THE STUDY OF CREATIVITY OF ENGINEERING CURRICULUM OF DEPARTMENT OF TECHNOLOGY EDUCATION IN COLLEGE

Jeh-Lou Meng

Abstract—In professional curriculum of engineering education, the development of creativity of student is an important mission in the era of Knowledge Economy. This study aims to explore the relationship between the reformation of engineering curriculum and the development of creative ability in undergraduate students. The research includes four subprojects that are conducted by the departments of electrical engineering, industrial management, industrial design and apparel engineering. To begin with, one professional curriculum was elected from the subprojects. Emphases, firstly, would be put on strengthening students’ domain knowledge that includes formal and informal ones. Secondly, a research framework is proposed, which is divided into two parts, to establish a systematic model for creativity, and to analyze and discuss the collected data. In addition, the systematic model for creativity covers the definition of creativity, the definition of creativity nature, and the measuring instruments of creativity. Based on the creativity theory, the research structure is to establish the framework of creativity and to develop teaching units of creative ability and then proceeds to conduct the teaching experiments. To complete the research, the research team expects to compile four teaching handbooks to stimulate students’ creativity in engineering colleges. To have further verification, the teaching methods designed will be adopted next year in the curriculum.

Introduction

Education has always been a key public-agenda item because the policies of educational reform have a great impact on stimulating a country’s economic growth. Teachers, under such circumstances, have to be constantly award of new techniques and be receptive to learning creativity skills so as to impact their students. Repaid changes in a knowledge-based economy and an information technology environment have led to an urgency in revolutionizing some of the ways educational training has been for centuries. For example, in Singapore, students would rather taking up courses related to science and engineering to meet the changing economy where technology and knowledge matters. The future is always uncertain but we will see:

1. more academic demands for teachers
2. lifelong learning for all who wish to remain in the workforce which has to constantly keep up with new changes and rapid technological advances,
3. growing emphasis on science, technology, and technical courses in an IT environment, and
4. flexible school scheduling to accommodate the varying demands for new courses and work hours.

Creativity may also be considered as a physical process that one must undertake to achieve a particular goal, as well as an individual quality that one naturally possesses.

So we can state creativity in education is addressed as a way to help educators in their journey into the next century.

Referring to the current teaching methodologies adopted by most colleges in Taiwan, lectures or speeches take most part of the through curriculum. This does a little effect on developing and inspiring students’ creativity. In the past, the main goal for teaching college students is to broaden their knowledge and to develop their specialist skills. However, in the era of Knowledge Economy, the nature and complexity of technology have changed so significantly that the skills learned today might be useless in the near future. What students need to acquire, therefore, in order to meet the workforce, is the ability of creativity.

In Taiwan, the government proclaimed to carry into a “9-year consisted course” in elementary school and junior high school from 2000. Many courses reorganize and regulate, attach important to develop students’ creativity. But professional curriculum in colleges and general courses are different. It is important to innovate in teaching method and teaching material and to inspire students creativity.

On the aspect of the programs designed by academics in colleges, the critical concern is how to adopt novel teaching methodologies and refine academic content that help to attract students’ interests and develop their potentials. Consequently, students can be benefit by maximizing their potential, effectively utilizing their knowledge and abilities as well as their creativity as soon as turn into the workforce environment.

The Research Objective and Structure

The study is concerned with exploring the ways in which conventional teaching methodologies may be adjusted within colleges by means of developing novel curriculums. Designed to help students to deal with the pressure of

1 Jeh-Lou Meng, Oriental Institute of Technology, mj@mail.oit.edu.tw
today’s competitive environment. The program will be of major benefit to individuals whose creativity can be inspired and developed. With this purpose in mind, this research focuses on examining the major departments in industrial colleges which are electrical engineering, industrial management, apparel management and industrial design. Each department chooses a course in which the content comprises lectures and laboratories. The four subprojects under this research would be conducted individually by the departments to examine the procedures of conveying professional programs in order to develop teaching units that help to cultivate students’ creativity. Eventually, the teaching units would be assembled as a teachers’ handbook. The research structure is as follows:

1. Forming teaching unit that addresses the key professional knowledge, creativity and practices.
2. Evaluating the effects of the teaching unit.
3. Compiling a teachers’ handbook. The content of the teachers’ handbook will be adjusted further by an empirical research.

