region for master-level education. Luckily for the programme, the departments participating in the network have a great number of teachers who are highly motivated to collaborate internationally, to update their teaching skills, to create new courses, and to develop and implement new technologies in teaching. As a result of this, there has been a variety of teaching and learning methods available for the ABS programme students, e.g. e-learning, intensive courses, problem-based learning, new technology supporting learning, and training of a variety of transferable skills during the programme.

DOCTORAL LEVEL EDUCATION: JOINT PROGRAMME

At the University of Helsinki, the doctoral training is organized in the framework of a national doctoral programme “Atmospheric Composition and Climate Change: From Molecular Processes to Global Observations and Models (ACCC)”. As described in the previous section, multidisciplinary education is to a certain degree available already to undergraduate students. However, the undergraduate students are educated mainly within their specific disciplines, ensuring a strong scientific basis. The shift from still quite strongly discipline-tied fundamental education towards multidisciplinarity at the PhD and post-doctoral levels is needed. Therefore, the chief educational and knowledge transfer goal of the ACCC programme is to educate scientists in a truly multidisciplinary way of thinking. The direct involvement in industrial research and development is also addressed at this point.

The offered graduate courses combine core and transferable skills, but always ensuring that these skills are learned actively and kept fully relevant to the students' own research. The key transferable skills in the Doctoral Programme are (i) working in the field, (ii) instrument technology, (iii) data analysis, (iv) computer modelling, (v) writing articles, (vi) popular science writing, (vii) presentation skills including audiovisual skills, (viii) teaching skills, (ix) project management, (x) writing proposals, and (xi) commercialization of scientific ideas.

The programme-wide training consists of scientific and technological knowledge, transferable skills and public outreach, and includes several annual activities: winter and summer schools, field courses, a researcher workshop, and a workshop for teachers and supervisors. The training is a combination of lectures, field measurements, computer modelling and transferable skills. The winter and summer schools combine several topics each, and always include training on transferable skills. A key part of the annual three-day researcher workshops is a two-day seminar where the Doctoral Programme students present their recent research results, and a networking day where distinguished researchers and industry representatives are invited. The researcher workshops provide an authentic experience, in which the research of the doctoral students is fused with their training and supervision by university, institute and industrial partners. In the annual teacher and supervisor workshops, lecturers and supervisors are trained on teaching, communication and supervising skills, including web-based teaching. The hosting of the annual events is circulated between programme partners, enabling all the students to get to know each of the Programme partners. In the organization of the joint activities, the good practices and experience from existing joint efforts, e.g. ABS Masters Degree Programme, are fully utilized.

CASE STUDY: NEW TECHNOLOGY TO SUPPORT TEACHING

An example of the new technology used in the research-oriented joint programmes at the University of Helsinki is Smart-SMEAR, a tool for structuring, visualising and analysing complex environmental field data [4]. Smart-SMEAR is a handy and inspiring tool to present complex environmental measurement data, and to see different causal connections in an understandable and simple way. The tool consists of two separate applications. The first is a visual implementation of the 15-year continuous dataset from the SMEAR II environmental and atmospheric measurement station in Hyytiälä, Finland [5], and the second one is used to download the desired data for further analysis. The central pedagogical principle is student's inspiration through getting the idea. The Smart-SMEAR database contains several measured and modelled parameters, each of which requires special tools and knowledge to work with. The web-based tool collects and processes all the data so that the user does not have to know practically anything about how the data should be treated. This provides means for beginning scientists, students and researches from other fields to explore the data and see correlations and behaviour of different parameters without losing time in collecting data, pre-treatment and learning special plotting tools (e.g. plotting maps and surface plots).

The pedagogical philosophy of the Smart-SMEAR is based on the idea of meaningful learning. Smart-SMEAR emphasises learning as the learner's own process of constructing new information on top of the already achieved knowledge. This poses a few requirements to the learning environment. First, the already existing information structures and understanding of the student must be correct and well organised, so that the learning of the new information becomes meaningful. This can be achieved via various methods: discussions in small groups, questions, simple recapitulation and outliners. Second, the teaching becomes coaching, where the teacher allows the student to create understandable and meaningful information structures out of the material to be studied. This presumes that various pedagogical approaches are adopted, e.g. collaborative learning, reading and writing, discussions. The activity and motivation of the students play the key role. Third, the students need to have the time and space for reflection, which means that the students can evaluate their own learning and develop their metacognitive skills. This way they have the possibility to become experts of their own learning process. Fourth is the Smart-SMEAR emphasis on social interaction and shared cognition. It has been shown that working in small groups and talking about the cognitions enhances understanding [6]. Social interaction can consist of e.g. internet discussions and reading and commenting each other's texts.

The contextuality and constructiveness of Smart-SMEAR are based on the idea that by associating old and new knowledge in a meaningful way the student achieves true expert information, which is thoroughly understood and, thus, correct and reusable. The experiences have shown that students with very different backgrounds benefit from the usage of Smart-SMEAR. The tool was used as a part of teaching first time during an intensive field course given in spring 2007, and it was admitted an honourable mention in the University of Helsinki educational technology competition in 2007.

CASE: INTENSIVE FIELD COURSES

Intensive field courses are given by the University of Helsinki several times a year, and have proven to be of great interest to both students and researchers. The forms of working during intensive courses include lectures, exercise sessions, seminars, discussion sessions, field work as well as social activities. Very often the emphasis is placed on intensive work in small student groups. From the pedagogical point of view, the intensive courses often represent a form of problem-based learning (PBL; see e.g. [7]). This instructional strategy was adopted in order to emphasize the students' own responsibility of their learning process, with support from the instructor. The goals for the course are often set by the students in the beginning of the course, after a few introductory lectures. Teachers take the role of facilitators rather than lecturers. Collaborative learning is carried out throughout the courses. This allows for the social construction, sharing of information and cognition, and finally improves the metacognitive skills of the students, which, in turn, enhance self-directed learning skills. We have also noted that motivation and sociability is blossoming in these small groups, which allows the students to easily adopt the studied issues and open their minds for creative problem-solving.

Another pedagogically interesting fact has been the horizontal learning process during many of the courses and other training events. The participants of the events come from very different backgrounds and are specialized in very different topics. Thus, traditional "vertical" training courses have been out of question. Instead, horizontal learning has taken place, taking a broader approach, addressing a cross-section of knowledge from different fields and blending the information to reach new levels of understanding. As the goals of a course are typically commonly agreed in the beginning, the students working in small groups take the responsibility to find the best ways to reach these goals in a short time. Often the solution has been horizontal: students from different fields of study give small lectures to each other in the groups, and several times it has occurred that students wanted to present their ideas to the whole audience for a common discussion. This horizontal learning principle has been shown to be a good example of participatory action research.

The experiences on the courses have been very encouraging, both from the teachers' and students' points of view. Generally, students have given very positive feedback of the training in ABS, and we expect that our experiences allow us to further enhance the quality and innovativeness of teaching.

CASE: E-LEARNING

The internet provides an interesting, flexible and versatile learning environment that, at its best, motivates and inspires the students. E-learning frees the student from the requirements of time and space. In its own way it even enhances social interaction, although it is different from normal face-to-face interaction. The background for introducing e-learning courses was practical. Some teaching capacities could be released for additional courses, if the students could take certain courses remotely. Interaction in e-learning is three-fold: it is very much based on the student's own activity, but is still based on the student-instructor-material triangle. An e-learning course demands thorough preparation in order to succeed. The planning consists of at least evaluating the needs for the course, the future students, the learning outcomes, the choice of contents and pedagogical approaches, provision of the needed material to the students, arrangement of a personal support for students if they face problems during the course, and last but not least, planning the evaluation of the students after the course. E-learning courses also form an integral part of the student's curriculum, at both Master and Doctoral levels.

CONCLUSION

The chief goal of the joint programmes at the University of Helsinki is to educate a next generation of top-level scientists and experts with all the necessary multidisciplinary skills to tackle the future challenges of climate change, air quality matters and environmental technologies. The supra-disciplinary education will enable those experts to serve in different challenging positions in society and industry. Besides classical curriculum skills and knowledge, the education on the state-of-art measurement technologies (laboratory, ground-based and remote sensing) are emphasized. The master and doctoral programmes are an effort at a national level in advanced and comprehensive climate change research education with main focus on training of students in the field of atmospheric and biogeochemical sciences, covering phenomena from the nanoscale to the global level and from nanoseconds to centuries. The success of this effort is showcased by the 100% employment rate of doctoral students immediately following their graduation, as well as by the overwhelming majority of students finishing their degrees.

Special forms of teaching, namely intensive field courses and e-learning courses, can improve the learning compared to a traditional classroom course. Transferable skills can, and have also been successfully taught using these teaching forms. New technologies, such as Smart-SMEAR, can be used to support learning and students' inspiration.

The development of research-oriented joint programmes has not been without its challenges, and the improvement of these programmes is an utmost priority. In the past several years, the rapid internationalization of the research community has resulted in a few challenges both for students and the staff; however, the ABS Programme steadily continues to be dominated by foreign students, and the percentage of foreign doctoral students has also been increasing from 15% to 25% during the 2009-2010 period. Another challenge that remains to be solved is increasing the presence of industrial sector. Possible means for this include utilization of industry-related FiDiPro professors [8], and boosting the employment of the doctoral graduates by the industry by providing direct contacts between the students and industry representatives, and deepening collaboration between the programmes and industry.

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Interregional and Intergenerational Virtual Collaborative Teaching Using the Apple FaceTime App: The East L.A. to PA Project

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ABSTRACT

This paper examines the utility of engaging middle school students living in the inner city of East Los Angeles with undergraduate college students at a women's liberal arts college in Eastern Pennsylvania. This collaborative intergenerational and interregional research project involves social media and the use of the Apple app, FaceTime, as a method of experiential and virtual learning.

Keywords: Virtual Learning, Experiential Learning, Apps, Convergent Media, Intergenerational, Interregional, Virtual Classrooms

INTRODUCTION

Building healthy and strong relationships is powerful for middle school and college students. This paper examines the utility of engaging middle school students living in the inner city of East Los Angeles with undergraduate college students at a women's liberal arts college in Eastern Pennsylvania. This collaborative intergenerational and interregional research project involves social media and the use of the Apple app, FaceTime, as a method of experiential and virtual learning. The female undergraduate participants designed mentoring and communicative goals specialized to engage in dialogue with the middle school students through the technology of video chatting twice a week throughout the school year and to take ethnographic notes of their experiences.

Enrique Legaspi, the Hollenbeck Middle School history instructor and his students developed conversational and technological goals to discuss a variety of historical, regional, and cultural topics with the Cedar Crest College students. Hollenbeck Middle School is over a hundred years with old with decades of tradition and history. The population of its students is 98.4% Latino. The students at Hollenbeck reflect the generation of students who are digital natives and possess the need for classrooms to leverage technological access and resources to enhance media literacy and content expertise. The successes of the school are incredible as well as its failures, as it is a community that thrives on talented scholars who dream big and loud. It was important for the female college students to encourage the option of some day attending college as part of the middle school students' dreams.
Review of Literature

REVIEW OF LITERATURE

Creating pedagogical environments and projects where experiential learning moves the focus away from the professor or instructor and to the experiences of the students provides the students with active and thoughtful leadership roles [1]. Social media gives us many opportunities to be mobile, interactive, and convergent in our activities. In this project, the female college students interacted, mentored, and engaged in a bi-coastal, multicultural, intergenerational, and interregional communication research project with the Hollenbeck Middle School classroom on the West Coast. Experiential learning has been an important characteristic in education throughout history [2] and in present day, social media increases the opportunities of teachers linking pedagogy and projects that contribute to diverse communities and to society.

