

Engineering Teaching Courses Leading-in Creativity which Demands Teaching Situation and Element Analysis

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Abstract

In the era of industry 4.0, students not only need to cater to the needs of customers but also need to achieve the goal of integrating industrial skills with sales and products experience. It also helps to build up the complete adaptability, efficiency of resource and smart factory of human factors and ergonomics. As the result, there is a huge change of education in the field of engineering. Systematic cultivation of theory of innovation thinking and the practical application would be valued. Thus, this research chose the engineering students from one of the famous universities in Taiwan as the objects of study and also chose three courses of the college as the research samples. This research aimed at qualitative analyzing by doing in-depth interview and class observation to examine the teachers' teaching, students' learning attitudes and the arrangement of courses.

According to this research suggests that there are two parts of the characters of teachers' teaching and students' learning of the college of engineering. First, teachers from engineering fields still focus on the outcome of 'power of operation', thus, teachers especially emphasize on logics and 'elaboration'. Furthermore, they regard students' 'internal interests' is the top condition of learning. Second, the characters of the students from the college of engineering put stress on learning knowledge and skill systematically. Brainstorming and skill integration of project are developed in the end. Although the students show the positive attitudes of solving problems, it is hard for them to present the achievements of the course in finite time. As the result, this research suggests the adaptability and supporting measures of leading Three-Capacity to courses to advance the efficiency. In basic engineering courses and experimental courses, students need to learn basic concepts and skill; therefore, teachers have to provide the students with concrete practical teaching materials and proper materials and guide them to observe, thinking, present and lead creative thinking to courses. The advanced courses of engineering belong to be practical learning. To make students get rid of the old way that learning systematically and guide them to think creatively and integrate what they learn, teachers adopt unit-oriented teaching with creativity methods to be one of the characters of guidance of engineering teaching.

Keywords : Creativity · Innovation teaching · Industry 4.0

Introduction

In recent years, innovation, creativity, and design had been a new prominent subject of the world. In the future, Teaching for creativity will be one of the directions in the teaching field, and to make a comprehensive survey of European countries, British and

Finland use creativity as the backbone of their own economy. British's science and art education achieved a great success in creative economy and Finland used 'storytelling' as their strong weapon to cultivate students' creativity. It becomes thriving that use education as a foundation to form creative industries (Global Views Monthly, 2014 ; Vista, 2000) . Recently, Asia confidently starts to try innovative teaching; and China integrates creativity teaching with country development, then Hong Kong, Singapore, and Korea follow-up as well. Taiwan is also affected by this trend and keeps the tight relationship between academic teaching and industries. Microscopic viewing through the industry 4.0 concept; in addition to teaching professional skills and knowledge, how to enhance students' competitiveness in industries by leading creativity and innovation into courses is the topic the research will discuss. This research will discuss how to effectively integrate 'imagination', 'creativity', and 'innovative', the Three-Capacity (the following called Three-Capacity for short) into engineer college course with present conditions of teachers and students in engineer college. According to above thought and motivation, the following is the purposes of the research:

Research Purpose:

- (1)Exploring the characteristics of the engineer college teachers and their teaching attitudes toward Three-Capacity.
- (2)Exploring the engineer college students' learning characteristics and attitudes.
- (3)To address the adaptability of Three-Capacity integrated into engineer courses.

Literature Review

A. The current situation development in engineer field.

According to Department of Technological and Vocational Education planning in 2015, there are 8 categories of engineer college (Ministry of Education, 2016). Through the comparison of the way of entrance, the characters and cooperation of industries, there are three departments are similar and in a good relationship. One is Department of Electrical Engineering, another is Computer Science and Information Engineering, and the other is Department of Electronic Engineering and the goals of teaching put stress on professional skills and innovative capability. According to the courses, the engineer college students have to learn the structure could be basic course, experimental course and advanced course the 3 categories. The basic course is talking about theory and concept, experimental part focuses on experiment practice and machine operation, and advanced course put stress on real case-oriented teaching and topic practice lessons.