**Research Methodology**

This study is initially undertaken a literature review to find out what has been written on the subject area. An array of secondary information, from text books, theses, and journal articles, will be used to build up an information base. After completing the literature review, a secondary data research, open-questionnaires and in-depth interviews shall be undertaken as the primary data research. This research design should provide a detailed investigation into developing students’ creativity. The teaching units and teachers’ handbook shall be drawn upon by researchers according to their expertise and experiences. The research methodologies are

1. Collecting and organizing useful information about the teaching methodologies and strategies on enhancing creativity.
2. Classifying documentation relating to the teaching methodologies and strategies on enhancing creativity as well as the ideal teaching subject matters.
3. Gathering information and literatures about the techniques on developing creativity and categorizing the recognized teaching units. Inviting renowned scholars and experts to reassure the developed structure by means of Delphic method. The teaching units in the program content shall be defined and make contribution to file the teacher’s handbook.

**Creativity Teaching**

In the past, development creative teaching methods had been developed a lot. But those creative teaching methods are not all suitable in practice course in college. This research will introduce and choose suitable methods in each unit and item. The chosen three basic teaching strategies and seven teaching methods areas follows

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Occasions</th>
<th>Teaching Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cramming</td>
<td>A. Textbooks</td>
<td>A. Introductive lectures</td>
</tr>
<tr>
<td></td>
<td>B. Teachers and students are less interactive</td>
<td>B. Drawing upon Examples</td>
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<td></td>
<td></td>
<td>C. Equipment operation</td>
</tr>
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<td></td>
<td></td>
<td>D. Organizing visit activities</td>
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<tr>
<td></td>
<td></td>
<td>E. Watching video tap</td>
</tr>
<tr>
<td>Q&amp;A</td>
<td>A. Teachers give questions for students to answer.</td>
<td>A. Q&amp;A.</td>
</tr>
<tr>
<td></td>
<td>B. Teachers got only “Yes” or “No” feedback</td>
<td>B. Test.</td>
</tr>
<tr>
<td>Conversation</td>
<td>A. Teachers give question and students starts thinking and discussion.</td>
<td>A. Team work</td>
</tr>
<tr>
<td></td>
<td>B. Teachers comments student respond</td>
<td>B. Theme report</td>
</tr>
<tr>
<td></td>
<td>C. Teachers and students are more interactive</td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. Encourage suggestions and question</td>
<td></td>
</tr>
</tbody>
</table>

Besides, it also references teaching methods as follows

1. **Brainstorming**
   - Originated by Alex Osborn in 1938 as a method for improving group problem solving in advertising firm. Brainstorming is probably the most widely used program designed specifically to enhance creativity. Osborn (1963) suggests that the creative process involves two steps idea generation and idea evaluation. Idea generation can be further subdivided into fact-finding, problem definition and preparation and idea-finding. Combination of and extrapolation from old ideas. According to Osborn, brainstorming is most useful for idea-finding.

2. **Syneclics**
   - Developed by William Gorden in 1944. Syneclics
is a creativity-stimulation program whose title is taken from the Greek work for joining together different and apparently irrelevant elements. Specifically, participants are instructed to use four types of analogy: 
- A personal analogy, in which the individual imagines himself to be the object with which he is working; 
- B direct analogy, in which facts, knowledge, or technology from one domain are used in another; 
- C symbolic analogy, in which images are used to describe the problem; and 
- D fantasy analogy, in which the individual expresses his wishes for ideal, though fantastic, solutions to the problem.

3. Creative Problem Solving
Creative problem solving is an eclectic training program developed by Sidney Parnes in 1976. The program comprises both individual and group techniques, including brainstorming and the use of checklists for generating new ideas from old ones.

4. 6W Methods
According to question quality, from "what", "why", "who", "when", "where" "how" finds shortcoming and improvable ways.