For both the Hollenbeck Middle School students and the women at Cedar Crest College, the goal of this research was to provide interregional access and an experiential learning environment where two classrooms that were very different in age, location, ethnicity, size, and gender collaborated with one another. Online environments have the ability to create "fluid boundaries" [3], where the idea of a virtual field trip to opposite sides of the U.S. gave students the authentic experiences to communicate, inspire, and build their networks with each other.

METHODS OF COLLABORATIVE VIRTUAL LEARNING

Intergenerational and interregional communication is an important form of communication research in studying and learning more about the wants, needs, and communication norms and habits of future generations of people. In the Cedar Crest College women's class the students watched a short CNN news clip about Hollenbeck Middle School's use of social media. The college students engaged in conversations with students of the ages 13-14 years old on a weekly basis. The women college's students were encouraged to mentor the middle school students about topics such as higher education, U.S. history, geographic locations, and their daily diets. They also provided them with information about living in the eastern region of the U.S., the history of Pennsylvania, and their personal interests.

Multicultural stories and leadership contribute to history and culture. Women and men play important roles as carriers and teachers of their cultures to the future generations. There is a focus on difference in history between genders and the women's college students were enthusiastic to share their experiences with the middle school students. The ability to communicate life and cultural experiences on gender, ethnicity, and social class was empowering for both the women's college students and the middle school students [4].

DISCUSSION

Both participants from the west coast and east coast reported personal benefits from engaging in the intergenerational and interregional pedagogical and virtual projects such as an increase in communication, technology, cultural knowledge, and social skills. The process and focus of students from the middle school and the college reflecting of their experiences was a significant benefit of the experiential and virtual learning. Through this project the students increased their knowledge and use of social media to understand the importance of their digital responsibilities to each other. The students also developed their inter-classroom experiences to learn and view the different lifestyles, diets, and cultures in the different regions of the U.S. Because of their interregional and intergenerational communication, their inquiries of U.S.

history, geography, and technology has advanced and become more meaningful.

Students from both the college and the middle school displayed an improvement in classroom attendance because they looked forward to the biweekly conversations with the students at each school. Last but not least, the students at the middle school's coursework was connected to Pennsylvania, a state that is rich in history and making it applicable for the students to learn more about U.S. history and the events that shaped our nation.

Online environments create many opportunities for its users [5] and media literacy and power influence one another [6] The process of reflection in experiential learning makes students accountable for the interactions and the decisions they made during the research process [7]. The students at the women's college reflected on some of the challenges they faced, ranging from technical issues to age and cultural differences. The majority of the students at the college found the experience of talking to middle school students in Los Angeles to be very rewarding. As one of the female college students said:

> "The FaceTime project is my favorite. It's not only about mentoring but using the technology to reach people all across the country…It's great to be able to give them information and I really enjoy it and think it's a good experience."

This collaborative teaching and research project aims to provide an example of applying the intersections of generation, region, and technology into a dual classroom where students of various backgrounds, ages, and locations can take place. The virtual collaboration LA2PA project gave students online experience in bi-coastal networking, helped them builds skills using technology, and more importantly, it gave students an authentic experience to build their language and knowledge to with others outside of their local cities and age groups. The students were excited to learn about the world and adventures happening in the classrooms using technology. Going beyond the boundaries of classroom walls and using virtual technology enables students to gain more worldly experiences where they can interact with people outside of their location, city, state, and age group.

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Research, Teaching and Industrial Problem Solving Activities in the Field of Production Information Engineering at the University of Miskolc, Hungary

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ABSTRACT

In the last 150 years a rapid progress and several big paradigm-changes have happened in the field of technical sciences. Information Science (IS) has a great impact on today's industrial practice. IS is not only a special branch of sciences considering that the principles, means and methods of information acquisition, processing and transfer are indispensable for every engineer, moreover, for our society as a whole. Today's richness of IS has derived from the enormous area of applications (applied informatics, Information Technology (IT), Information Engineering (IE)). In mechanical engineers' training, Production Information Engineering (IT for Manufacturing) has a key role. These aspects justified the foundation of the Department of Information Engineering at the University of Miskolc. The subjects of IE have already appeared in BSc, MSc and PhD education. Applied informatics has facilitated the introduction and education of engineering systems approach. In the new approach IT has played the most important role because complex, large systems can neither be planned nor be controlled without IT. The demands of industrial enterprises in this field have permitted a consortium-based cooperation of universities, research institutes and enterprises. The paper gives a summary on the results of R&D works connected with an industrial project realized.

Keywords: Application Software, Information Engineering, Production Information Engineering, IT for Manufacturing, Systems Engineering, Digital Factory, Cooperative Production.

INTRODUCTION

In the course of the last 150 years an extremely rapid progress and several big paradigm-changes have happened in the field of technical sciences [1]. In the twenties of the last century the rapid advance of processing industry was established by the activities of *Ford* and *Taylor*, the creators of "mass production" paradigm. The development of automotive industry has been based on this paradigm up to now (*The machine that changed the world* [2]). In the sixties, "automation" paradigm resulted in an unprecedented increase of the productivity of machine tools and manufacturing systems (*Programmable Automation* [3]). The high production performance of technological capacities operating in global economy at present, can be considered as a consequence of this paradigm.

The development of Information Science has the greatest impact on today's industrial practice, on technology in a wider sense and on numerous other areas of society as well. The "digital factory" paradigm, within the framework of several consequent waves, has transformed the entire internal structure of enterprises. It is interesting to recognize that this process has been carried out in a "bottom-up" way. It started with process control digitization (NC, CNC, PLC), then it has continued with digitizing engineering design and planning (CAD/CAM). The top level is the digitization of several enterprise management activities (MRP, ERP, SCM) [4].

In the seventies of the last century, it became clear at technical universities that Information Science required not only separate specialized engineer training (i.e. IT-oriented engineer branch), considering that the principles, means and methods of information acquisition, processing and transfer were indispensable for all kinds of engineers. This recognition resulted in the requirement that it was expedient to establish departments of Information Science, similarly to Mathematics, not only in the faculties of Electrical and Electronic Engineering but at all technical universities.

The two keystones of Information Science are Information Theory and Computer Science, but its richness originates in the wide range of applications built on these bases (see: Fig.1.). These applications represent interdisciplinary fields, where the laws of the systems and processes specific to the given domain (Information Technology, IT) exist together with the laws, methods and tools of applied informatics (Information Engineering, IE). This branch includes computer aided design, planning, organizational, decision making and controlling methods and means using computer tools and applications for defining and solving technical problems.

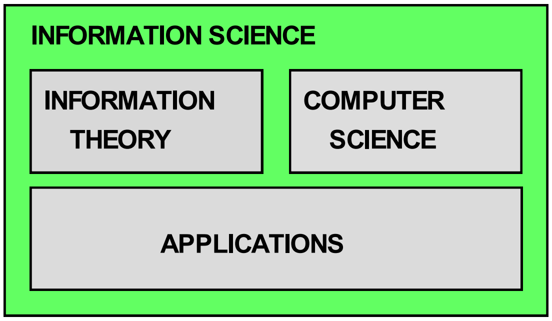

Fig. 1. The main fields of Information Science

The huge quantity of new information can only be used for the members and organizations of the society by means of computer applications. It is known for everybody how and to what extent the role and importance of computer applications, which were implemented in many millions of copies and run every day (e.g.: Explorer, Word, Excell, Power Point or MatLab, AutoCAD, SAP R/3) have been increasing. The development of applications has a special, unique technology, in which platform definition, software engineering and program coding appear only in the second phase of creating the software-product. There is a previous phase, in which

- the conception of application,
- the content and form of input and output,
- the internal model of information processing,
- the method, algorithm, accuracy and validity of problem solution,
- a user-friendly man-machine interface (HMI with graphical display, visualization), and
- the design of application level protocol for machine-machine network communication (Application Program Interface, API)

are the tasks to be elaborated.

It is obvious that the professional users of applications have to know more than the source language of the software and/or the features of the hardware platform. Nowadays there is a special information technology for hiding the latter from the users ("virtualization", cloud technology [5]).

APPLIED INFORMATICS, PRODUCTION INFORMATION ENGINEERING

Faculties and branches of Information Science, Engineering and Technology have special stories in the life of universities. In Hungary, after a long development process, Information Science became an independent branch of science in the early seventies. It can be originated in two main sources: Electrical and Electronic Engineering and Computational Science as a branch of Mathematics. In the process when Information Science has become independent, Systems Theory also played an important role. The third aspect of the development in Information Science is related to application systems where the specifications of the fields of application come to the front line.

In engineers' training and in engineering practice an applied informatics branch has become of great significance, which is named as Production Information Engineering (or: IT for Manufacturing). This branch includes computer aided planning, organizational, decision making and controlling methods and means using computer tools and applications for defining and solving technical problems.

The multilevel (multilayer) and concurrent technical systems of today's modern enterprises (cooperating with the financial, economic and business systems) can not dispense with these tools any more if they want to be competitive in global economy [6].

These considerations motivated the establishment and development of the departments of applied informatics at the Hungarian universities. In conformity with this motivation, Department of Information Engineering was established at the University of Miskolc in 1995. Computer application programs stand in the centre of the activity of the Department. Their development and effective use are of primary importance for industrial practice.

According to the conception suggested by the Department, Production Information Engineering is the field of science of the IT-based methods, procedures and means suitable for planning (analysis and synthesis), organizing and controlling industrial processes.

The scope of the branch is extremely complex and far-reaching [7]. On the one hand, the specific properties of production systems and processes require IT-tools differing from one another to a certain extent (think of the different properties of discrete and continuous technology processes). On the other hand, different IT-applications are required by the rich functional subsystem set of production systems. At last, special application methods have been elaborated for Production Information Engineering using the most general IT-technologies (shared systems, data base handling, artificial intelligence methods, etc) (see: Fig.2.).

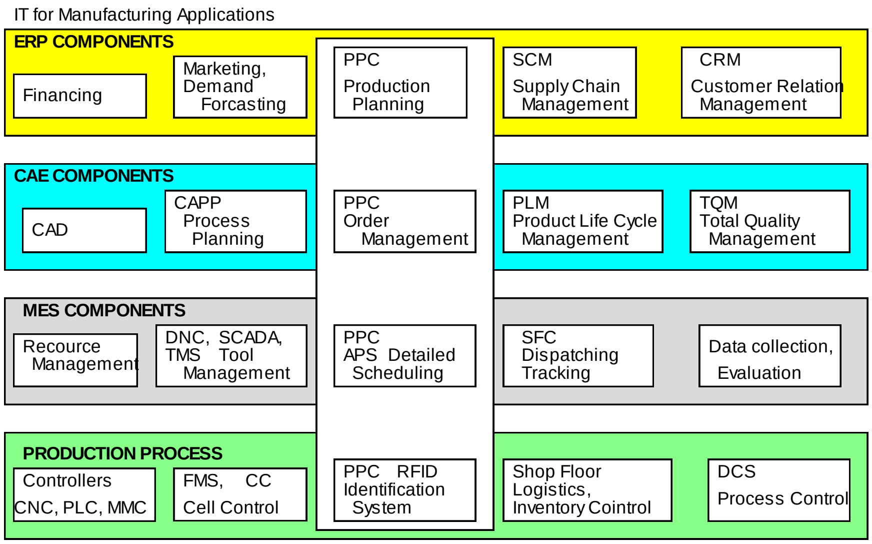

Fig. 2. IT for manufacturing applications

In the focus of research, teaching and industrial (technical problem solving) work are the following:

- system and data models, their structures and modeling methods;
- ontological analyses, conceptual and object-oriented approach;
- application of standards in informatics;
- connecting integrating and synchronizing systems;
- practical application of the paradigms of "Digital enterprise" and "Virtual enterprise".

