An Exploratory Study on Teaching Methods of Professional Course for Teachers from Engineering Colleges of Universities of Science and Technology

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Abstract

This study aims to gain an insight into the teacher's pedagogical content knowledge and teaching implementation from engineering colleges of universities of science and technology (UST). A total of 32 domestic public and private UST with engineering colleges were investigated. Through questionnaires, the pedagogical approaches used in the teaching of professional courses engineering college teachers were surveyed. Frequency distribution was adopted to describe teachers' choices of certain instructional approaches in practice. The χ2test for independence was then used to explore whether significant differences can be found in terms of instructional methods chosen. Findings show that "didactic instruction" was most commonly used as professional course methods by the teachers; the "drama/play" was the least commonly used. The χ2test for independence was then conducted, deriving results as follows: topic production commonly adopted in the fields of electrical / electronic engineering and design; team teaching occasionally used in those of information engineering; computer-aided instruction frequently used by mechanical, energy and civil engineering as well as architecture and design.

Key Words: *Engineering Education, Teaching / Instructional Methods, The X2test* for Independence.

Introduction

Engineering Education is very important to economic development. In response to global economic pattern changes and in the advent of the knowledge economy era, the governed has continued to include creativity improvement as the main national development strategy (Ministry of Education, 2003). Innovative thinking, critical thinking, and problem solving ability alike are important basic skills for future world citizens. Through teachers and the use of effective teaching methods, new opportunities can be created for the country and society (Ming-ta Wu, Pei-wen Liao, 2007). According to White Paper of Creativity Education (2003), future education plans will focus on important issues such as development of creative teaching and teaching innovation. The Ministry of Education (2000) pointed out hindrances to student creativity, including: 1. Schools' organizational culture does not encourage innovation and lacks long-term thinking; 2. Student appraisal overemphasizes results, but lacks measures for eliciting internal drive; 3. Teachers are overworked, creativity teaching materials are inadequate, resulting in the continued use of old materials that lack innovation. Future schools must seek management change, or they will be phased out. School management requires change and innovation at full blast in order to make creative management the drive for school improvement and development (Ching-shan Wu, 2005). Institute of Engineering Education Taiwan (IEET) stresses on graduates' core abilities, including the seven items below: 1. Mastery in knowledge, techniques, skills, and tools needed for professional practice; 2. Proper implementation of standard operating processes and the ability to analyze, explain, and apply experiments in improving practical techniques; 3. The ability to apply creativity in practical techniques; 4. Ability in project management, effective communication, and teamwork; 5. Ability to confirm, analyze, and solve technical problems; 6. Learning events and issues to understand the impact of practical techniques on the environment, society, and the world. Cultivate the habit and ability of continuous learning; 7. Understand professional ethics and social reasonability, and emphasize that schools should focus on students' practical technique ability, an indication of the importance of creativity in practical teaching. Technical and vocational education have always played pivotal roles in our country's economic development process (Ming-ta Wu, Pei-wen Liao, 2007). They not only increase students' learning opportunities, but also enhance the culture of creative teaching actions (Xiu-ying Hong, 2008). Technical and vocational education are intended to enhance national competitiveness, promote industrial restructuring, cater to social needs, and boost teaching growth. However, the industry is currently dissatisfied with talent cultivation. It is only through teaching for creative thinking and the use of innovative teaching strategies and methods can students' creativity be enhanced (Wei-wen Lin, 2007). Empirical studies on the teaching methods adopted by teachers of UST remain scarce. In this study, teachers from engineering colleges of UST with different backgrounds were adopted to obtain their different teaching methods and conduct in-depth analysis of areas to improve as far as teaching methods are concerned. This will, in turn, enhance teachers' creative teaching knowledge and the effectiveness and quality of their teaching.

Literature Review

The Summary of Taiwan's Education in Engineering Colleges of UST

According to the statistical data of the Ministry of Education for academic year 2014, ranked from high to low in terms of the number of students enrolled in undergraduate studies, it was found that among the top 10 departments, engineering related departments account for four. Hence, based on the statistics, engineering education plays a pivotal role in Taiwan's training of senior professionals. At present, there are a total of 14 public UST in our country, including 10 UST with engineering colleges and 36 engineering related departments; There are 43 private UST, including 22 UST with engineering colleges, including 48 engineering related departments under engineering colleges. About 5224 people graduate from engineering colleges every year.