In the courses of Three-Capacity , the result of courses

searching system shows that there are only one or two courses in the engineering college, and not even to mention the practical and application part through an introduction to creativity. The engineering college seldom treats the Three-Capacity as independent courses. If teachers want to promote students' creativity ability, the direct way is put creativity skill into teaching; however, this kind influence cannot show the effects (Chia-Chun Hsiao & Chih-Hsien Tu, 2012). In contrast, there is an integration plan, 'A Study of Three-Capacity Building Course for Imagination,

Creativity and Innovative', about cultivating talents and research from Ministry of Science and Technology, the core of research development in Taiwan, and the part becomes the main research recently means there are many relative types of research about lesson contents and operation lessons come out.

From this, the engineering education should change the way of teaching because of the transformation of Taiwanese industries and the concept of industry 4.0 are the direction in the future. Nevertheless, there are difficulties in making creativity course as an independent course. The courses categories and adaptability would be the keys of Three-Capacity under the situation that the academic plan is encouraging this type of courses to be realized. According to the related research suggested that if teachers want to promote the creativity performance of students, the direct way is to put creativity skills into teaching; and there is no obvious effect of putting intention of potential impacts (Chia-Chun Hsiao & Chih-Hsien Tu, 2012). The result of 'Course Information Website of Universities 'shows that there are only one or two elective courses about creativity in recent two years, and those are most about the introduction of creativity. However, Ministry of Science and Technology, R.O.C., the core organization of academic research, executes the integrated plan of engineering teaching courses leading-in imagination, creativity and innovative, and this is also the main research promoted and researched recently. There are several related researches about putting Three-Capacity into courses of the college of engineering.

The changing of education of engineering field is necessary because of the trend of industry transformation in Taiwan and industry 4.0 concepts. The categories and adaptability of engineering courses are the crucial points under the situation with difficulties in setting the courses about Three-Capacity and the initial stage of the academic plan of creativity led into courses.

B. The requirements of building Three-Capacity and the performance characteristic in engineering field

The concepts of imagination and creativity are the same, but different by levels. Imagination is one of the dimensions on affection level, this is different from logic thinking, but this could help bring about many thoughts and enrich the connotations of rational thoughts. Thus, imagination could help learn new things and then the accumulation of knowledge and skills enhance the development of imagination (Kieran Egan et. al · 2014, ; Mark A .Runco · 2008 ; Chen, Yu Shu · 2016). Creativity means the capacity of creating, and this also put emphasis on new and useful, including the 5 dimensionalities: sensitivity, influence, flexibility and original; and the 4 different affection levels are imagination,

curiosity, challenge, and adventure. Creative thinking is a whole brain combination of logic and non-logic thinking means the process of developing the whole new thoughts, the points of view and knowledge and then producing the products, skills, approaches, systems, processes and forms which are not produced before. The training of observation, thinking, and expression is a quite important preparation to have the capacity for creative thinking (Xu Bin · 2010 ; Fox hsueh · 2016).

College of Engineering has the different educational goal to pursue. College of management focuses on innovative, and they put creativity into practice at work based on cost-benefit and create value for groups. However, college of engineering focuses on creativity and original. It is obvious that the differences of characters of creativity performance between the college of engineering and design. The performance of the college of design is overt, but the college of engineering put stress on efficiency and function. Most of the thoughts, logic and performance are internal and not easy to observe (Nien yu-hsun · 2016).

C. The influence of teaching self-efficiency and creative teaching behaviors toward creativity teaching

Creativity comes from the interaction of three elements which individual, fields and academic discipline. To students' creativity, those school teachers are the most important gatekeepers and the backstage driving force. Teachers' confidence in teaching is the guaranty of teaching efficiency. Therefore, cultivating teachers' confidence in creativity teaching is the main point of putting teachers' faith of creativity cultivation into practice.

Teachers' creativity teaching behaviors could affect students' learning and developments of creativity, and teachers' self-efficiency of creativity teaching is 'teachers have the faith to produce the achievements of creativity teaching.' The higher self-efficiency of creativity teaching, the higher creativity teaching behaviors; and teachers have much more positive teaching behaviors (Pi-Fang Lin, Hawjeng Chiou · 2008 ; Yu-Lin Chang, Hsueh-Chih Chen, Chih-Chun Hsu · 2010). Yu-Lin Chang ect argue that there are four facets of valid scale, fields of knowledge and ability, creative thinking, trait motivation and environment opportunity. Fields of knowledge and ability mean the strategies and principle of teaching and put stress on motivating students' self-learning behaviors. Creative thinking means the teaching strategies of creative thinking and high-level thinking. Trait motivation means the teaching strategies of cultivating the characters and intention of creativity. Environment opportunity means the interaction between students and teachers, offering resources and opportunities.