The most important academic subjects of IT for manufacturing, which are present in the BSc, MSc and PhD trainings at the University of Miskolc are as follows:

- Production systems and processes,
- Operations Research and Mathematical Programming,
- Modeling of production processes,
- Elements of Artificial Intelligence,
- Logistic systems and Supply Chain Management,
- Production Planning and Control,
- Computer Aided Manufacturing,
- Computer Aided Quality Assurance,
- Computer Integrated manufacturing (CIM),
- Virtual Enterprise.

SYSTEMS ENGINEERING APPROACH

Applied informatics has enabled the introduction of a more general and important discipline and approach in engineers' training. This branch is called Systems Engineering (SE) in the literature. This includes all the specific knowledge that characterize the whole complex technical (engineering) system during its planning, implementation and operation. Nowadays, being an expert of technical systems means not only to be a "system engineer" or "system administrator", because this latter refers mainly to a specialist of introducing (installing) and servicing systems. In this new approach, the professional knowledge of a "system engineer" is the result of the technical scientific progress occurred in the last 25 years with the establishment of large complex technical systems. In this process IT has played the most important role, because these systems can neither be planned nor be controlled without IT. In today's industrial practice the expert support of controlling large systems generally means IT management service.

The two basic fields of SE are:

- structure and dynamics of technical or socio-technical systems,
- structure and operation of information systems.

The first branch deals with the theory, build-up, processes, temporal behaviour and energy management of the most fundamental general and specific technical systems. The second branch is concerned with the theory, means and methods of integrating systems, with special regard to IT infrastructure.

Manufacturing Technology based on discrete parts and assembly is one of the leading technologies in industrial practice and its position seems to be immutable. In mechanical engineering practice production systems, logistic systems, energetic systems, transport systems are good examples of systems approach for engineering applications. At the University of Miskolc the Information Engineering program had formed from a Mechanical Engineering background in the nineties. It was clear from the beginning that the students of Information Engineering program should attain a special IT knowledge in such a way that special application fields suitable for testing their current expertise should be available already in the course of their undergraduate period (see: Fig.3.).

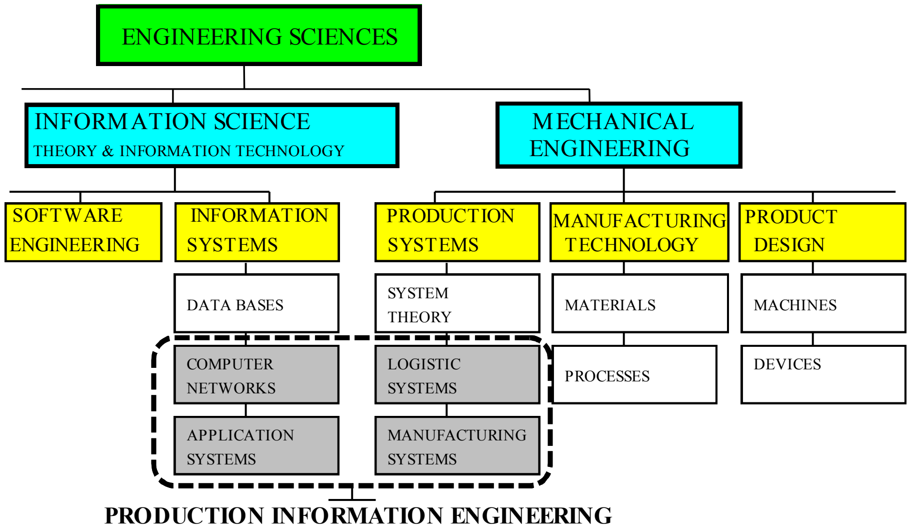

Fig. 3. System engineering approach for Production Information Engineering

At the Faculty of Mechanical Engineering there were many departments which used and taught applications connected with Information Sciences. This was the basis of the complex planning work of Information Engineering students. Joining to this process at the Department of Information Engineering of the University of Miskolc we have taught and studied Production Information Engineering for several years, which field fits into the line of Systems Engineering to a great extent [8], [9].

R&D TASKS, THE PERFORMANCE OF PRODUCTION SYSTEMS

In the last few years several industrial development tasks have been presented for the Department of Information Engineering which permitted the application of the theoretical results and the improvement of the education of students.

Production Information Engineering has obtained a key role in an interesting and important application area, in the field of performance evaluation of production systems. In Hungary, the demand of the industrial companies has made the consortium-based cooperation of universities, research institutes and companies possible in this area [10].

Production performance can fundamentally be measured on the basis of the quantity and quality indices of the products manufactured, but this should be complemented by keeping the customers' terms of delivery, by minimizing the stock levels, and by maximizing the capacity of machine- and labor force. In addition to the demand for measuring performance, there is a continuous need for improving production scheduling which makes the analysis and synthesis of dynamic production models necessary. However, the models proposed in the literature are not in all cases able to satisfy the ever-growing requirements to the extent desired [11].

Last year, a large-scale industrial development project series connected to an actual industrial demand and led by the Production and Business Intelligence Research Laboratory of the Computer and Automation Research Institute of the Hungarian Academy of Sciences was closed successfully. These projects are connected to factories of Hungarian and multinational companies which are operating according to the principles of Customized Mass Production (CMP). Their production is characterized by a wide variety of products, but the demand for the products is highly fluctuating and is therefore hard to predict. In order to keep their market positions the customers' (great shopping centers') terms of delivery (e.g. product parameters, ways of packaging, deadlines for delivery) should strictly be fulfilled. Accordingly, customer-centered production policy has become vitally important at these companies, which makes the measurement of production performance and the integration of multilevel production planning and control indispensable.

For handling the tasks appeared, new model classes have been defined by the researchers which are appropriate for the solution of extended flexible flow shop (EFFS) problems, and their computer representations have been developed as well [12]. The new model representations enable the consideration of the parameters and requirements of customized mass production even in the case of higher technological and management demands.

The integrated method of this new approach supports the decisions on combining and/or dividing the orders, on the dynamic determination of production lot sizes, on handling technological alternatives, on positioning machine resources, on specifying production tasks and on scheduling their accomplishment. The solving algorithm of the method, beside using initial heuristics and search techniques, applies problem-space transformation based on discrete event type simulation. A new mathematical model and solution technique have been developed by the researchers for the joint manipulation of objective functions and for quantifying the quality of the solutions allowed. The method can also be utilized in other multi-objective combinatorial optimization tasks with different structure, where the objective functions have dynamically changing importance, differing dimensions and co-domains.

Depending on the effects of unexpected events on the production performance indices, various re-scheduling procedures can also be used. There exist conservative, time-shifted, partial, parametric and full re-scheduling. Conservative re-scheduling aims at minimizing the number of set-ups. In the case of time-shifted re-scheduling only the time of completing certain tasks or jobs are modified without changing the resources and lot sizes assigned to them. In partial re-scheduling only the jobs directly concerned are modified. In this case the intervention has a smaller impact on the resources. By parametric re-scheduling the rates and paths may be changed. Full re-scheduling serves for creating a totally new, realizable schedule.

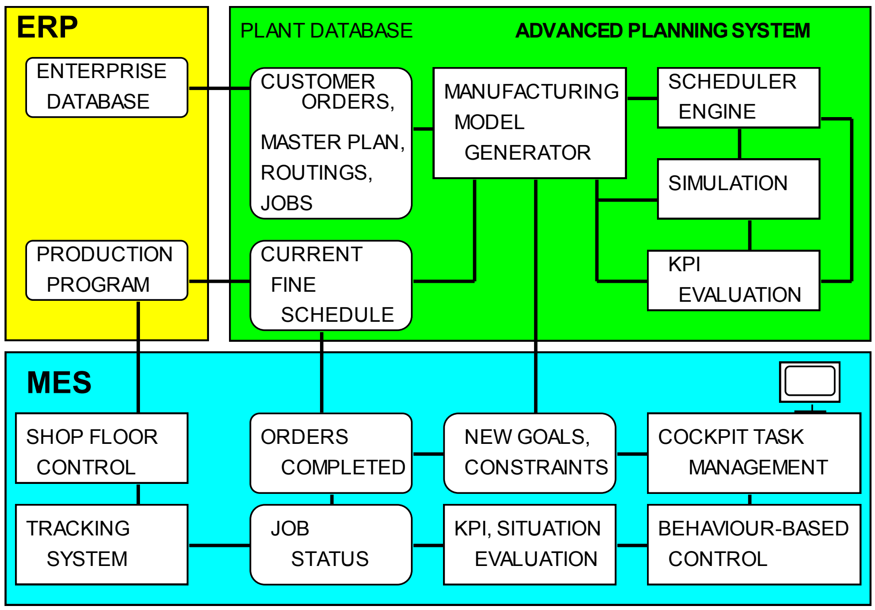

Fig 4. Integrated scheduling and res-cheduling system

During the course of the research the optimization of the component-based stock management policy of the suppliers has also been investigated. The task has been interpreted as a nonlinear optimization problem and the analytic solution of a multi-period model has been developed. By introducing the concept of specific stocking cost, a new heuristic solution has been proposed for determining the number of periods of parallel production on a production time horizon with arbitrary length. The bases for handling models with multiple products and resource limitations have also been developed. The results of the simulations show that the computational time complexity of the method is low enough to be applicable for decision support and for testing different strategies and decision alternatives [13].

CONCLUSIONS

Nowadays Information Science has the greatest impact on engineering, on industrial practice and on technology in a wider sense, and also on several other fields of our society. In the seventies of the last century, it became clear at technical universities that Information Science required not only separate specialized engineer training, considering that the principles, tools and methods of information acquisition, processing, visualizing and sharing by network were indispensable for all kinds of engineers.

The two fundamental fields of Information Science are Information Theory and Computer Science, but its richness originates in the wide range of applications built on these bases. These applications represent interdisciplinary fields, where the laws of the systems and processes specific to the given domain (Information Technology, IT) exist together with the laws, methods and tools of applied informatics (Information Engineering, IE).

Application programs stand in the centre of the activity of the Information Engineering Department at the University of Miskolc, Hungary. Effective use of application is of primary importance for Hungarian industrial practice, too. In the focus of research, teaching and industrial (technical problem solving) works are the following:

- system and data models, their structures and modelling methods;
- ontological analyses, conceptual and object-oriented approach;
- application of standards in application design;
- connecting, integrating and synchronizing applications to information systems;
- practical application of management paradigms: “Digital enterprise” “Cooperative production” and “Virtual enterprise”.

The projects demonstrate the efforts that agile enterprises in Hungary have to make in the competitive global market in order to achieve the strategic goals in planning and control of the production systems and processes. These tasks, in the majority of the cases, can only be solved by means of a new approach, new models and new software applications of information engineering and technology.