Table 1 Distribution of engineering colleges in UST

	UST	Engineering college	Department (Doctorate, master, 4-year, 2-year)	No. of teachers	No. of students	Graduates for last academic year
Public	14	10	36	425	10876	2778
Private	43	22	48	410	10097	2446
Total	57	32	84	835	20973	5224

One of the main tasks of technical and vocational education is to training professional technical talents for practical uses. In particular, engineering education integrates technology and industry related knowledge and techniques; it is an important drive for national economic growth and social development. In view of this, the Ministry of Education (2013) promoted "Phase II Technical and vocational education Reform Program", including three dimensions consisting of nine strategies: 1. System adjustment (policy integration, department adjustments, practical talent selection); 2. Course activation (course flexibility, equipment update, practical empowerment); 3. Employment promotion (employment connection, innovative entrepreneurship, certification and capacity in one). It is expected that graduates of vocational senior high schools, junior colleges, technical colleges, and UST will be equipped with the ability to have immediate employment ability, while providing outstanding technical manpower that cater to industrial development needs and changing society's perspective on technical and vocational education, thereby enhancing the overall competitiveness of technical and vocational education. Due to increasingly improved global technological innovation and the impact of globalization and industrial upgrade, universities or science and technology must take industrial needs into more serious consideration in order to design practice-oriented courses and teaching materials to cultivate students' practical abilities. At present, talent cultivation in UST in Taiwan are professional general knowledge based, which is not in line with the industry need for hiring professional talents, thus resulting in the failure to apply learning (Ren-cai Zhang, 2014).

Teaching Methods adopted by Engineering Colleges of UST in Taiwan

The primary task of engineering education is to train engineers not to be biased towards theory and prioritize practice (Yih-young Chen, 2008). With the deepening of education reform, teaching should not only about letting students acquire certain existing basic knowledge (Dian-hua Chen, 2005). The cultivation of student's future competitiveness requires efficient learning through the implementation of teaching processes, thereby achieving the goal of education (Bao-shan Lin, 2003).

Therefore, new teaching methods and strategies should be sought in order to enable students to effectively learn professional knowledge and skills (Kose, Sahin, & Aysegul, 2010). Creative teaching encourages teachers to engage in versatile teaching to inspire students to be motivated to create and encourage them to perform creatively, in order to enhance the development of creative ability (Yu-lin Chang, Hsueh-chih Chen, Chih-chun Hsu, 2010).

Akerson & Hanuscin (2007) pointed out that in addition to correct and contemporary perspective on the essence of science, teachers should have knowledge of incorporating the essence of science into inquisitive teaching activities during teaching. They should also adopt diverse teaching methods to guide students to understand the perspective of the abstract essence of science. Meichtry (1995) found in his study that teachers' provision of hands-on practice to students when engaging in inquisitive activates allows students to feel like a scientist, thus making it the most effective teaching strategy for assisting students in paying attention to the inquisitive dimensions of science. Therefore, educational concept renewal, innovative atmosphere creation, innovative motivation, innovative potential exploration, and innovative behavior (Bu-Yi Cghenang, 2005) incentives are needed to cultivate ore creative future generations.

The 14 common teaching methods in university education summarized by Regina, Emmanuel, & Josiah (2010) served as the bas in this study in studying teachers' perception of innovation and teaching methods. Additionally, many domestic and foreign scholars' definition of the 14 teaching methods were compiled in Table 2. These 14 teaching methods served as the basis for the questionnaire questions that explore the teaching method use of teachers from engineering colleges of UST. Future recommendations for adjustments or improvement were also put forth accordingly.

