Experiential learning for Engineering Education

A school reconstruction project in Sichuan after the 5.12 Earthquake

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Abstract

This paper presents elements of the experiential learning in engineering education through a real-life project case. The project included a team of university students from Hong Kong traveling to Sichuan, China and implementing various engineering systems from solar energy to e-learning systems for a reconstructed school in Sichuan, which was destroyed by the 5.12 Sichuan earthquake in 2008. Some successful factors for the process of experiential learning are also described. The cycles of experiential learning proposed by Kolb was introduced and fitted into different teams in this project. Students applied their knowledge to design the prototypes, acted and built the system, observed and evaluated their performance and conceptualized their experience into knowledge. Besides the successful factors, the weaknesses of experiential learning and how the project team minimized the impacts of the weaknesses were also described.

Keywords: Experiential learning; Engineering education; Sichuan reconstruction; Learning-by-doing

Introduction to Experiential Learning

Experiential learning is a teaching and learning methodology that is becoming more recognized in university education. It is the process of knowledge generation from direct experience [1]. According to Aristotle, the infamous Greek philosopher, "For the things we have to learn before we can do, we learn by doing."[2]. Another famous Chinese philosopher – Confucius, who also known as "The Forever Teacher" quoted, "I hear and I forget. I see and I remember. I do and I understand." [3]. Thus, the importance of direct involvement in the process of experiential teaching and learning had been well-realized for more than two thousand years ago.

In this Sichuan reconstruction project, we introduced the element of experiential learning in the project. We provided opportunities for teams of students to directly involve in the project through organizing, planning, implementing and evaluating.. We focused on the learning process of the individual student, by providing actual opportunities for students to make discoveries and allow them to experience firsthand in Sichuan. Learning was done through real-life practice, observation and interaction with the local students, instead of hearing or reading about others' experiences in books or in class.

Elements in Experiential Learning

Though the fundamental concept of experiential learning is to learn knowledge through individual's direct experience and no formal teaching is need, there are still some essential elements in order to create a serious and effective learning experience.

Knowledge is continuously gained through both personal and environmental experiences [4]. According to David A. Kolb, in order to gain genuine knowledge from an experience, certain abilities are required [5]. First, the learner must be willing to be actively involved in the experience. Then the learner must be able to reflect on the experience. The learner must also possess and use analytical skills to conceptualize the experience. Finally, the learner must possess decision making and

problem solving skills in order to use the new ideas gained from the experience. Kolb's Experiential Learning Theory defines experiential learning as "the process whereby knowledge is created through the transformation of experience. Knowledge results from the combination of grasping and transforming experience."[6].

Kolb's Experiential Learning Theory

The Kolb's Experiential Learning Theory [5] presents a cycle of four elements, namely Concrete Experience, Reflective Observation, Abstract Conceptualization and Active Experimentation.

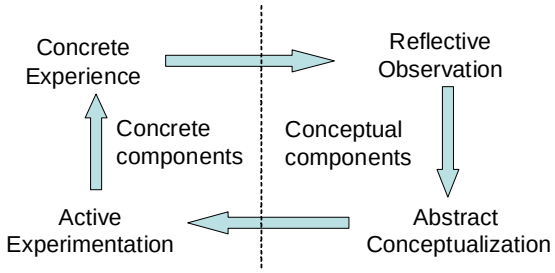

Figure.1. Kolb's Cycle of Experiential Learning

After gaining concrete experience, students should be encouraged to reflect on that experience. Through this reflective observation process, students could conceptualize and draw conclusion on their experience. It could then lead to different future actions in which the students can experiment with different scenarios. This learning cycle involves both concrete components and conceptual components which require a variety of cognitive and affective behaviors [7].

Experiential Learning in the HKU Sichuan Reconstruction Project

Objectives

A whole-person professional development is one of the educational aims of the University of Hong Kong. Engineering can no longer be taught mainly in classrooms, workshops and laboratories alone. Societal technical observation and community commitment are necessary to shape up this discipline and the young engineers today. In the summer of 2009, over forty undergraduate students were recruited to form a Sichuan reconstruction team. Two-third of the team members were engineering students and the rest were students from other different faculties. The objectives of the team were to design, implement and build various engineering systems for a reconstructed school in Sichuan that was affected by the Sichuan earthquake. The systems include solar energy panels, multimedia classrooms, satellite educational television, e-learning System and a computer laboratory.

Students were grouped in to five different groups and each group was responsible for different systems and tasks including: designed and built the solar energy system; installed the multimedia classroom and satellite TV; implemented an e-learning system; taught the local teachers and skill transfers, and interviewed with the local teachers and officers of the Education Bureau.