ACKNOWLEDGEMENTS

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Learning Together with Entrepreneurs - Description of a Project-Based Learning Process

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Abstract. This article describes a learning process between students, teachers, entrepreneurs and partners based on the output of the first year students in HAAGA-HELIA University of Applied Sciences, Porvoo unit. The students carried out a research project which gave students opportunities to learn the business processes of the local small and medium sized companies. The project provided extensive hands-on material for further use for the students and the researchers and trained the team working and project management skills of the students. The research was the base for a further co-operation with the companies in the field of business developing tasks. This article consists of the following parts: the inquiry-based learning method, the progress of the project, the research questions, the main results of the interviews, the beneficiaries and the benefits of the project, and conclusions.

Keywords: Inquiry-based learning, life-cycle curve, SME's, shared expertise, regional development

1 Introduction

This article describes a learning process between students, teachers, entrepreneurs and partners based on the output of the first year students in HAAGA-HELIA University of Applied Sciences, Porvoo unit. The main reason to the research project was to implement the new curriculum that is based on inquiry-based learning method. In addition the research was designed so, that it can be repeated annually in order to collect material for an extensive company life-cycle curve research. Added to this the results of the survey can serve the local entrepreneurs in their developing work as well as giving information to the public sector organizations. The aims of the research were:

- to give opportunity for the first year students to make aqcuaintance with the business processes of the local small and medium size companies,
- to train students team working and project managerial skills,
- to provide hands-on material for student's further use,
- to serve local partners in cooperation.

According to the Finnish Polytechnics Act (2003/351) the mission of the polytechnics is to provide higher education based on the requirements of working life and its development, to support the professional growth of individuals, and to carry out applied research and development that serves polytechnic education, to support the world of work and regional development taking the industrial structure of the region into account. In executing these tasks, polytechnics shall promote lifelong learning. In carrying out its mission, polytechnics shall cooperate with business and industry and other sectors of the labor market, in particular within its own region, and cooperate with Finnish and foreign higher education institutions and other educational establishments.

HAAGA-HELIA renewed the curricula during 2007-2010 in order to meet the requirements of the new strategy. The main points of the new HAAGA-HELIA strategy are:

- Pedagogic strategy - learning together with the working life
- Research, development and innovation strategy – reformation of business operations
- Service, salesmanship and entrepreneurship strategy – reformer of service and sale
- Internationalization strategy - strengthening competitiveness together with selected partners
- Know-how strategy – proactive working life skills

The new curriculum of HAAGA-HELIA Porvoo unit emphasizes inquiry - based learning method. Porvoo campus is considerably small having approximately 1000 students (HAAGA-HELIA in total 10000 students) and it is therefore agile and swift in adopting new methods.

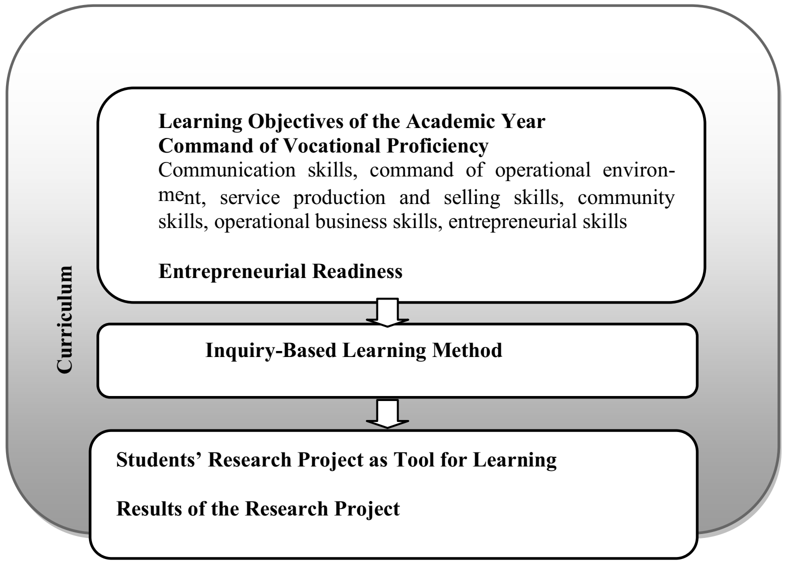

Fig 1 Strategy, Curriculum, Learning Objectives, Method, Tools and Results

Porvoo town is situated close to the Helsinki metropolitan area, in the middle of Eastern Uusimaa region with the biggest centre of oil refining and petrochemical industries in the Nordic Countries and a nuclear power plant. In spite of the small size of the region (90000 inhabitants) and Porvoo town (50000 inhabitants) the business life is active and buoyant. The industrial giants attract subcontractors and increase the business possibilities. The limited size of the economic area enables easy networking between HAAGA-HELIA Porvoo unit, entrepreneurs and public sector organizations.

2 The Inquiry-Based Learning Method

According to Hakkarainen, Lonka and Lipponen (2004) the inquiry learning process can be divided into different core components. The process is shared between various players, and after the process the players share the experiences and findings, they share the expertise.

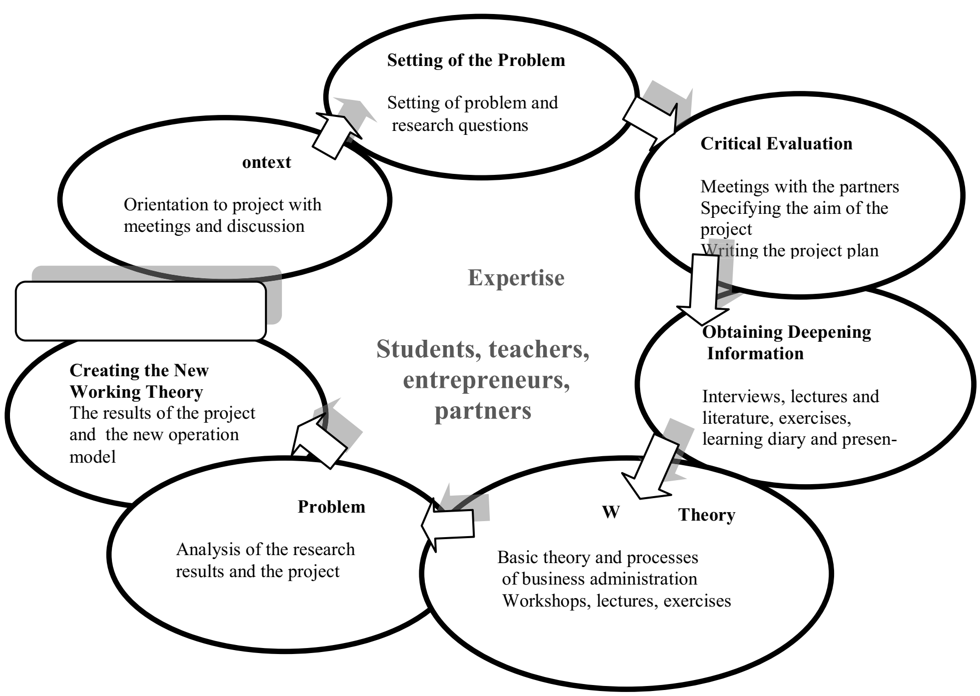

Fig 2 Inquiry-Based Learning Method

In order to apply the inquiry-based learning method in addition to the theoretical business studies, the teachers created a project for the first year students, during which the students interviewed local entrepreneurs, collected data and processed and analyzed it. The main aims of the project were to give students opportunities to learn the business processes of the local small and medium sized companies. The project also provided extensive hands-on material for further use and trained team working and project management skills. The project provided relevant information for two public sector partners in cooperation, municipal development company Posintra Oy, which was interested in how well the entrepreneurs knew about the supply of the public services and the sources of public funding. Employment and Economic Development Office was mainly interested in knowing the need for recruitment as well as the need for further training of the staff in the companies.

3 The Progress of the Inquiry-Based Learning Project

The autumn term 2010 started with traditional basic courses in business administration, communication, economics, business law and ICT. The students participated in lectures, exercises and exams. At the same time the students, teachers and partners in cooperation orientated to the research project by defining its aims, tools and research questions.

The size of the group, 72 students, was challenging. The students were divided in teams of 3 - 4 persons, and each student was responsible for finding one company for the interview. The companies were mainly found in the list provided by Posintra Oy. The whole team discussed with each entrepreneur and the team members were acting by turns as chair person and as secretary, who filled in the questionnaire. The rest of the team filled in the observation form.

The quantitative research method was chosen in order to secure the reliability of the result, and it also served the ICT learning best. The students pondered the research questions in details according to the theories they had just learned. The structure of multiple choice questions turned out to be very difficult, and finally the teacher team finished the questionnaire, which was commented by the partners and tested by the students in interview exercises. In the end of October the questionnaire with 82 questions was printed out and the teams started working.

After some difficulties and with the help of the teachers each team succeeded in finding suitable companies and in the end of November the teams recorded information in Excel. After that students analyzed the data and started to write comparison reports of the companies. The reports adhered to the structure of the questionnaire and included both SWOT and PESTEL analyses. In December the teams were gathered in a seminar where they held presentations and compared the findings. During the spring term 2011 students continued analyzing the data whilst their ICT skills improved. In May 2011 the final results such as frequencies and cross tabulations were presented to the entrepreneurs, partners and the media.

It is worth of mentioning that during the research project the students continued with their theoretical business studies as usual. In spring term the students carried on with their work with the entrepreneurs by preparing marketing plans for selected companies, and in autumn term 2011 they will write internationalization plans for some of the companies.

The teacher team continues the work on the data. The amount of the year 2010 observations is huge: 72 entrepreneurs answered 82 questions, of which 57 were multiple-choice questions and 25 open ones, in order to help students to create comfortable discussion.

There are plans for the future that during next 3 - 4 years the first year students will interview new entrepreneurs in order to collect enough material for statistical conclusions of the life-cycle curve of the companies.

3.1 Research Problem and Research Questions

The research problem of the students' learning project was formulated as follows: What kind of businesses there are in Eastern Uusimaa region and what kind of differences and/or similarities do the companies have during different stages on the corporate life-cycle curve and in different industries?

Research questions were phrased in following way:

- How do the companies perceive their future, the growth of demand and competition?
- How does the development of national economy affect a company's everyday life?
- What is the impact of political, institutional and social environments on the companies?
- Do the companies need more work force?
- What is the level of know-how in the company: Does the entrepreneur or the staff need any additional training?
- Do the entrepreneurs need coaching?
- To what extent are public funding and public services used?
- How do the entrepreneurs perceive the status of entrepreneurship in Finland?

The life-cycle research continues until year 2015. The (annual) themes and questions for research are;

Growth of the company,

Labor => do the company need more labor and how to find the requisite
labor?

Learning => what are future skills needed for the company?

Finance => how to finance companies investments?

Investments => what kind of investments are needed?

The research problem in the long run is to find out what kind of problems companies meet in different stages of their life-cycle and how they see the next stage in the companies life-cycle curve according to themes for the research.

3.2 Results of the Students' Research Project

Reliability and validity are the most important qualities of the instrument. Reliability is the consistency and the repeatability of the measurement, or the degree to which an instrument measures the same way each time it is used under the same condition with the same subjects. In this research the questionnaire was detailed and well defined, so that even the first year students were able to interview the entrepreneurs and to make notes. The partners, as experts, actively took part in the formulation of the questionnaire and it was tested several times by the students and the teacher team. The big number of interviewers may have affected the reliability, but the teacher team was aware of this risk and controlled closely the process, and even contacted some of the entrepreneurs afterwards. Validity is the strength of the conclusions, inferences or propositions. In our case, the questionnaire was strictly based on the business processes and the questions of the partners' were answered.