Conclusion:

To respond to the transformation of an environment, leading Three-Capacity into courses is the trend. Under the situation that there no individual courses of Three-Capacity and the situation of an initial stage of Taiwan academic plan operating the leading in the course, the courses categories and applicability are the key points.

The college of engineering focuses on efficiency and function more, and most of the thinking, logics, and achievement performance are introversive and imperceptible. This research

uses the five dimensions and the four affection facets of teachers and students' creativity and the teaching environment as the points of observing to know the characters of teachers' teaching, students' learning, teachers and students' tendency of Three-Capacity. Using the four facets of creativity teaching behaviors to analysis the teachers' teaching performance, and suggest the applicability of integrating the Three-Capacity with engineering course.

Research Method

There are 3 categories of courses, 'basic course', 'experimental course', and 'advanced course' being the research subjects, and 2 teachers from the department of electronic engineering and 1 teacher from Computer Science and Information Engineering are selected to do the semi-structured interview; and choosing the 3 courses, 'color engineering', 'digital logic design practice' and 'portable multi-media experience' they teach to execute classroom observation. Last, executing qualitative analysis by the contents of the in-depth interview which before courses starting, the records and the photos from classroom observation. With those data to understand the differences in teachers' attitudes toward teaching, students' characters and Three- Capacity led into courses. The creativity dimensions, affection facets, and teaching performance behaviors that are used as the dimensions of the research methods, and coding those data. The following chart 1 is the interviews and class observation. (I-interview of teachers; O-classroom observation, S-student, T-teacher,subjects and the sequence of outline, and coding data to form the following chart)
CHART 1-CHART OF IN-DEPTH INTERVIEW OF TEACHER AND CLASSROOM OBSERVATION

The points of interviewing and class observation	Basic course-color engineering	Experimental course-digital logic design practice	Advanced course-portable multi-media experience
A.teachers teaching behaviors	O-WT-A	O-YT-A	O-CT-A
B.Students' learning performance	O-WS-B	O-YS-B	O-CS-B
C.The knowledge and attitude of Three-Capacity	I-WT-C O-WT-C	I-YT-C O-YT-C	I-CT-C O-YT-C
E.Other related behaviors	E-P-(Number) E-T-(number)		

Research Analysis

A. Characteristic of teaching and attitudes of college of engineering

(1)'Power operate' is the basis of achievement, and teachers emphasis on logic and creativity are the dimension of 'elaboration' The thinking of college of engineering is using 'power operate' as a basis of judgment, even the result is the same. However, with the difference in materials, time and schedule, the power will be different. Then, this could be seen as a part of the inspiration of creativity (I-YT-A-14). Above all characters is the influence on the elaboration part that the teachers of engineering emphasis on. (2)Teachers easily get into 'courses are subjects' thinking, and emphasis on results more than process of creativity 'Achievement of producing creativity teaching' is the

reinforcement of teachers' self-efficiency. As a result of the importance of teaching of creativity, the result is not obvious in the short time; and this is still a whole new field of teaching, teachers will be worried and hesitated. The Teachers easily get into 'courses are subjects' thinking, and ignoring the dynamic factor of teaching the process(I-CT-C-5) (I-WT-C-11). One dimension teaching that teachers are the center of teaching will be easily ignoring the process and focus on the contents of teaching (Ching-Tien Tsai · 2016).

(3) Teachers pay more attention to students' interests, and interests are the top condition

Teacher uses self-experience indicate that 'interests could make course last longer and really learn things'. If the interests used as the top condition, teacher thinks that even students' insufficient of skills and knowledge could not be the difficulties of Three-Capacity teaching and cultivating.

"Y teacher: I'd fixed one radio as I was a little kid, then I fascinated with the electronic field."(I-YT-C-1)

"W teacher: I hope they would feel interested, and learn from the interesting part, and I prefer application rendering. The most important thing is to inspire them could self-learn. "

"Teachers use electronic parts as toys to attract students to achieve the goal of assembling, and initiate their interests and as the learn motivation. The whole process that grows out of nothing, teachers think it as the process of creative thinking. "(O-CT-A-25)

B. investigating the characters of engineering students' learning and attitudes

(1) They are more sensible of charts and engineering data, and easily avoiding conceptual questions

Students almost did not answer and avoid the conceptual and professional subjects questions (O-WS-B-3)(O-CT-A-5). Especially the proper nouns and texts, it is hard for students focusing on class, but they are sensible of charts and engineering data.