In order to achieve an effective experiential learning, the whole experiential learning cycle: from goal setting, to experimenting and observing, to reviewing, and finally action planning, was experienced first hand by each individual student in the project.

Solar Energy Team

In the Solar Energy Team, the team members set a goal to design a 2kW solar energy system for the reconstructed school. They designed a prototype of the supporting frame and took actions to build the prototype by themselves. As they did not have enough practical experience, their design was over specification and it was hard to manufacture it. They realized the problem by themselves through experimenting and observing the manufacturing process. Then they reviewed the design and tried again. After many attempts of trials and errors of designing the prototypes, the team figured out the optimal solution and finally planned the actions for the site implementation work.

Figure 2: Team members applied their knowledge to designed a prototype in the workshop (left), then built it (right), evaluate the performance and conceptualize for an optimal design

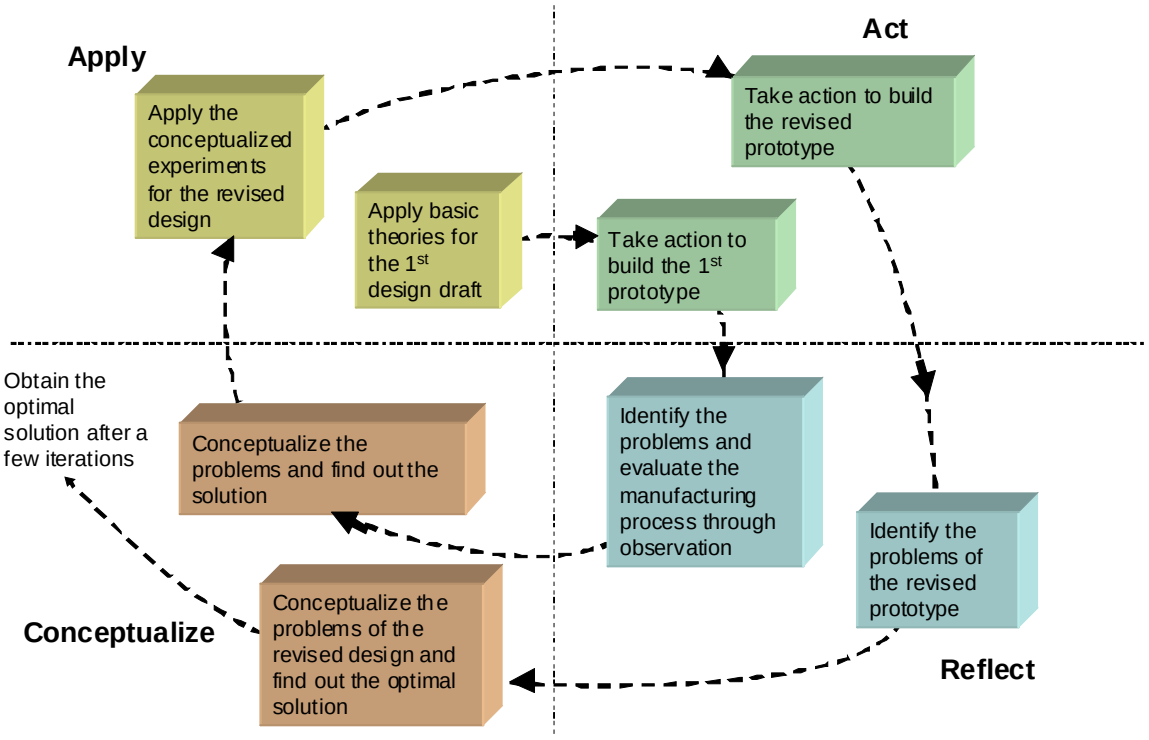

Figure 3: The experiential learning cycle of the Solar Energy Team

e-Learning Development Team

In the e-Learning Development Team, the team members set a goal to develop a user-friendly and effective e-learning system for the local Sichuan students. Before arriving Sichuan, the team members did not have any idea on the exact demands and needs of the local students. They applied their limited prior knowledge and prepared a few e-learning sample systems for Sichuan. These sample systems included an educational TV server, a digital story telling editor, an environmental awareness e-learning game and a Chinese hand-writing training software. The team believed that these applications should be useful for the local students.

The team acted and implemented these applications in the computer laboratory of the reconstructed school. They also transferred the skills to the local teachers and students. Through this experience, the team observed that some applications popular in Hong Kong, such as the hand-writing training software, might not be well perceived by the local

students. During that reflective observation, they became aware of the cultural and educational background differences. This experience is something that cannot be received from a lecture or a textbook or even the internet. A direct experiential involvement is the most effective and impressive way for international awareness and global citizenship education.