Most of the interviewees were the entrepreneurs themselves. The majority of the companies had turnover less than one million Euros and less than ten employees. The age distribution of companies was considerably even, 21 companies were under four-year-old, whereas 22 companies were more than 20 years old. The market area of the companies was mostly local. The two most common branches were trade and welfare sector.

Most of the entrepreneurs considered the demand of their services and products good and the majority believed that both the demand and the turnover will grow in next 2-3 years.

The competitive position was considered to be good, although it was expected that the competition stepped up. The worst competitors were the local companies in the same field. The strength of the company was generally the client service, good quality, good products and suitable business location.

In the opinion of most entrepreneurs, the local politics had effect mainly in form of the taxes and in town planning. State politics and EU regulations had effect, too, e.g. alcohol locks in buses and in taxis.

More than half of the entrepreneurs answered that the lack of competent workforce has negative effect on the company's growth. New employees were mainly recruited on the basis of recommendations.

The employees needed training mostly in sales, marketing, customer service and information technology. Training was also needed in service production and service development. Entrepreneurs themselves needed coaching in sale and in marketing, ICT and in the use of the social media. Coaching was sought in most cases from the consultants, but one third of the entrepreneurs suffered from the lack of time. Most of the entrepreneurs were familiar with the public services and public funding, but they did not use them.

Most of the entrepreneurs felt that becoming an entrepreneur was easy and that the society offers enough of advice and service. Increasing the output and size of the company was considered difficult. Also the roles of the employer and the leader were seen as difficult and demanding. Very positive signal was that only one of the 72 entrepreneurs contemplated closing down the business in nearest future.

There were significant differences between men and women when comparing the attitudes towards entrepreneurship and the development plans as well as the growth of the companies. Men were willing to take more risks and to grow faster, while women were more careful in running the business.

4 Conclusions

The benefits of this research project can be divided in two parts: The benefits inside HAAGA-HELIA Porvoo unit and in Eastern Uusimaa region among the companies and partners in cooperation.

Inside HAAGA-HELIA the students were the major beneficiaries of the project. While visiting the companies the students observed the everyday life in the companies. In parallel with the interviews the students had great opportunity to train their skills in project management, team working and in self management. They also could compare the theories of business administration, economics and business law to the practice in small and medium sized companies. The students used their fresh communication knowledge when contacting the entrepreneurs and writing the comparison reports. They learned how to find information and how to master the MS-Office programs. The idea was not to train the students to become researchers, but during the project they familiarized themselves with the structure and management of a survey and learned to interview and observe. Event management was practiced, when the students organized an informative meeting to the media, partners and entrepreneurs. Motivation to business studies was high as the theory and practice were combined in the process. The collected material is so extensive, that it can be collated in final theses by the third year students.

The teacher team met new challenges due to the size of the group and consequently more attention had to be paid to management and control, and the teachers' leadership skills were tested. The new teaching method was interesting and the teachers found rational reasons for deeper cooperation and team working. The project itself gives potential for a long-span and productive cooperation with the local entrepreneurs, too. Thirty eight of the seventy two interviewed companies wanted to continue cooperation with Haaga-Helia in the form of developing work and during the spring semester 2011 a marketing plan was made for six companies. In the autumn semester 2011 the cooperation continues with some of the companies and the students are making developing projects both in internationalization and in financial accounting.

HAAGA-HELIA Porvoo unit could through the project fulfill the obligation given in the Polytechnics Act. At the same time the main issue in the HAAGA-HELIA strategy, learning together with the working world, was fulfilled. Also the demand of shared expertise was met and the aims of the first academic year were attained.

The partners in cooperation, Posintra Oy and Employment and Economic Development Office, received up-to-date information from the topics that are important at the present moment. The occupying questions were answered, like how the entrepreneur feel about the use of social media, how much they use governmental and municipal consultation services and do the companies need financing for investments or for developing the operations. The voice of the entrepreneurs was clearly heard in the results and thereby the partners can develop their services to meet the needs of the entrepreneurs in a better and more efficient way.

At the interviews the entrepreneurs in Eastern Uusimaa had the opportunity to contact students, future potential employees, directly. The entrepreneurs were content with the chance of sharing their experiences with keen young listeners and with the opportunity to tell their thoughts of the highlights and mishaps of the entrepreneurship. The majority of the respondents appreciated the contact from the school and would find it easier to turn to the teachers and students in their future projects. By means of the results the entrepreneurs can compare and contrast their own business situation with the others. Even 38 companies answered, that they are willing to cooperate with HAAGA-HELIA in the future, too, and during the spring semester 2011 students prepared six marketing plans for the companies.

The officially approved strategy of HAAGA-HELIA defines the operational framework, but in practice the teacher team was obliged to plan and define the new process and the structure to implement the strategy. Also, a special attention has been paid to integrate the general learning goals of the BBA program, including both generic competencies, professional skills and the project goal to meaningful entities. In addition teacher's work has been changed from the role of independent actor to the role of team worker. The project has been designed for serving the partners, and in the long run, also the local entrepreneurs. However, the most important outcome of the project was the broadened experience of the students.

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Collaboration between Industrial Computing and the Final Integration Project Courses of a Degree in Electromechanical Engineer with specialty in Industrial Automation, to gain competences in HMI/SCADA Systems

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***Abstract*— This work is intended to show how the Industrial Computing Course, part of the second cycle of Electromechanical Engineering oriented in Automation curricula, can collaborate with the Final Integrator Project, in order to allow students to gain competences on the design, deployment and start up of automated electromechanical systems, including the development of a Human Machine Interface (HMI). This HMI not only acts as the project presentation, but also allows executing the trial showing how the batch evolution is being done, reporting any event or alarm that might be summarized, and saving historical records of any measurable magnitude for off line analysis. On that purpose a local application simulation of a generic standard batch process was developed, including Temperature Control, Flow Computing, Level Indication and Control, Valves, Pumps and other field devices,.**

***Index Terms*—Programmable Logic Controller, Supervisory Control And Data Acquisition, Human Machine Interface, Remote Web Server,**

I. INTRODUCTION

Standard Industrial Automation and Process Control teaching approaches are in general terms more oriented to theoretical concepts, and the gap between how things are being done in the real world and how students are learning those concepts to apply them later, is normally very wide.

On that purpose, to bridge the gap between those instances, we developed a program that consists in building a Process Control Simulation Model that could be used to demonstrate general behavior of instruments, pumps, valves, sensors and actuators, involved in a classic thermal process (heating and cooling water that can be used in another reactive process).

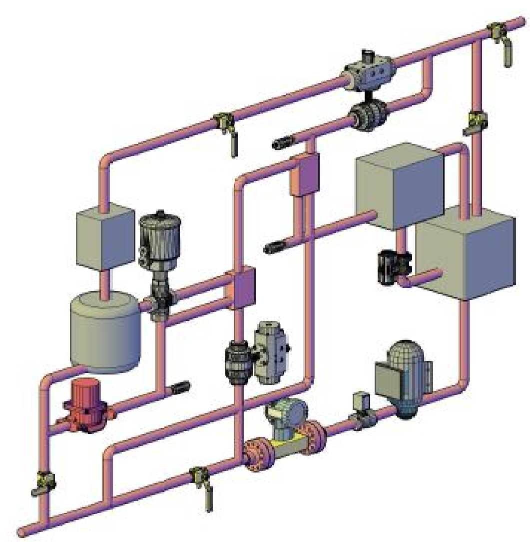

Figure 1. Process Model as it looks in a 3D picture

Figure 2
Pilot Plant – Rear View

In order to apply Factory Automation to a Standard Instrumented Process, all the necessary equipment was intentionally defined to support Input and Output Interaction with Programmable Logic Controllers (PLC), industrial communication protocols, Field Buses, local human Machine Interfaces (HMI), local and remote Supervisory Control And Data Acquisition Systems, and Intranet and Extranet Services, to provide full access from everywhere.

As the Industrial Computing Course takes place in a single semester, it cannot handle by itself developing a complete SCADA interface. On the other hand, the requirements and the necessary data to build this interface are often very specific to be treated as an in class experience. So, as most of the Final Integration Projects can handle a sort of Supervisory System, then it is mandatory for this project to include a standard HMI/SCADA interface, as a way to present all the related Project information in a condensed way, over a PC screen. Then, over this PC screen the students will have to demonstrate not only that the test is being done in a proper way, but also to get the right information and reports from the application, to strengthen its presentation..

II. CLASSIC APPROACH

The standard way to develop PLC and SCADA programs is to create algorithms, sequences and graphic interfaces, based on specific process documentation that try to explain how the process needs to behave, by the use of standard representations and symbology over drawings, tables and diagrams, supported by written documents that explain in words what is supposed to be done by a Factory Automation Engineering Team.

The way to try and demonstrate that sequences, loops, graphics and alarms are being programmed as expected, without needing to connect to thereal process, is by using

Figure 3
Pilot Plant: Side View

some standard programs called ¨simulators¨, that have the ability to interact directly with the PLC Programming software providing ¨reactions¨ to the actions ordered by the Graphic or Manual Interface, replacing the information that would be provided by analog and digital process variables.

Simulation is very useful, but the main problem is to recreate all the conditions that the system would experiment, in order to have a real response, and a reliable model that helps to understand the process behavior.

On the other hand, simulations are only software pieces, portables, that allow students to analyze the process behavior without being connected to the real variables just beside the pumps, valves and instruments. This is a very flexible and costless way to study process models, but oftenly there is an undetermined extra modeling job, because you need to presuposse process behaviors and reactions, without having seen the real process running in the real world.

So, it is better to have a real model running and connected to Supervisory Control and Data Acquisition applications, in order to analyze the real process behavior, to understand how to apply control algorithms. On this way, students learn from the real processes how variables evolve when applying Control Algorithms. Only after this experience, with the addition of math modeling algortihms, the they can develop simulated process behaviors, to recreate normal process reactions.

But process evolution in some cases take long time to complete a batch, and statistics must be taken from a large series of samples, so student groups must spend many time beside the process in order to get the right information from it.

III. Remote Supervisory Systems

When processes are very long, or, for many reasons, it is not possible to stop the process when it is unattended (continuous processes), Modern Process Control provides today a complete set of different options in order to remotely supervise and control batch and continuous processes, leaving only a few operators for emergency purposes and special issues. Here we show a few of these options

- Remote Alarm and Event System
- Remote Process Information System
- Remote Process Control System

In the first kind of systems, a selected group of Plant people receives through special devices alarm and event data. Those devices includes beepers, mobile phones, PDAs, portable and home computers. If a crytical or important alarm and event occurs, a dedicated system generates a broadcast or single oriented message containing the information about the variable, the kind of alarm, and the corrective action to be taken (some of these systems allow also to interact with certain process variables, directly from the receiving device, by clicking a combination of keystrokes or functions, like a self banking system, for example).

The second Group allow the key people to receive complete Process Information in a text or tabular format at the client user request, or in ashift period basis. This kind of remote connection has the same functionality than a printed report, but in a remote way, because the report is ususally being sent to selected people e-mail addresses, with the formatted report printed over the mail body or as an attachment, or as a periodical advice with an hyperlink related to a web address in HTML or FTP formats, either for on line reporting, or a file server ready for downloading, indexed by specific date or kind of report.

