ABSTRACT

In this paper, the development of a pilot project that utilizes new Multimedia technologies in teaching engineering concepts for undergraduate students is presented. A transportation engineering courseware is being developed over four years. It aims to enhance the students' learning capabilities using state-of-the-art technologies. A model is developed in a way that permits the students to use the course material through a university local network and later on through the Internet. Course materials are presented using different media types such as: text, still pictures, graphs, animations, sound, and video clips. They are integrated to provide a new way of delivering course material. The system uses different navigation tools to increase the level of student interaction. Preliminary testing and evaluation were performed. They showed positive impact on teaching the course.

The project was funded by the UNESCO through a regional program to upgrade science and engineering education in southern Mediterranean. An-Najah National University was selected to develop such a courseware. The procedures and templates designed in this model could be used for the preparation of other engineering courses.

Keywords: Transportation, Multimedia, Engineering, Education, Software.

1. INTRODUCTION

Recent advancements in science and engineering university education have revolved around the introduction of computing and networking technologies, as well as the application, modification or production of interactive and multimedia technologies. Adopting such technologies in teaching results in teaching methods which are described as multifaceted (with more than a single modality) and flexible. This is considered of great assistance to facilitate productive learning and to overcome a number of education-related difficulties, such as the mismatch between teaching and students' learning styles (i.e., how information is perceived, organized, processed and understood).

Currently, multimedia and computer networking technologies have limited utilization in engineering departments and faculties. However, the training of faculty members and the development of appropriate courseware, associated with the emergence of inexpensive computer and networking technologies and mass storage media, would bridge the gap. There is a great need to upgrade the efficiency and quality of teaching programs using such technologies in order to educate and graduate engineers who, at the one hand, are well trained and highly qualified and capable of utilizing the latest technological computing tools, and, on the other, know exactly their society developmental needs and objectives.

2. SIGNIFICANCE AND OBJECTIVES

The main purpose of the project is focused on the development of a pilot course in engineering design, considering the model of transportation engineering, using advanced computer, multimedia, and networking technologies. It aims to enhance the students' learning capabilities using state of the art technologies. To facilitate achieving this aim, the courseware is being designed in a way that permits the students to use the course material through the university local network and later on through the Internet.

The use of interactive and multimedia technologies in teaching facilitates the know-how
transfer and it will improve the learning process for the students, since it provides for both self and interactive teaching. Such an opportunity enhances the students understanding of the study material especially where there are no enough teaching assistants, as in the case of most local universities. Moreover, for some students, it provides a supplementary learning environment free of the psychological influences associated with the classical in-class teaching.

The specific objectives of the project include:

1. Enhancing students’ learning capabilities and training them utilizing state-of-the-art multimedia technology and advanced interactive computing tools with especially tailored engineering design courseware, considering transportation engineering as a model topic.
2. Developing Computer Aided Instructions (CAI) for the courses to be developed which encourage interactions among students and with the instructors or experts in the field.
3. Facilitating authoring of multimedia courseware and facilitating the interaction with existing software through developing proper computing interfaces.
4. Developing a web-based courseware, including both static web contents and dynamic, interactive web contents.
5. Facilitate building custom applications for the already available software and multimedia technologies through proper interfacing and modifications in order to suite local needs, including the introduction of transportation-related data, maps photos, aerial photographs, video clips and other sources of information.
6. Exploiting the capabilities of multimedia and computing technologies in engineering design in general, and the model topics of transportation engineering at specific, to other Universities.

3. METHODOLOGY AND RATIONALE

The methodological approach followed in the development of the multimedia courseware includes a description of the course, trends in engineering design courses, aspects of the developed learning tool, the software utilized, training provided and the plan of investigation. The outcome of the approach led to the arrival at a fully interactive multimedia learning tool that covers a broad range of transportation engineering disciplines.

**Description of Course:** The main course considered as the target of investigation and improvement is Transportation Engineering, with basic extensions of the approach to two other related subsequent courses: Highway Engineering and Traffic Engineering. Transportation Engineering is a basic and compulsory course for all civil engineering students at the undergraduate level. Most universities follow the same or a similar structure of the series of transportation engineering course.

Current teaching methods in these courses follow mainly the traditional style of in-class lectures and instructions supplemented by practical design and lab sessions and in some cases utilizing the available educational software.