Figure 4: Through observing the responses of the local students, the team identified the right e-learning solution for the Sichuan local students

Learnt from the experience in the aforementioned two teams, such iterative experiential learning process allowed the team members to encourage new engineering design, learn new skills and even new ways of thinking. It is vital that the individual is encouraged to directly involve themselves in the experience. From that they gain a better understanding of the new knowledge and retain the information for a longer time [8].

The Successful Factors of the Experiential Learning project

This reconstruction project was a successful experiential learning project because many essential components of experiential learning were met. According to Andresen, Boud and Choen [9], the following attributes are essential for a project to be truly experiential.

Attribute 1: Meaningful Experience

First, the goal of experience-based learning should involve something personally significant or meaningful to the students. The Sichuan earthquake had created a great impact to China. Over seventy-thousands lives were killed and school campuses were destroyed. When we recruit student helpers to join the reconstruction team and asked for the reasons of joining, most of them indicated that they wanted to do something meaningful for the peoples in Sichuan.

Attributre 2: Engagement

The second attribute is that students should be personally engaged in the project. For most of the summer in 2009, students were deeply engaged in the project. They spent an one week trip in Sichuan where actual implementation took place, Prior to the trip, students were involved in the preparation and design of the systems at the university workshop. They attended meetings to discuss about the design, operation and logistics for the project. They prepared the delivery of parts and materials for the installation. After the trip, they also shared the experience with other students by means of publishing book and producing a video documentary program. This deep engagement gave students a strong sense of ownership to the project and their level of understanding and commitment were much higher than just acquiring knowledge in a lecture.

Attribute 3: Self-Reflection and Peer Evaluation

Third, after gaining the experience, there should be an ongoing self-reflecting and opportunities for students to write or discuss their experiences. In this project, students drafted their proposed installation designs and passed to one another for peer evaluations. Through this exercise, students could learn from one another and improve their designs in a collaborative way. Supervisors also gave comments and feedbacks to ensure that their experiential learning process was on the right track. After the project, students also wrote their feelings and self-reflections which later they published that in a book to share their reflection and knowledge with others. This ongoing self-reflecting process and documentation of their experience were one of

the important factors for the success of experiential learning.

Attribute 4: Whole Person involvement

Fourth, in order to reinforce the experience for the students, the whole person should be involved. In other words, we should involve not only students' intellect but also their senses, their feelings and their personalities. In this project, there were components such as the caring activities and memorial events being organized before and after the reconstruction works respectively. An environment for students to rethink on the reasons and objectives for the reconstruction project was created. Their memories on these remarkable experience could help them to retain the lessons for a longer period.

Attribute 5: Supervision

Last but not the least, teachers need to establish a sense of trust, respect, openness, and concern for the well-being of the students. In this reconstruction project, direct supervisions and interventions from teachers were minimal. Most members in the reconstruction team had their own different roles and responsibilities such as team leaders, general secretary, logistics secretary, designer, programmers and application developers. They were encouraged, trusted and respected by teachers to explore their best way of implementation. Students understood their own roles and importance in the project and all of them contributed their best for the team. These autonomous and self-motivation were important factors for the success of the project.

The Way Forward: Experiential Learning for Engineering Education in Hong Kong

Hong Kong being a knowledge-based economy, it is important to prepare our students to ensure international competitiveness in the global economy and bring in international dimensions. Experiential learning is one of elements to achieve this and bring our university students to produce well-rounded and whole person global citizens. Complexity of new engineering systems demands a more both in-depth and practical education for engineering undergraduates. Experiential learning could address this demand and equip engineering graduates with both theoretical knowledge and practice skills for paving the way to be a professional engineer.

As a matter of fact, the philosophy of experiential learning had been well deployed in professional engineering bodies. Elements of experiential learning had been included in well-structured engineering professional trainings in Hong Kong as early as 1990's. The Training Scheme "A" of the Hong Kong Institution of Engineers (HKIE) is intended to be 'Learning-by-Experience' and is based on the belief that this period is a natural progression in a trainee's education, with respect to putting theory into practice, and thus enhancing previous academic studies in terms of their 'real-life' application. The underlying HKIE philosophy is that the training experiences should be relevant and of the right level. It is considered that there is no better way to learn than by the trainees being practically and personally involved, in a 'hands-on' way, on their prescribed training activities. In this context it is expected that the training experiences will, wherever possible, be of an everyday kind normally arising within a project or a company [10]. This philosophy of experiential learning had in fact already been embedded in the engineering professional training in Hong Kong.

Looking forward, it is expected that experiential learning will play an important role in engineering education, not only for the university education but also for continuous education in professional bodies.

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