This kind of connection can also be used as an ¨on demand¨ information application that can be consulted on a regular basis, and allowing also viewing the last logged report or all the available list of generated reports, but also prepared to generate a new report at any time.

The third kind of remote client application is the real Time one, in where the remote user can interact with a remote application, that might be identical to the local one, but through the use of Internet thin clients, and publishing dynamic XML pages originated in each local SCADA applicaton Screens. Some standard SCADA packages offers Web enabled software that can be purchased as an add-on that gives to the standard SCADA application the ability to be published on a web address, as a read only app. or a read-write one.

On the other hand, there are standard software packages, as the Microsoft ® Remote Desktop, or the VMC, among others, that allows to a remote user to do a take over action on the entire PC user interface. These kind of service is better used for a single user application, because implies only one connection at a time, and allows the remote user not only monitor the SCADA program, but also the PLC programming software, and any other diagnostics software resident on the local PC. That's why this mostly used as a Teleservice option for a support provider, than a multi user application, that needs independent or related clients interacting at the same time on the same application, with different access levels, if necessary.

TABLE I.
Type of connection

Remote System	**Required ADD-on**			
	PLC level	**SCADA level**	**DataBase level**	**OS Level**
Alarms and events	dial-up MODEM GPRS modem	dial. up app Internet comm., provider interface	dial.up app Internet comm, provider interface	no
Process Information	Web Server - Internet connection	Web Server - Internet connection	Web Server - Internet connection	Remote desktop Internet connection
Process Control	Web Server SCADA - Internet connection	Web Server - Internet connection	no	Remote desktop Internet connection
Technical Support	dial-up modem - Ethernet & VPN services	Ethernet & VPN Services	Ethernet & VPN Services	Remote desktop Internet connection

IV. Laboratory at the Classroom Level

The idea of this model is to provide remote access to the laboratory application, not only to receive real time data from the process at any time, but to prepare the students to be familiar with the different options available today for remote supervisory information systems. The Laboratory at the classroom is a small standard cooling and heating process where we can interact with valves, pumps, RTDs, flowmeters and other kind of devices, as level transmitters and indicators. Those devices should be equipped with some kind of communication ability, depending on the model complexity and costs. Digital devices, as switches, proximity sensors, etc. are standard digital Inputs, while electrovalves and contactors are standard digital outputs.

Analog variables are quite different to be treated. They depend on accuracy, but mostly on what kind electrical output signal can they provide to be connected to a Data Acquisition System. Those devices can provide one of these different kind of output signals

- Pulse train
- Current loop (0-20 or 4-20 mA)
- Voltage (0-5v, 0-10v, -10+10v, etc.)
- Low voltage (thermocouple measuring)
- Resistor bridge (RTDs, Strain Gauges)

There are more sophisticated instruments that provide digital information through standard fieldbus protocols, as the following ones:

- Modbus
- Hart
- Profibus
- Fieldbus Foundation
- Profinet
- Etc.

The extra benefit is to provide remote setup, configuration and diagnosis, while bringing a converted process value. Extra cost and complexity are their major disadvantages.

More sophysticated instruments require more powerful interfaces, and the PLC who will carry out this job must have more digital ports avaliable, more memory and capacity. On the other hand, the accuracy will be higher and the system more reliable.

The need is to have a system that could be interfaced by a PLC and SCADA, and after that, the best way to provide remote access to this plattform. The benefit of a modern and sophysticated PLC resides on special features like Ethernet connection, embedded web server and different expansion slots, that provide, as is, direct connection to an Internet Remote Client.

The following table shows different options that we need to consider for the local devices and applications, in order to provide remote access based on the kind of service needed.

The combination of two or three of the above hardware and software options, is the best approach to design a very powerful remote supervised and controlled model, to show how different key plant people should receive different process information packs.

Process Engineers should see how process normally evolves and the KPIs (Key Process Indicators). Maintenance engineers should receive downtime alarms and preventive alerts. Production Manager needs to receive a completion and deviations report. Students must adopt a role under this pilot plant and take care of his function in a local and remote way.

Process roles will need to log in the system and watch in real time what´s going on, from their remote places. Maintenances roles must receive every critical alarm in their mobile phones as an SMS or email message. Manager roles must require complete reports in their notebooks wherever they are (number of batches, global process information, totalyzers, etc.).

So, a complete remote supervised system, in our case, includes the following services:

a) Alarms and Events: send email messages and SMS messages to certain people
b) Process Information: complete reports in HTML format to be sent by email and published in a web page
c) Process Control: provides remote access through a web application that emules the same local SCADA Application.
d) Technical Support: provides remote access through a Remote Desktop application and brings remote access to the SCADA and the programming software

A. *Alarms and Events*

These applications are normally available from the SCADA side. Using a commercial package, there are two ways to get data from the Alarms and Events Table and send messages to another application:

- Using and configuring the alarming module that normally comes as an add-on of the base software. There are certain packages that comes with partial functionality, such as emailing alarms.
- Using the SDK (System Development Kit) that comes with programmed Dlls and routines to be applied in .Net, Java and other programming languages, to develop a short application that interfaces alarm tables on one side, and the telephone application on the other.

The student model is based on a standard SCADA

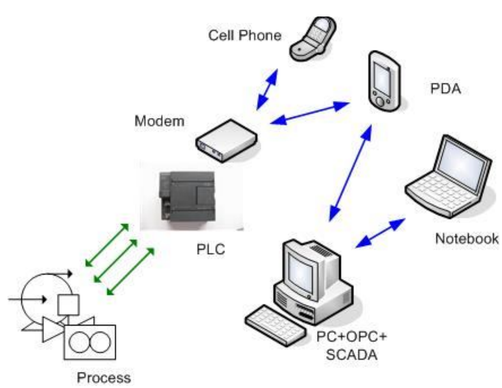

Figure 4. Process and peripherals

System that handles alarm emailing.

Once the local SCADA Station is connected to the Internet, it will be necessary to configure an existing email account for the application, with smtp and pop servers, account name and all the data.

On the other side, each event and alarm that might be considered critic, will be configured to be sent to a group of email address list. The System requires return response, as a way to confirm that the alarm is already acknowledged. All these events (alarm, sent messages, every recipient acknowledge, are recorded on the History table, and gone away from the Summary table when normalized)

The remote alarm System is running at the same time of the local one, and permanently supervised by the same log application and the general event viewer.

B. Remote Process Information

The process Information is coming both from the email Server Application, and also from a Web based application that allows certain people to login and select or demand a sort of dynamic reports that represents periods of logged information condensed and rearranged, in order to provide a feasible way to analyze and measure how things are being done in the model/process/plant.

This is a web based reporting application in HTML/XML format, retrieving information from the Historical and realtime database, as a classic printed report, but now available from the Internet.

Then, a comparison between target and really done, is from the management point of view, a business process control loop

C. Remote Process Control

For certain people, this kind of remote operator interface is the model final purpose, as it looks like the local one. Teorethically, it would be highly recommended not to operate this kind of interfaces, but functionality is completelly available, and depends on the Internet provider bandwidth and connection speed. If the local application is developed in one of the last generation languages, as .Net VB or C Sharp, e.g., then the application is completely portable to a Web Server, in order to be published and viewed from any point of the Internet.

Most of the commercial SCADA packages are based on this language, and Windows ™ is a de facto standard for industrial communications, so it is relatively easy to migrate local to remote applications.

But, Universities and Companies are very committed to neworking security issues. And traditional OPC (Ole for Process Control), is normally captured by Firewalls and other security issues. So it is a must to get permissions and tunnels from IT (Information Technology) people, in order to assure reliable communications. OPC UA (Unified Architecture) is bridging this gap, because it is based on .Net Framework, instead of COM and DCOM (Comunications Object Model and Distributed Comunications Object Model)

The comparison in this case with the real industries is to provide the same functionality to a Proces Specialist, Maintenance Manager or Production Manager, from a Remote Location (Another Plant, home, or mobile position), terieving the whole information needed, as being beside the process at the same location of the Local Scada System Application.

D. Teleservice

This functionality is very easy to be provided over Windows ™ XP Pro Operating System, by the use of Remote Desktop Application, that is available in standard WinXP Pro packages.

This software has the abilty to provide a PC Desktop sharing througout the Internet Network. On this purpose it is normally needed that anyone at the local PC is able to command the application while is being controlled or modified through a remote application anywhere in the Internet. In this case the remote application is using local resources and licenses.

Some PLC and/or SCADA manufacturers offers different kind of Remote Service applications, bur they normally require also a remote license and some extra conditions like a VPN (Virtual Private Network) or a dedicated phone line.

V. Final Project Integration

As the degree includes a specialization in Automation, it is very desirable that most of the final projects that the students has to develop, also include an automation device and an HMI interface, not only to gain specific competences in automated interfaces, but also leveraging the opportunity to protocolize the experience through dedicated reports and data logging.

On this purpose, the Industrial Computing Course has established that all the HMI/SCADA practices are mostly oriented to planify and develop the Final Project Interface.

It is well known that the knowledge is more applicable when it is demanded to solve a real problem. So the real problem is the Final Project, normally designed to be approved in focus to obtain the degree.

The Course gives the students the opportunity to define and design the Project HMI while being trained in SCADA Systems and Communication Interfaces. This is a goal that empowers both Courses, and it is confirmed that produces sinergy between both practices, because some of the typical project inconveniences may be solved in the Industrial Computing Course time.

VI. Conclusion

It is possible to recreate modern industries supervisory Control, Alarm Management and Report capabilities from a remote site, in a University model application, without any important investment to be done, optimizing resources and equipment, and also without any important software development, as it is not the purpose for our students to be experimented programmers, allowing them to better concentrate in automation and control issues.

In addition, the collaboration between the Industrial Computing Course and the Final Project allows the student to develop the application while learning to design SCADA Systems and HMI interfaces.

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Engineering Proyect (Case Study) to Obtain Polymer Concrete through Recycled PET

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Keywords: Polyethylene terephthalate, polymer concrete, thermoplastic, commercial thermoplastics, engineering thermoplastics.

ABSTRACT
We must continue to environmental awareness at all levels of education and even more on graduate students, thus engaging them in real trouble but looking for alternative solutions, this is a case study of a graduate student in materials engineering, in which the project was to develop a new composite material from recycled PET. It is necessary to generate activities recyclable solid waste processing, thereby decreasing the density of garbage and recyclable materials are harvested. The accumulation of solid waste is an environmental problem that, without recycling, reusing or reducing its potential value is wasted. The time taken for the decomposition of waste is variable depending on the type of material to be extremely slow in the case of plastics. Polyethylene terephthalate bottles (PET) take longer than 50 years to decompose and last longer if they are buried.

This research work aims to take advantage of recyclable solid waste to generate new composite materials that help to minimize environmental contamination and allowing for sustainable development by giving economic value to waste. New materials to consider in this paper as the main application area of construction, is aimed at generating alternative construction materials comprising a mixture of recyclable material such as PET, to generate alternative building materials that improve the properties mechanical properties of traditional building materials. It also established a methodology feasible technique for the development of a new composite material to called "polymer concrete with recycled PET".

INTRODUCTION
For convenience, most engineering materials are included in three main groups: metallic materials, polymers and ceramics. In this paper places emphasis on polymeric materials and specifically to research on those who are otherwise recyclable solid waste such as polyethylene terephthalate, to recycle, reuse and give it value as a component of a new composite material called "recycled PET polymer concrete."