Transportation Engineering courses in the undergraduate programs consist mainly of an introductory course, a highway engineering course, and a traffic engineering course. The introductory course presents a conceptual framework for transportation planning and engineering, and the types and elements of transportation systems. The course also introduces the various transport systems with concentration on their characteristics, general design considerations, design of main elements and main operational characteristics.

The developed course is intended to serve as a basic general introductory course in transportation engineering presenting the above topics. This is mainly done to fit the requirements for almost all undergraduate programs. Other specialized courses are recommended in the field of both highway and traffic engineering. Those courses concatenate on the geometric design of roadways, structural design of roadways, and analysis and design of highway operational analysis.

**New Trends in Engineering Design Courses:** Although a number of engineering design web-based courses have been developed especially in
American and European universities, a review of literature or authored multimedia did not indicate that a comprehensive transportation engineering course has been developed. Most of the developed courses, which utilize advanced multimedia and networking technologies applications, concentrate on very basic courses such as mechanics of materials, statics, dynamics and engineering drawing.

Aspects of the Learning Tool: The major aspects of the learning tool, which developed for the courseware, include:

- Designing the main and secondary homepages.
- Provision of the syllabus and course calendar.
- Design and provision of static lecture contents, including text, solved sample problems, reference materials, still pictures, motion pictures (animation), sound, and movies.
- Design and provision of computer aided instruction, and dynamic/interactive instructions and assignments.
- Design and provision of interfacing with available educational software in the engineering design and analysis of transportation system.
- Design and provision of necessary help menus.
- Design and provision of mail instructions.

Software: The approach utilized professional software intended for authoring static and interactive web-based courseware. The methodological approach paid attention to the integration of various multimedia aspects into the learning package; such as projected video images, animation, sound, and full motion video.

The professional multimedia authoring software utilized in this course includes:

- A general purpose editor such as Word for Windows for text and equations
- A drawing software, such as Freehand
- A photo editor, such as Photoshop
- A sound editor, such as Sound Forge
- An animation software, such as Flash and Extreme
- A video editor, such as Premier
- A simulation software, such as Director

4. APPLICATION AND COURSEWARE DEVELOPMENT

The application of the methodological approach indicated above towards developing the courseware is presented here. The application is illustrated in terms of activities, application structure, multimedia materials utilized, template design, and implementation plan to develop the courseware.

Activities: The application is developed by combining simple and controlling activities. Simple activities have one start point and one end point, but controlling activities have one starting point and multiple end points. An example of simple activities is viewing the contents of one section in one of the chapters. Controlling activities are used in the main menus of chapters and to navigate between various sections and chapters.

Application Structures: Four types of application structures were used in the development: linear presentation, hierarchical menu, hypermedia, and simulation. The learning tool has several examples that utilize these types of structures and hence increase the level of student interaction. Each of these structures is presented briefly below.

- Linear presentations: A useful linear presentation needs to have some control points such as the ability to go forward or backward in the presentation, or the option to simply quit the presentation. In the following example shown in Figure 1, the user can explore the contents of the project chapter by chapter, section by section, or page by page. An iconic representation of the forward and backward is chosen from the transportation environment, namely the small cars and traffic signs.

- Hierarchical menus: A linear activity displays the menu and then a controlling activity receives the user’s selection. The result of the selection could go directly to another presentation activity or it might go to another menu level. In Figure 2 below the
student can go directly from the pull down menu to any of the chapters or sections in the project. Only simplified menus were setup in the project.

- **Hypermedia**: The user is allowed to make direct selection to hot words or hot images in the presented information. If the user needs additional information about such a word or image, then he can simply click on it and the information is displayed. In the example shown in Figure 3 the user can seek more information regarding the figure presented elsewhere in the presentation by clicking on the hot word Figure 3.6. Upon clicking on this hot word the control of the browser is transferred to the page containing the desired figure as shown below.

- **Simulation**: Real transportation system concepts are simulated throughout the project. They simplify understanding of the concepts by the students using animation. For example, the concept of stopping sight distance which is the minimum sight distance a driver needs to stop the vehicle after seeing an object on the roadway without colliding with it is simulated.