5. Association
Use imagination and association to creative and problem solving

6. Morphological Analysis
Differentiation questions and listing any variable element, and combines this to get more concept.

7. Focus Group Methodology
The focus group technique involves interviewing two or more people at the same time. The size of the focus group should be large enough to generate diverse viewpoints, but small enough to be management. Krueger recommends seven to ten people per focus group. This will allow each person the opportunity to participate in the discussion.

The key elements of all the methods are to prepare the mind and to postpone evaluation for as long as possible increase the number of ideas.

Besides, also some ways can inspire students’ creativity as follows:

1. Establishing a Creative Climate
   It is important to begin by promoting a positive attitude towards creative education through talks, seminars, courses, and even campaigns. This attitude can only be sustained in a creative climate. In order to establish a creative climate where creativity can flourish, school principals need to:
   - Improve communication by encouraging feedback of new ideas to colleagues,
   - Encourage brainstorming at all levels, and
   - Market new ideas introduced into the schools.

   Classes need not be conducted in the traditional way. Students can have lessons outside the classroom in parks, on the road, or even in the canteen, so that they can use the surroundings to stimulate their thinking and come up with unexpected ideas.

   The atmosphere of the learning environments is also important. Teachers should try to create a soothing atmosphere so that students feel at ease to think creatively.

2. Encouraging Class Suggestions and Questions
In order to encourage learning, teachers must allow students to make suggestions freely. Teachers should never try to pinpoint their students' mistakes as this deters students from thinking creatively. Students may then think that whatever ideas they suggest will be marked down. Teachers should also not give students an outline or a set of guidelines to follow as this would restrict their creative thinking to what is given. Instead, students should be encouraged to question their teachers' viewpoints.

3. Organising Visits
   Visits are like explorations and should, therefore, be organised. Places like the Discovery Centre and Science Centre are the creative centres for students to explore. Seeing is believing. As they see the displays which are manifestations of creativity, they will begin to realise the impact of creativity on their life and society.

4. Innovation, Entrepreneurship and Global Management
   These can help students to become more cross-functional so that they can do multitasks. In other words, students should be exposed to multi-functions rather than be restricted by early specialisation.

5. Critical Thinking
   This will enable students to become effective workers who can contribute more productively in the workplace by taking on problems and proposing creative solutions rather than being overwhelmed by them.

   Engaging students in crossword puzzles or spelling is a straight-thinking skill. Critical thinking involves zigzag thinking which is a more powerful thinking mode that can aid productivity in the workplace.

6. Intuitive Thinking
   Albert Einstein once said, "I believe in intuition and inspiration; at times I feel certain I am right while not knowing the reason." Because the world has progressed from industries and manufacturing to entrepreneurship and service, it is beneficial to train students and employees to be intuitive. Research has shown a correlation between business success and intuition. Faced with pressures from competition, acquisitions, and cutbacks, companies are returning to logic and sequential, bottom-line thinking. However, intuition must be used.
in conjunction with rational, logical analysis to realize the full power of intuition in making difficult economic decisions.

7. Rethinking About the Examination
As it is widely said, "exams are a pain in the neck." We may not entirely agree with that but the truth is that the Singapore Institute of Management (SIM) will soon be a university fit for the 21st century where admission will not necessarily be based on examination results (The Straits Times, 23 August 1997). Moreover, the National University of Singapore will also introduce open-book examinations to test undergraduates' understanding rather than memory of facts. Even if examinations are here to stay, teachers should seriously consider setting challenging examination questions that not merely test students' knowledge but also encourage students to give creative answers through application and adopting a multi-disciplinary approach.

Instead of having two examinations in a school year, schools may consider reducing this to one main examination, at year end. The mid-year examination can be replaced by compulsory report writing, case studies, or workshops. This is a step towards experiential learning which enhances students’ learning strategies through group behavior as they interact during activities rather than through assessment in the form of examination.