Composite materials are classified primarily under the matrix, and therefore will have metal matrix composites, polymer matrix and ceramic matrix. [3] It is important to note that this research was obtained a new composite material which was used as polymer matrix polyester resin. Also composite materials are classified according to type of reinforcement or filler. Therefore there are particulate composites, short fibers, continuous fibers and laminar or layered. [3] A particulate composite material is one in which the reinforcement particle is approximately the same dimensions in all directions. Therefore, the particles can be rods, spheres, flakes and many other reasons which apparently are about 10μ. The reason apparently is the length ratio between the cross-sectional dimensions. In these composites, the size, shape and distribution, the rate and the form of particles affect the properties of the composite. Usually the particles of smaller size and more rounded work best. It must ensure that the distribution of the particles is uniform. [4]

Fiber composite materials are those in which the reinforcements have reason to look much larger than 10μ (is in which the length is much greater than the dimension of cross section). In the composites with short fibers or staple the properties vary with fiber length. [3]

The building today is demanding materials that exceed the usual properties and constraints. In the domain of concrete has long pursued, the resistance rapidly achieve high and very high, especially for prefabricated to reduce sizes, thickness and weight of their own, still very important to have a relationships tension / compression higher than in normal concrete. Besides the strength, durability is another property increasingly valued, today we see an abundance of certain premature aging concrete structures, built of course, with an emerging technology and quality defects in many cases, but cannot forget some weakness concrete against aggressive environments. Given the above, the use of polymers in concrete, which began in 1950 as addenda to improve the adhesion and wear resistance, has given way in the last 25 years to a widespread recognition of the manufactured concrete or modified polymers as building material. [5]

Polymer Formulation. Very few polymers are used in its pure, unadulterated, but mixed with other materials to enhance and improve properties for use in various applications. Formulation is the name of the process by which the components are mixed intimately with each other in a molten state or at room temperature until the dough is as homogeneous as possible. This is the general term applied to: 1) the procedure of alloy or polymer blend, 2) the use of additives and fillers such as colorants, flame retardants, antistatic agents, plasticizers and others and 3) the addition of braces or a combination of the three treatments. Usually, the product of the third is known as reinforced plastics or polymer matrix composite materials. [3]

It is noteworthy that for recycled PET polymer concrete, a mixture is made with a polyester resin as a binder, are added particles or short fibers mechanically recycled PET is used for calcium carbonate in the structure volume.

Polymer Blends. The mixtures are combinations of polymers by mechanical means, these combinations are not dependent on chemical bonds, but typically require compatibilizers that prevent segregation of the components. The mixtures are normally kept the best features and in many cases the goal is to find two or more components which, when mixed, produce synergistic property improvements, beyond those that are purely additive in their effect. The improvements sought are in the areas of impact resistance, weather resistance, better behavior at low temperatures and flame retardation of. [3]

Recycling of Polymers. The classifications of polymers are determined by the type of recycled resin and symbols of identification. The ID code is adopted in Mexico, November 25, 1999 in NMX-E-232-SCFI-1999 based on the identification of Europe and American countries. [1]

According to the 2008 Statistical Yearbook of the Mexican Association of Packaging (AMEE), for the production of packaging consumed approximately 2.3 million tons of various resins. According to the Mexican Institute of Industrial Plastic (IMPI), the total production of plastic, 43% represents the packaging market, being the most widely used plastics as follows: 1) PET, 2) HDPE, 3) PVC, 4) LDPE and LLDPE, 5) PP, 6) PS and 7) Other. Apparent Domestic Consumption of plastics used for packaging development has shown a positive trend in recent years. With respect to 2007, total consumption of plastics increased by 4.5% compared to 2006 for each type of plastic. Today, the plastic with the highest recycling rate in Mexico is PET, however, the bulk corresponds to polyethylene. Therefore the challenge for Mexico is that there are more than one million outlets. The largest source comes from post-consumer wastes which are more difficult to separate contaminated and wash, they arise from scavenging garbage, or specialized collection centers as in the case of containers PET. Each plastic must be analyzed independently, as to choose the most appropriate technology for recycling is important to know the characteristics of the waste and the product sought, and though the teams are often multi-recycling in the area of specialization is worth.

PET is used to make bottles that are packaged in soft drinks and purified water, mainly due to its transparency, gas barrier and impact resistance, is also used for food packaging and products household cleaners and some pharmaceuticals. The participation of this resin in the total consumption is 33%. According to the presentation; challenges and prospects for the plastics industry in México. Conducted by the National Association of Plastic Industries (ANIPAC) notes that the plastics industry in Mexico has recorded in recent years a trade deficit in As resins (raw materials), as its imports are more than exports. Hence the urgent need for the government to speed up investment projects in the petrochemical industry. Mexico imports more than 50% of the resins they consume, in fact no one in the world plastics industry strong and competitive in the short and long term which in turn depends on both imported raw materials. So says the ANIPAC not enough to invest in modernizing the plastics industry in Mexico, because without sufficient local raw material is vulnerable. In addition to the outlook in the medium term indicate high commodity prices and limited supply of polyethylene (2006-2010), among others. It also recommends further develop petrochemical projects, pricing of basic commodities, diversifying sources of supply, procurement organization, negotiation and consolidated purchasing more efficient and competitive logistics as well as the urgent need for legislation for efficient recycling recyclable resins. [6]

Plastics are important engineering materials mainly for its wide range of properties relating to the ease of molding into the desired shape and relative low cost. PET is considered a thermoplastic (TP) which have a glass transition temperature above which these materials behave like elastic solids and viscous or below it behave as brittle solids, glassy. Above the glass transition temperature permanent deformation occurs because the molecular chains slide with each other, breaking and re-form the secondary links. [4]

Thermoplastics are classified as business or engineering. The Commercial thermoplastics (TPC) is generally used in applications without load or load very small, while engineering thermoplastics (TPI) support loads for long periods and compete with metals in certain structural applications. About 90% by weight all plastics are TPC and only 10% are engineering resins. [3]

The TP (entangled polymers) in particular, are easy to recycle using simple technologies, without a clutch because the melting temperatures of the different plastics are different, sorted plastics require a guy with similar melting properties for a cast homogenous.

Types of Recycling. Recycling plastic is a very useful practice to reduce solid waste, and that plastics represent about 8% of municipal waste is expected that this year the percentage will increase to 10% currently receiving increased attention recycling and continue to develop techniques to improve it. Some techniques were first developed in the 70's, when some countries began to burn their plastic waste. Since then there have been many advances in the way of recycling plastic, resulting in four types of plastic recycling: primary, secondary, tertiary and quaternary. [2]

EXPERIMENTAL METHODOLOGY

The experimental process for obtaining polyethylene terephthalate polymer concrete recycling is divided into two main stages: the first is in the process of obtaining mechanically recycled PET flake-shaped and the second stage is the technique to get the new material particulate reinforced composite fiber and recycled PET.

STEP 1. Obtaining process mechanically recycled PET.

As a first step applies primary recycling is the conservation of plastic waste items with physical and chemical properties identical to the original material. Usually this type of recycling is done with thermoplastics such as PET (polyethylene terephthalate).

• Collection. It is one of the initial activities for recyclable plastics, which is important to identify and separate the solid waste plastics by type of recycled resin that can be profitable. In particular are selected those PET bottles that contained a beverage as natural water, carbonated water or other beverage ingested.

• Transport. After the harvest is carried out transport of PET bottles, to a temporary storage warehouse, in which continuous recycling process.

• Classification. On the site for the mechanical recycling of PET bottles, is a classification of PET products by color, by hand. Taparosca subsequently separates and falls off the label, which are stored separately.

• Primary or mechanical recycling. PET bottles are washed with pressurized water to remove accumulated debris inside the bottle. The bottles were allowed to dry, preferably indoors in an average of 2 to 6 hours. If the bottles are completely dry, go to a conventional mill. It is noteworthy that the mill has built a mesh that serves as a sieve which passes only a certain size from ground PET flake, is particles are obtained from 0.1 to 1 cm. Milled PET particles larger than 1 cm and are collected in the mesh, to be ground again. The particle sizes between 0.1 - 1 cm, packed in bags and stored as raw material for the production of polyethylene terephthalate polymer concrete recycling.

STEP 2. Getting Technical with RPET CP mechanically.

As a second stage of the process to obtain the polymer concrete is necessary to mix calcium carbonate and polyester resin, PET chips were obtained as part of primary recycling waste bottles that contained water or a carbonated drink.

Raw Materials.

• Polyester resin. As experimental design variable is chosen this type of resin as binding agent characteristics (matrix) in the mixture of the composite. In addition belongs to the group of synthetic polyesters known, so this feature makes it compatible with polyethylene terephthalate.

• Calcium carbonate. Chemical Formula: $CaCO_3$. As raw material is added to calcium carbonate as a filler that provides volume to obtain a composite material.

• Flake RPET. The recycled PET flakes are mechanically obtained from step number 1 and which are added as filler in the binder to obtain reinforcement in the polymer matrix composite material.

• Color. We used a commercial dye in liquid, brown for signs of new polymeric materials.

Variables in the design of experiments.

Design Variable 1. Resin Type, as a base and binder in polymer concrete composition as presented in Table 1.

Type of Resin	Degree of toxic	Cost	Commercial availability
Polyester	Low	Low	High
Phenolic	High	High	Low
Epoxy	Means	Means	Means
Vinyl ester	Means	High	Means

Table 1 *Comparison of four types of resins used as a base matrix and / or binding agent.*

Based on comparative data are presented in Table 1 the polyester resin has greater advantages drank to their low toxicity and does not contain agents highly aggressive, low cost and greater commercial availability, which is why using this type of resin as binding agent in the polymer mixture to formulate the new composite material (polymer concrete with recycled PET).

Design Variable 2. Type of recyclable plastic, according to their classification by type of resin.

Based on the general characteristics of PET and be considered a thermoplastic which belongs to the group of polyesters; this material to be recycled mechanically and get chips as feedstock is technically compatible with the polyester resin used as binder. In addition, our country is the second most recyclable waste generation and its consumption. Due to the above classification of recyclable plastics PET is chosen for the development of new composite material.

Design Variable 3. Mechanically recycled PET in the form of flakes.

The process of obtaining mechanically recycled PET, the material is RPET flakes with a size between 0.1 to 1 cm long and 0.1 cm thick, which are added to the polymer mixture as a filler and reinforcement. It is important to note that the materials laboratory, samples were prepared by varying the amount by weight and size of RPET flakes greater than 1 cm in size and failed attempts the samples had an irregular appearance on the surface because the saturated reinforcement the base (polyester resin).

Design Variable 4. Equivalent portions of compounds (raw materials) in the polymer blend, for the formulation of new composite material.

In failed attempts of the polymer blend samples to be changing the amount by weight of the load (RPET flake), it was determined that the relationship to obtain a homogeneous polymer blend is a function of the amount by weight of the load added as reinforcement in polyester resin. That is why the relationship with respect to the amount of polyester resin used is 1:2. taking as calcium carbonate fillers and RPET flakes as reinforcement is for every 1 ml of binding agent is added to 1 g and 1 g $CaCO_3$ RPET flakes. In Figure 1 will represent the amounts that were used to obtain a cube-shaped sample of the composite.

Procedure for obtaining polymer blend.

1. Measure out 100 ml of polyester resin in a glass test tube.
2. Weigh 100 grams of calcium carbonate on a beam balance.
3. Weigh 100 grams of RPET flakes which have a particle size between 0.1 and 1 cm.