(2) An attitude of solving problems vigorously and stressing on learning knowledge and skill by the procedure.

Students would figure out the way to solve problems when they face the problems of assembling unexpectedly. Most of them would go back the last step, and think it is also a kind of learning by solving problems. However, students are getting used to following the process, they would learn the whole knowledge and skill first, then execute the special topic. Because of the limitation of the time, they could not learn the knowledge and skill they need to present the result they are supposed to have(O-CS-B-15). Teachers also could not know the power of outcome, and it does affect teachers' teaching to students(O-CS-C-2).

C. Suggesting the adaptabilities integrated Three-Capacity with engineering teaching

(1)Basic and experimental courses belong to be concrete practical teaching material that is beneficial to lead Three-Capacity to courses.

From basic and experimental courses, the teachers of engineering fields get used to making students learn the contents of engineering practices quickly, and also enforcing students' understanding of basic concepts by current events and practical

experience(O-WT-A-12) (O-WT-A-15) (O-WT-A-19). In the process of experiences, teachers would use structural sheets or questions to train students to have the abilities to observe, think, and present. During practice, to make students get into situation quickly, teacher assistants usually do a complete model as teaching materials to guide students; thus, students would deduce the executed parts backward to integrate the parts of operation and the parts need to be paid attention. This could be seen as the preparation of nurturing Three-Capacity and level up students' abilities of basic learning and sensitive observation(O-YT-A-8) (O-WT-A-25).

(2) In basic and experimental courses, students rely on the resource teachers provide. Teachers only need to provide those materials carefully.

It is quite important that the cases and materials for operating provided in class because the composition of the student in those classes are junior grades. Students most rely on the resource that teachers provide for them. Thus, the cases, definition of noun and materials that teachers offer could affect students' associative thinking and achievements(O-WT-A-10) ((O-WT-A-50).

(3) Advanced courses are unit-oriented teaching, creativity integrated with courses could guidance students to use engineering skills in achievements' presentation efficiently.

Leading Three-Capacity to courses needs the basis of skills, knowledge and skill could lower the difficulties of integration of Three-Capacity. Most of the advanced courses are arranged in junior and senior grades, and it is also the strength of the advanced courses. According to the habits of students from engineering fields, through teachers' unite-oriented teaching methods could help them improve the situations of command-oriented teaching. Through the divergent and convergent creativity methods, students could learn, integrate and apply the skill of units with projects' presentation.

Conclusion and suggestion

Overview the result of research, the thoughts, logics and presentation of the college of engineering are introversive and imperceptible. The characters of teachers' teaching take 'power of operation' as the basis of achievements, and emphasize on logic and 'elaboration' of creativity. Students' inner-interests are seen as the top learning condition. The students of the college of engineering get used to being the systematical learning, even they have positive attitudes of solving problems; however, they still could not present the achievements they are supposed to have, and it also makes teachers could not understand the 'process'. It does affect the teachers' judgments of students' learning efficiency. In respond to the characters of teachers' teaching and students' learning of the college of engineering, this research suggests that the adaptabilities of Three- Capacity integrated to engineering course could make sure the efficiency of learning; teachers could offer the efficiency way of teaching methods of Three-Capacity led in courses by the characters of courses. There are some suggestions for teachers and related units to think about the transformation if course:

(1) In basic and experimental courses, students most rely on the resource, concrete material and proper materials that teachers provide for them. It does guide students to do observe think and

present; It is not only beneficial to students learn basic professional knowledge and skill but also help students think associated and presentation by integrating creative thinking with courses.

(2) Teachers use unit-oriented teaching methods in advanced course, and it does solve the situations of command-oriented teaching methods by leading creativity in courses. Students also could learn the skill of units and present the outcomes flexibly.

Suggestions

This research argues that through the interviews and class observations of the characters teacher should have and the process of leading Three-Capacity in courses is worth investigating. The tendency of Three-Capacity could affect the directions of courses.

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