8. Customer-Oriented Skills
These are becoming increasingly important in business because customers are getting more knowledgeable and demanding on service. The retailers of tomorrow need to be more customer oriented rather than just profit oriented. Moreover, the teachers of tomorrow at all levels of learning, including tertiary institutions, will need a more extensive repertoire of teaching strategies. They will be a resource for innovation and problem solving in the community. As the world becomes more entrenched in technology, they will need to be well versed in applying technology. Teaching students will be a more challenging task as teachers seek ways to engage students in higher cognitive processes based on breakthroughs in brain and human cognition research. This works both ways. As more research is being done, more new findings will benefit the community and teachers will need to upgrade their knowledge of the new advances resulting from research. Thus, teachers will need to adopt a “approach brain” approach in their teaching, that is, an approach that goes beyond testing merely students’ ability to recall facts. Future teachers will need multi-skills in organization, communication, and human relations in order to participate in a new world of teaching and learning. Their experiences will enable them to draw on real life examples to illustrate the principles and concepts in their lessons.

In the classroom, teachers must reduce on textbooks for answers. Teachers can emphasis creative thinking during lessons by encouraging students to think creatively for the answers instead of copying them from textbooks. Goal-oriented questions can be set to challenge students to work out different ways of attaining the goal. This is especially useful in developing skills in product innovation.

Research Objects of Investigation
Each of the four departments chooses a course as the research objects of investigation
1. Department of Electrical Engineering
   Practical of Interface
2. Department of Apparel Engineering
   Manufacture System Integrated
3. Department of Industrial Management
   Commercial Automation
4. Department of Industrial Design
   Product Design

Result
The four courses develop the teaching units are as follows

1. The Practical of Interfaces
   This course, the practical of interfaces, is categorized into 6 parts:
   1.1 Introduction to the Interfaces.
   1.2 The comparison among the standard PC’s I/O interfaces, i.e. ISA, PCI, USB, AGP, etc.
   1.3 Serial Interface, such as RS232.
   1.4 Parallel Interface, such as 8255A IC.
   1.5 Addressing Decoder and Implementation of Interfacing Cards
   1.6 Factory Automatic Control Modules, such as A/D Temperature Control, Step-Motor Control, DC motor speed control, DC motor Position control, etc. converter, D/A converter, Traffic Light Control, teachers’ handbook.

2. Manufacture System Integrated
   This course, the manufacture system integrated, is organized into 9 parts:
   2.1 Creativity and Thinking
   2.2 Form Design
   2.3 Organization Chart Design
   2.4 Motion-Study—Block Movement
   2.5 Robert Manipulation Design
   2.6 Factor Simulation
   2.7 Operate Heat Transfer
   2.8 Painting Clothes
   2.9 3D Human-Body Movement Scan

3. Commercial Automation
   This course, the commercial automation, is organized into 9 parts:
   3.1 Introduction-commercial automation introduction.
3.2 Commercial Flow-selling floor management
3.3 Goods and Goods Data Base Management
3.4 Customer Management
3.5 Information Flow-distribution management and information system structure.
3.6 Information Flow Technology of Commercial Automation
3.7 Distribution-distribution automation
3.8 Money Flow-money flow modernization
3.9 Future Developed Trend-commercial automation developed trend and situation

4. Product Design
This course, the product design, is organized into 4 parts:
4.1 Definition and Analysis -Title and Problem.
   4.1.1 Principle of development.
   4.1.2 Choice Title.
   4.1.3 Analysis -from design problem to design model.
   4.1.4 Product Plan.
4.2 Ideal Development.
   4.2.1 Awareness of creativity.
   4.2.2 Model Analysis
   4.2.3 Concrete Design.
4.3 Policy and Evaluation
   4.3.1 Policy goal and model
   4.3.2 Model of Measure policy.
4.4 Detail Development
   4.4.1 Design case study.
   4.4.2 Simulation: forecast design attribute.

Due to the limits of the article, the researchers choose the course of “Manufacture System Integrated” to represent the four courses and to explain the summary of the teaching handbooks which are Apparel Engineering Department “Manufacture System Integrated” Creative Skill Study, Teaching Strategy and Method Study.

Unit 1: Creativity and Thinking
1. Item: A. The usage of brain B. The important of creativity. C. To modulate the creativity
2. Teaching content: Symbolize the creativity, to furnish the goal and solve the problem.
3. Strategy used in Creativity Teaching: Creative Problem Solving.