4. In a mixing bowl add the 100 ml plastic polyester resin, gradually incorporate calcium carbonate alternating equal portions of RPET flakes with a rubber spatula to mix the components until a homogeneous mixture.
5. Add to the mix 5 grams of commercial dye.
6. Stirring the polymer blend, we proceed to pour it into molds of high density polyethylene to obtain the desired shape.
7. Castings let stand for 24 hours at room temperature.
8. Remove from molds, parts of CP with RPET.

Figure 1 specifies the amounts used for polymer concrete sample of 25 cm^3.

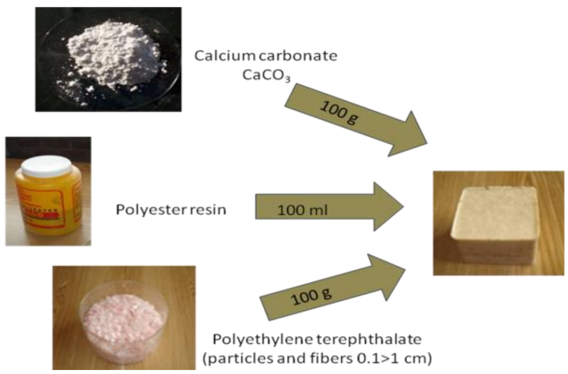

Figure 1. *Getting polymer concrete using recycled PET as raw material.*

CONCLUSIONS

The technology developed from recycled materials is a first step in our country because the economic value of the components that can be used in the application of new technology. In addition research has made it possible to reduce waste, leading to the development of new technologies, ensuring that the rate of recovery and recycling of plastics and products will increase in the future.

The emergence of recycling starts to try to preserve non-renewable natural resources as a way of harnessing the waste with economic and ecological value. It is also worth mentioning that by recycling one ton of plastic saves 7 tonnes of crude oil and pollutes 55% less.

The use of polyester resin as binding agent in the polymer blend is feasible due to its low cost, commercial availability and environmentally acceptable because of its low toxicity, in comparison with other resins such as epoxy, phenolic or vinyl ester.

The development of polymer concrete using recycled polyethylene terephthalate is technically and economically feasible, thereby contributing to minimize the negative environmental impact generated by excessive consumption of PET. In addition to this technological innovation would help reduce environmental pollution, and recycle the plastic that is discarded daily to apply it in developing a new composite material that can be applied in the construction industry for its high resistance. Moreover this research does not do justice compared to traditional concrete hydraulic technologies and that over time we are witnessing an effort in all respects to the development of polymer concrete as a new environmentally friendly alternative materials, together with a wealth of theoretical research and experimental materials appearing on the market with special properties, yet little used, but promising future.

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Design and Implement a System of Wastewater Treatment Based on Wetlands

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ABSTRACT

The wetlands are considered as a natural passive cleaning of waste water. Is a process characterizes by its simplicity of operation, low or zero-energy consumption and low waste production. These consist of shallow ponds planted with plants. The processes of decontamination are performed simultaneously by its physical, chemical and biological properties [1].

The objectives of this work are design and implement a system of artificial wetlands as an alternative method for treating waste water produced from the Faculty of Chemistry Science and Engineering that allow to reduce the costs of operation, knowing the degree of water pollution to determine how efficient the wetland and, finally improve the health and environmental conditions of the irrigation water.

So the first step was to know the degree of water pollution and quantity to determine the wetland process variables.

The second step was to determine the kind of plants that allow reducing the water contaminants. The Manning formula was applied to evaluate the free flow and Darcy's equation for the surface flow by wetlands. A micro-scale prototype was design and built based on buckets.

The absorption capacity of several plants (*Bacopa monnieri, Nephrolepis exaltata,Tradescantia zebrine*) was determined. Also we use a natural filter consisting of Tezontle (first layer), sand (second layer), gravel (third layer), sand (fourth layer), Tezontle (fifth layer), gravel (sixth layer), sand (seventh layer) and, organic substrate (eighth layer).

A wetland decreases more than 60% the cost compared to a water purification plant as everything is based biodegradable materials and not using any energy or sophisticated equipment to water filtration.

Wetlands not only help to purify the water, but also help the conservation of flora and fauna that is dependent on wet conditions, as only biodegradable materials are used there is no pollution to the ground, helping the conservation of the environment. Today we are evaluating the wastewater flow because the prototype only allows treating from 0-1 L/min.

Key words: wetlands, phytodepuration, *Bacopa monnieri*, *Nephrolepis exaltata,Tradescantia zebrine* wastewater treatment plant.

1. INTRODUCTION

Because the treatment of wastewater through conventional treatment systems are expensive both in construction and in operation and taking into account that the pollutant removal rates are poor, alternative methods have been designed and constructed wetlands that are specifically designed and built systems for wastewater treatment in conjunction interacting plants, animals, microorganisms and abiotic environmental factors for treating waste water.

The artificial wetlands are artificial constructed wetland systems for wastewater (the term wetlands means Phytodepuration are wastewater systems designed to artificially recreate ecological conditions similar to those established in the areas of water).

The system consists of the development of a cultivation of certain plants rooted on a bed of volcanic rock gravel or sealed. The action makes it possible to plant a series of complex physical interactions, chemical and biological weapons through which the influent wastewater is cleaned and slowly progressive.

A wetland can have the following characteristics: treatments are based on physical, chemical and biological nature, requiring no extra supply of chemical reagents. In regard to its functioning as biological treatment, are operated under anaerobic conditions, facultative and/or aerobic in which oxygen is supplied spontaneously by transport from the atmosphere, which represents a significant saving of energy without mechanical aeration.

Wetlands remove pollutants through various processes including sedimentation, microbial degradation, plant action, absorption, chemical reactions and volatilization.

The operation of constructed wetlands is based on three basic principles: the biochemical activity of microorganisms, the oxygen through the plant during the day and the physical support of an inert bed serves as a support for rooting plants; and serve as filter material. Together, these elements dissolved and suspended materials removed in the wastewater and biodegrade organic matter to mineralization and form new organisms.

Wetlands have three basic functions that give them attractive potential for the treatment of wastewater: contaminant physically set on the surface of soil and organic matter, use and transform the elements by microorganisms and achieve levels of treatment consistent with a low power consumption and low maintenance [2].

Constructed wetlands can be classified according to the type of macrophytes (plants) used in its operation: fixed to the substrate macrophytes (rooted) or free floating macrophytes.

Considering the way of life of these macrophytes, artificial wetlands can be classified as:

Treatment systems based on floating leaf macrophytes, mainly angiosperms on waterlogged soils [3]. The reproductive organs are floating or air. The water hyacinth (*Eichhornia crassipes*) and duckweed (*Lemna sp.*) are the species most used for this system.

Treatment systems based on submerged macrophytes: include ferns, mosses, and charophytes numerous and many angiosperms. They are found throughout the photic zone (at which sunlight reaches), although vascular angiosperms only live to about 10 m depth. The reproductive organs are aerial, floating or submerged.

Treatment systems based on rooted macrophytes emerging in waterlogged soil permanently or temporarily, in general are perennial plants with aerial reproductive organs.

Wetlands rooted macrophytes based on emerging can be of two types, depending on the movement of water used:

1) Surface flow wetland, if surface water circulates among the stems of the macrophytes and,

2) Wetlands subsurface flow, if the water flows below the surface layer of the wetland.

2. METHODOLOGY

We use the Manning formula applied to free flow wetlands and Darcy´s Law applied to surface flow wetlands.

The method used a free-flow wetland due to ground conditions.

We performed a micro-scale prototype, based on buckets, to test the absorptive capacity of each plant to use.

The plants used were *Bacopa monnieri*, *Nephrolepis exaltata* and *Tradescantia zebrina* (See Fig. 1).

Fig. 1. Planst used in the prototype: (1) *Bacopa monnieri*, (2) *Nephrolepis exaltata* and (3) *Tradescantia zebrine*.

3. RESULTS

A natural filter was added consisting of eight layers:

First layer (Tezontle)
Second layer (Arena)
Third layer (gravel)
Fourth layer (Arena)
Fifth layer (Tezontle)
Sixth layer (gravel)
Seventh layer (Arena)
Eighth layer (organic substrate)

In Fig. 2 is shown the material used.

Fig. 2. Material used in the wetlands prototype.

In the Fig. 3 is presented the layers compositions of the support material.

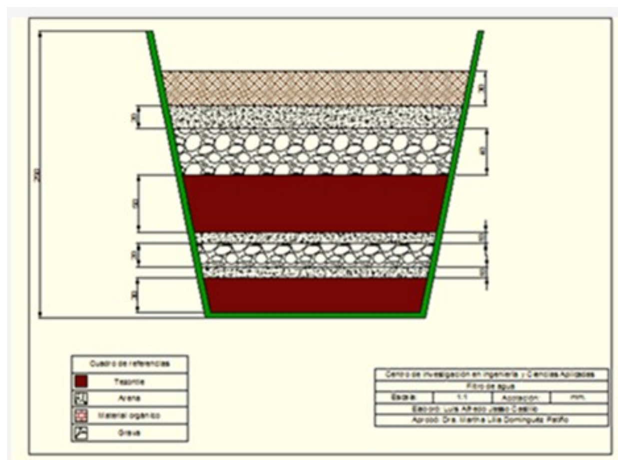

Fig. 3. The final design of layers in the wetland prototype.

This alternative was implemented effluent treatment for reducing costs.

It was designed with the future implementation data shows a micro-scale design of a wastewater treatment plant based on wetlands, testing the ability of absorption of three different plants.

With the above conditions are improved and environmental health irrigation water.

In Fig. 4 is shown the final dimensions of the wetland prototype used.

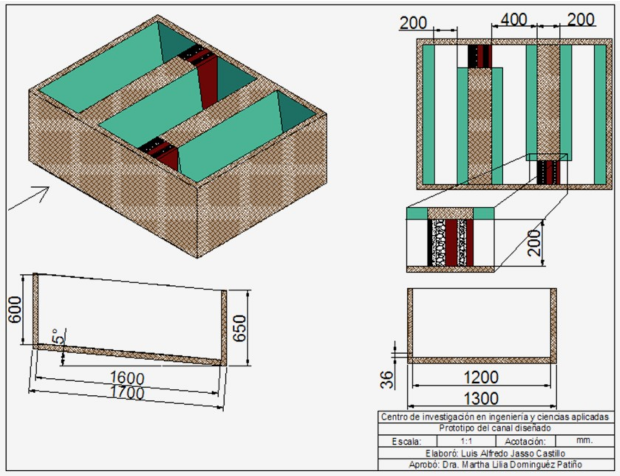

Fig. 4. Final dimensions of wetland prototype.

In the hydraulic design was observed that the flow through the wetland must overcome the frictional resistance of the same system. This resistance is imposed by vegetation and the sediment layer and the medium, the roots of plants and accumulated solids.

The best solution in terms of construction, the wetland is to provide a fund with an inclination sufficient to allow complete drainage and finally apply Darcy's law and the Manning equation applied to artificial flow wetlands.

4. CONCLUSIONS

A wetland decreases more than 60% the cost compared to a water purification plant as everything is based biodegradable materials and not using any energy or sophisticated equipment to water filtration. Wetlands not only help to purify the water, but also help the conservation of flora and fauna that is dependent on wet conditions, as only biodegradable materials are used there is no pollution to the ground, helping the conservation of the environment. Water is one of the most precious and if we do not LUID aware that both the hand of man does this precious liquid, finish with it.

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