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**Figure 1**: Navigation through the page

**Figure 2**: Pull down menu

**Figure 3**: Hot words

The animation shows a driver driving his vehicle and suddenly a deer is about to pass the road in front of his car. He has to break and completely stop before hitting it as shown in Figure 4.

**Multimedia Materials**: Since the application is going to be used in a one-on-one computer environment, it is very important to get the student attention and keep the focus on the
material presented. This was accomplished by including different media types in the proper cue points of the presentations. The course material is presented using different media types, such as text, still pictures, graphs, animations, sound, and video clips. These media are integrated to provide a new way of delivering course material.

**Figure 4: Simulations**

**Template Design:** Screen contents are organized in templates to preserve consistency in the course of project development. The templates are at the chapter level, the section level, and at the page level. For example, the colors are selected in a way that will not bother the user and will not get him tired from reading the text. Frames in the page are setup to allow the student view the text and the attached image or graph illustrating it at that stage.

**Implementation Plan:** The project is implemented as part of the Special Program for Upgrading Science and Engineering Education (USEE) in Universities, administered by UNSECO Regional Office for Science and Technology. The project is intended to assist science and engineering departments and faculties in Universities in upgrading the efficiency and quality of their undergraduate teaching programs through intensive and dynamic use of computer multimedia and networking technologies. The project involves cooperation with Oxford University in the form of limited technical consultancy.

The implementation plan is composed of the following tasks:

**Task 1- Preparation of the Courseware and Introduction of Multimedia Technologies:**

This initial task involves the general preparation of the courseware and the development of the detailed methodological approach to be followed. In addition, the proper multimedia software tools are specified and purchased. This task also involves the investigation of how various multimedia technologies can be introduced.

**Task 2- Developing and Teaching the Course:**

This task involves teaching the Transportation Engineering course. The students are taught the theoretical background in two lectures per week for the whole semester. In addition, there is a practical session in which the students are introduced to the learning tool through practical training, demonstrations, and in-class assignments. As a test, and in number of cases, mixed type of presentation is being performed to examine the impact of different teaching styles of students learning abilities. The courseware is this task is prepared in detail in order to satisfy the stated objectives.

**Task 3- Evaluation:**

Testing the performance of students, and getting their opinions and evaluation of the multimedia courseware is essential. The students who will be asked to evaluate the course material, relevance, teaching and learning through especially designed questionnaires. Specific questions are included in such questionnaires in order to measure the student’s responses towards multimedia technologies through a rating system. The effect of multimedia on students attainment expressed in mid-term and final exams for the multimedia section of students compared to another section where students are taught in the traditional teaching style is measured.

**Task 4- Modification, Documentation, and Training:**

This final task involves the preparation of material in its final status after teaching the course and doing the evaluation. Proper documentation is to be made, finally methodological procedures for training the interested instructors from local Universities are to be prepared and implemented. Through dissemination of information, workshop
meetings and other means, interested instructors will be able to know about the package and its use.

5. CONCLUSIONS

Conclusions include the following:
1. The new approaches in developing engineering education programs and curricula concentrate on using computer, multimedia and networking technologies.
2. There is a good potential to develop engineering education basic courses using multimedia technologies as such courses inherently possess capabilities to express real life concepts using various multimedia tools.
3. In the course of the implementation of the project, students interacted very well with the engineering concepts and applications presented.
4. Having completed the development of the Transportation Engineering multimedia courseware, and arranging for dissemination and training of faculty from other universities in utilizing the courseware, a unified course material available in a high technology format will assist in the linkage of interested instructors and facilitate the exchange of ideas, and will lead eventually to common understanding and to subsequent upgrading of the courseware.

6. RECOMMENDATIONS

Recommendations include the following:
1. It is recommended to utilize the already developed procedures for developing other engineering courses.
2. It is recommended that universities upgrade their computing and networking capabilities as well as their distance learning facilities to be well prepared to cope with the advanced technologies being currently practiced worldwide.
3. School students at the basic and secondary levels can greatly enhance their capabilities in different disciplines by using multimedia tools, which will prepare them for interaction with more advanced applications of the tools at the university level.
4. Having the multimedia courseware posted on the Internet, it can be utilized in continuing education programs and self education, where engineers can upgrade their knowledge in the field.

7. REFERENCES