Unit 2: Form Design
2. Teaching content: Either in work or at home, it is very useful to use a form. Understanding it and then do the design, and design one that is useful in your work.
3. Strategy Used in Creativity Teaching: 6W Methods
4. Design of teaching project: A. Understand those about management system and environment. B. Assure the function of frm and its usage and

Unit 3: Organization Chart Design
1. Item: A. The meaning of organization chart.
   B. Attribute of the company. C. Design theoretical. D. Demonstrate on example
2. Teaching Content: The company organization chart design
4. Design of teaching project: Design for oneself that used to be stayed company.

Unit 4 ⊙ Motion –Study -- Block Movement.
2. Teaching Content: MTM unit motion study, micro unit motion manipulate, and manipulate analysis in the work space.
4. Design of teaching project: A. Give watch timing for student to test B. Block exercise.

Unit 5: Robot Manipulation Design
2. Teaching Content: A. Robot manipulate B. Use computer program to manipulate robot.
3. Strategy Used in Creativity Teaching: Morphological Analysis
4. Design of teaching project: A. Motion –study Block movement. B. Use teach-pendent for point definition.

Unit 6: Factor Simulation
2. Teaching Content: Student use computer simulation to practice factor arrangement
3. Strategy Used in Creativity Teaching: Synectics
4. Design of teaching project: A. Explanation before in class B. Operation computer

Unit 7: Operate Heat Transfer
1. Item: A. Dry transfer. B. Wet transfer C. Figure design
2. Teaching Content: Use heat transfer machine, in different temperature and material, print out different kind design, use different design to attract different label age of youth, to achieve their final goal.
3. Strategy Used in Creativity Teaching: Creative Problem Solving
4. Design of teaching project: A Study of cotton sheet. B. Operate explain
Unit 8  □ Painting Clothes
1. Item: A. Mix dye B. Dying material choosing C. Painting D. Ironing and pressing.
3. Teaching content: Use handwork dye in different material and painting pattern
3. Strategy Used in Creativity Teaching: Brainstorming
4. Design of teaching project: A. Explain dye function B. Choose fit cotton material C. Practice

Unit 9 □ 3D Human-Body Movement Scan
1. Item: A. Introduction and install B. Operation interface C. Introduction function D. Practice
2. Teaching Content: Drive human-body scan machine to measure body data. Lets students thinking and practicing how to get well-ways.
3. Strategy Used in Creativity Teaching: Personal analogy
4. Design of teaching project: A. Introduction and install B. Operate introduction C. Practice

Conclusion

In college, as the differences between the natures of practice courses, some of the courses are focusing on real operation experiences; some are on knowledge as well as theories. Similarly, Unit and Items also have the same emphasis situations. Therefore, it is better based on Items to select proper ways to stimulate students’ creativity.

When educators teach Items focusing on real operation, there are two things have to be completed after students understand the basic operation processes. First, educators have to give students the chances to do practice by following the operation procedure. Second, educators have to help students make real designs based on their own desire and understanding.

To some designs that require great effort and brainstorm, such as “automation design”, it would be better for educators to have case studies in class first, and then assign students to design their automation process. Necessarily, brainstorming, focus-group methodology and creative problem solving, discussion on the process has to be held in class. Through the interactive discussion, students can have better understanding on automation design; educators can give students great direction and stimulate their creativity.

Professional courses in college are broad and various. Each topic of each course has its own special features. Educators have to understand the philosophy and importance behind stimulation and creativity as well as the basic teaching methods for creativity. Then educators have to adaptively and flexibly adopt those methods in class to improve learning efficiency. For this study, we team up based on four different departments and four different courses. Each team studies independently, but interactively and frequently discusses with the other three groups. In the ways of efficiently sharing information including formal domain knowledge and informal domain knowledge □ and studying results, our team expects to complete four teaching handbooks to benefit stimulation and creativity teaching. To have further verification, those methods will be adopted in teaching next year to prove and have further modification.

Reference