Table 2 Common teaching methods and their definitions

Teaching method	Definition	Author/year
Lecture Mehtod	Knowledge and information are conveyed orally based on a pre-planned draft. Unidirectional communication is preferred. The main purposes are: conveying messages, explaining and eliciting interest. Didactic instruction is suitable: 1. When introducing new topics or units; 2. When teaching using hard-earned important teaching materials; 3. As supplemental materials for text books; 4. For drawing conclusions at the end of a unit; 5. To elicit students' interest and appreciation for subjects.	Hong-zhu Jian（2000）
Project	Through the exploration of issues, learners' thinking skill is developed. The learning process of revolving issues or completing topics helps achieve "learn how to learn". In other words, learners choose real and valuable topics to explore and attempt to seek solutions to problems during the problem exploration process. They work with others and use technological tools to propose learning results or works.	Giilbahar, Y., & Tinmaz. H. (2006)
Demonstration	The process of learning or changing behaviors by observing behaviors of others is a teaching method that emphasizes vision over hearing. Teachers execute a set of procedures or a series of actions to enable students to understand phenomena or principles in teaching. It usually covers actions, procedures, techniques, and knowledge. A variety of equipment and teaching assistants complement one another where appropriate. Special procedures include technical operations and scientific principles, and step-by-step demonstration. Teachers during the teaching process often demonstrate by behavior to teach students learn new behaviors, guide them to express learned behaviors, or demonstrate through appropriate behaviors to eradicate students' learned inappropriate behaviors.	Tian-zhou Zhang（2000）
Co-operation	This is a systematic and structured teaching strategy. During the process, teachers distribute students by aptitude, gender, and race into groups. Hence, this method is suitable for students of different ages and in different subjects.	Slavin, R. E. (1985)
Discussion	Every member of a group participates in activities. Teachers and students engage in discussions on certain topics to find answers or derive at opinions acceptable to most members of the group.	Bao-shan Lin（1997）
Workshop	A group of people with the same interest or focus is gathered. This activity enables students to promptly learn new knowledge and skills, or understand new trends and attitudes through a project or collaboration.	National Academy for Educational Research（2015）
Discovery	This method stresses the teaching process is based on students' inquisitive activities, from which, problems are found and their significances discovered.	Bao-shan Lin（1997）
Individual	Student interest is first elicited before arranging suitable learning contents based on students' individual differences.	Yong-xiang Chen（2010）
Team Teaching	Team teaching involves two or more than two teachers and assistants that establish objective-oriented professional relationships. In one or more disciplines, personal specialties are integrated and brought into full play. A variety of teaching tools and materials are put to good uses, thus teaching a group or student to apply different teaching methods.	Kun-qiong Li（2001）
Problem solving	This teaching method involves student's' practical problem-solving ability enhanced through search for a pathway to solving a particular problem.	National Academy for Educational Research（2015）
Computer-Aided Instruction	A computer is directly used during the teaching process to present teaching materials. Through conversations, students' individualized learning environment is provided and monitored.	Bao-shan Lin（1997）
Drama/play	Teachers design teaching situations that allow students to perform in person. In addition to stimulating students' keen interest, it is also a teaching method that enhances students' learning effectiveness.	Xing-chuan Wang（2001）

Teaching method	Definition	Author/year
Field Trip	Teachers and students visit actual workplaces or natural environments to observe and learn. Students will have an opportunity to combine class learning, real daily work, and activities, allowing them to understand the real; significance of class knowledge.	National Academy for Educational Research（2015）
Lab Method	Students' attention, observation, and thinking are guided through experiments or phenol. Teachers then introduce essential concepts and keywords in their explanation. Finally, the new concepts are elaborated and applied to solve new problems that arise.	Xing ao（1994）

Research Methods

Research Participants

In this study, full-time teachers from engineering colleges of all the UST in the nation were adopted as research participants. In accordance with the Table of 2014 Public and private UST prepared by Department of Technological and Vocational Education, a total of 835 teachers from 32 UST with engineering departments were adopted as questionnaire survey participants. The convenience sampling method was adopted, with a total of 480 copies distributed. Of the questionnaires recovered, 257 were valid copies (The effective recovery rate reaching 53.5%).

Research Tools

The content of this questionnaire survey is compiled based on the 14 teaching methods summarized by Regina, Emmanuel, & Josiah (2010). Additionally, through the expert content validity review conducted by seven scholars, the content and format of the questionnaire effectively were completed after integrating the theories and the opinions of experts and scholars. Thus, the questionnaire possesses a certain degree of face validity and content validity.

Data Processing and Analysis Methods

After recovering the questionnaire data, samples were strictly screened based on their answers. Incomplete invalid questionnaires were eliminated. Computing data coding was then conducted. Statistical package software SPSS was adopted to complete statistical analysis. The statistical methods used in this study are described below:

Descriptive statistics

Based on the background variables of the teachers from engineering colleges of UST, including gender, age, number of teaching years, main research field, practical experience, degree of teaching innovation, and other questions and through the use of frequency distribution and percentages, the distribution of the questionnaire respondents' basic information is described.

