IMPROVEMENT OF THE INTERDISCIPLINARY APPROACH FOR A TECHNOLOGICAL CREATIVITY COURSE

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Abstract - *In this paper we first provide the background of an undergoing project for enhancing the technological creativity. Next, we summarize the student responses of last year, especially their learning difficulties, in order to look for directions of improvement for the course. With the evaluation collected for last year as a base, we re-design the activity of case study to help student speculate about the possible explanations of a real-life problem. Next, we supplement the activity of mind-mapping to encourage students to learn divergent thinking skills and be able to select one path for further implementation through the integration of technical concepts of design. The goal of the improved course content is to link the classroom activities more effectively to the theory being taught and to appeal to students' diverse interests. The overall perception of the improved curriculum was determined using a Likert rating scale, while students' feedback was collected using open-ended questions. The results indicated that the level of students' comprehension of teaching activity was significantly related to the degree of teacher's participation, students' self-involvement, comprehension of teaching activities, cooperative learning, learning outcome of the instructional activities, and classroom atmosphere. The implications for future instruction as well as for future research will be discussed.*

Keyword: Engineering Education, Higher Education, Interdisciplinary Approach

1. Introduction

Over the past three years' efforts on the implementation of the course of creative mechanical design, the web-based multimedia courseware has earned good reputation and has received awards twice from the Minister of Education in Taiwan. However, the researchers faced the challenge posed by the lack of complex learning settings and proper assessment methods for the course. The class was developed to inspire students' technological creativity, and to give them the opportunity to solve open-ended problems within an industrial working environment. The course was developed and taught for two years by Professor Shu-San Hsiau. Based on experiences from the first two years (Hsiau, 1998), he perceived the need for professionals from other disciplines to stress the importance of both communication and teamwork skills for engineering students. Therefore, over the past two years the faculties in Mechanical Engineering department have worked with faculties in Education to improve the classroom activities for developing student creativity. We have taught the course twice and have gained valuable experience in teaching interdisciplinary course.

Beginning last year, quantitative and qualitative data from student interviews and questionnaires have been collected and analyzed to understand the students' learning

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difficulties in order to look for directions of improvement. Some students felt that traditional engineering courses rely too heavily on theoretical, monotonous lecturing within the classroom environment and over-emphasize grades. The results of the student responses from last year also emphasize the need to provide more hands-on activities to keep students engaged. They felt that they could be more capable of solving the water hammering problem once they have a clear picture for the source of the problem. The survey results also indicated that even though some students perceived the course as an opportunity to broaden their scope, others claimed that the challenge of finding a mutual and agreeable topic among the group was beyond their ability. Therefore, Beginning this year, the mind-mapping activity was used to develop students' ability to approach their project where they are not sure from the beginning what they want to do. In fact, this kind of open-ended process that leads to discovery was the most important problem finding process described by creative individuals (Runco, 1994; Csikszentmihalyi, 1996).

With the evaluation collected for last year as a base, we re-design the activity of case study to help student speculate about the possible explanations of a real-life problem. Next, we supplement the activity of mind-mapping to encourage students to learn divergent thinking skills and be able to select one path for further implementation through the integration of technical concepts of design. Two improved instructional activities were highlighted in the following sections.

2. The Improvement of Instructional activities

Case study

In order to improve the shortcoming of monotonous lecturing, we demonstrated the entire process of water hammering in front of the whole class to help students visualize where the causes and effects were. Next, students were encouraged to hypothesize the cause, and to verify that hypothesis with a mental simulation of the problem. If the hypothesis passed the mental simulation, they then devised a resolution and tested. Thirdly, students were asked to outline what steps they would take in determining the causes and how to resolve the problem. Students were encouraged to demonstrate what was its normal operation and what was wrong. Furthermore, they were asked to respond to the following three areas:

- How should the system work normally?
- What would they do to verify a match with the real system?
- How would they devise a set of TTL logic circuits in place of the relay controller?

After the above problems were presented and explained, students were encouraged to utilize Wallas' (1926) processes of preparation, incubation, illumination, and implementation in order to decide the course of action to discover the cause and the solution to the problem pipeline. This was an activity to facilitate their techniques of problem definition, brainstorming, and teamwork. These aspects are important, since their previous education had not given them the time and opportunity to see various possibilities. By discussing this case, we encouraged students to accommodate multiple aspects of a situation so that they were better able to see alternative solutions. Even if they did not have the competency to completely solve the problem, the procedure of creative thinking is worthwhile to stimulate their intellectual growth.

Mind-mapping activity

The mind-mapping activity is a non-competitive intellectual stimulating assignment to enrich students' understanding of the divergent thinking (Lumbsdaine, 1995). It not only creates opportunities for students to learn from one another, but also enables students to participate and interact. The emphasis of the approach is to take responsibility as an active learner and to develop the ability to find questions and make comments about the projects.

First of all, we introduced all of the components of a mind-mapping. The best way to convey students the significance of the activity is to show them the role it plays in an overall problem-finding process, including examples which show application of the divergent thinking skill in current professional practices. After introducing students to the mind-mapping done by the pilots of Boeing aircraft company, Digital computer company, etc., students were encouraged to produce a mind-mapping individually. The topic used for the individual activity was ***Fly*,** which would help them to design their own prototype airplanes for the upcoming creativity contest. Figure 1 is one student's mind-mapping to illustrate his concepts of *flying*.

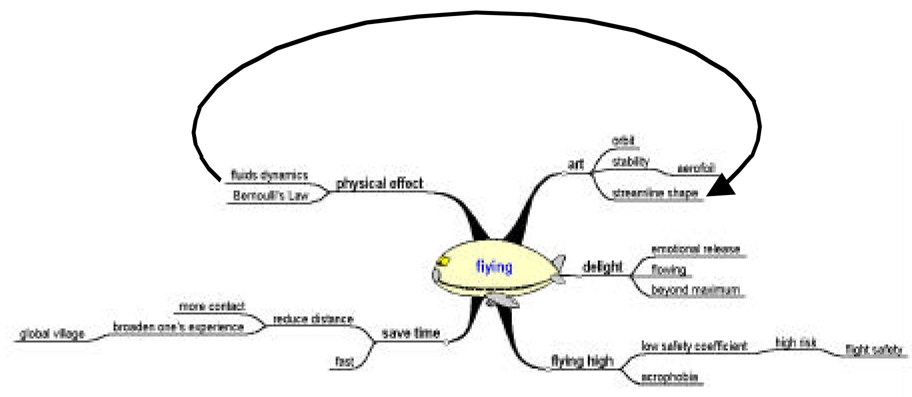

Figure 1. The Mind-mapping of the Concept of *Flying*

3. Discussions and Conclusions

The goal of our interdisciplinary approach in the technological creativity course is to integrate theories of creativity with project-based curriculum for the benefits of engineering students. With the partnership of the interdisciplinary researchers, we wish to establish an effective model to further cultivate the creativity in engineering students. By providing students with the experience of solving the kind of practical problems they will encounter as professionals, students can shed their deep-rooted question-and-quick-solution type of reflective learning style, and begin their evolution into seasoned engineers who would test, observe, incubate, and innovate.

The information generated by the rating scale indicated that the level of students' comprehension of teaching activity was significantly related to the degree of teacher's participation, students' self-involvement, comprehension of teaching activities, cooperative learning, learning outcome of the instructional activities, and classroom atmosphere. For instance, the findings for this study pointed out that if the classroom atmosphere was interactive, energetic and supportive, students would be willing to devote more time to apply the skills and knowledge they have learned in the case study to other domains, such as electrical engineering. In general, the involvement of students in this course was very active; if students had any questions, they were not afraid to ask them. They also learned to improve their problem-solving attitudes: as a future engineer, they have learned from the case study that a trivial error could still cause big problems. Furthermore, it is important to analyze where the problem came from by searching for the solutions through efforts and practices. For instance, throughout the process of solving the case of water hammering regards to problem pipeline, they realized that whenever they encounter an unknown phenomena, they should trace it from the beginning, and solved the problem based on collected evidence. On the other hand, during the mind-mapping experience, they gradually developed their sense of responsibility and realized that each member's involvement and contribution was very crucial to the group as a whole. Despite the anxiety and insecurity they felt when first confronting the challenge of divergent thinking, the mind-mapping activity offered the students a productive skill for responding to problems and thereby deciding on courses of action seen as possible and desirable.

Evidently, this research pointed to the crucial role of the teacher in facilitating creative learning. Teachers need to nurture student's own interests, arrange classroom conditions to emphasize intrinsic rewards, and to minimize extrinsic pressures for competition, grades, and rules. They need to "read" the shifting needs of different students, adapt to individual interests, and balance intervention, critique, and encouragement in interactions with students. Finally, it is important to further explore the interaction of factors to ensure that opportunities for enhancement of creative learning are optimized. Future research could be conducted to examine these engineering students' difficulties and their creative problem-solving strategies to cope with the barriers over the course of their learning to design.

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