Test for independence

Based on the background variables of the teachers from engineering colleges of UST and the 14 teaching methods summarized by Regina, Emmanuel, & Josiah (2010), the χ^2test for independence was conducted to verify whether or not the teachers' background variables produced significant differences.

Analysis

Analysis of Demographic Variables

The background information in this questionnaire includes: gender, age, number of teaching years, field of teaching, practical experience, and degree of teaching innovation, a total of six survey items. In the background information analysis, the males comprised the majority, accounting for 235 people (91.4%); most of the teachers belonged to the age group of 51-60 years old, accounting for 101 people (39.3%); as for the number of teaching years, 21-30 years comprised the majority, accounting for 94 people (36.6%); the main field of research is machinery and power, accounting for 90 people (35%); teachers with practical experience comprised the majority, accounting for 175 people (66.9%); the teachers who deemed their degree of innovative teaching average accounted for 110 people (42.8%).See Table 3 for details.

Table 3 Descriptive analysis of the background variables of teachers from engineering colleges of UST (N=257)

Item		Frequency	%	Item		Frequency	%
Gender	Male	235	91.4	Main research field	Machinery and power	90	35
	Female	22	8.5		Electrical and electronics	70	27.2
Age	Under 35 years old	12	4.7		Chemical engineering and material	25	9.7
	36-40 years old	25	9.7		Civil engineering and architecture	22	8.6
	41-45 years old	43	16.7		Design	3	1.2
	46-50 years old	65	25.3		Information and information engineering	21	8.2
	51-60 years old	101	39.3		Other	26	10.1
	Over 60 years old	11	4.3				
No. of teaching years	5 years (or less)	26	10.1	Practical experience	Yes	175	66.9
	6-10 years	41	16.0		No	82	31.9
	11-20 years	79	30.7	Degree of teaching innovation	Highly innovative	27	10.5
	21-30 years	94	36.6		Generally innovative	96	37.4
					Average	110	42.8
	30 years (or more)	17	6.6		Less innovative	21	8.2
					Completely non-innovative	3	1.2

Differential analysis of background variables in teaching method usage

This study contains data of two variable categories. Hence, the χ2test for independence was adopted to verify different background data and the usage frequency of teaching methods, Results are described below:

(1) Gender

Results in Table 4 were obtained through the χ2test for independence. Findings show that the teachers of both ganders reached significant differences in computer-aided detaching method usage. Moreover, up to 76.2% of the male teachers fell under “frequently use” and “occasional” in computer-aided teaching method usage frequency. On the contrary, most female teachers fell under “seldom” and “occasional” ($\chi2=7.934$, $p<.05$).

Table 4 Differential analysis of gender in teaching method usage

Teaching Method	Gender	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
Didactic instruction teaching method	Male	2 .9%	5 2.1%	45 19.1%	183 77.9%	1.998	.575
	Female	0 .0%	1 4.5%	2 9.1%	19 86.4%		
Project	Male	5 2.1%	29 12.3%	114 48.5%	87 37.0%	3.449	.327
	Female	1 4.5%	0 .0%	12 54.5%	9 40.9%		
Demonstration	Male	5 2.1%	28 11.9%	99 42.1%	103 43.8%	1.415	.702
	Female	0 .0%	4 18.2%	10 45.5%	8 36.4%		
Co-operation	Male	14 6.0%	78 33.2%	98 41.7%	45 19.1%	4.272	.234
	Female	0 .0%	4 18.2%	13 59.1%	5 22.7%		
Discussion	Male	6 2.6%	46 19.6%	129 54.9%	54 23.0%	.483	.923
	Female	1 4.5%	5 22.7%	11 50.0%	5 22.7%		
Workshop	Male	68 28.9%	84 35.7%	60 25.5%	23 9.8%	3.488	.322
	Female	3 13.6%	8 36.4%	9 40.9%	2 9.1%		
Discovery	Male	41 17.4%	98 41.7%	75 31.9%	21 8.9%	4.437	.218
	Female	6 27.3%	5 22.7%	10 45.5%	1 4.5%		
Individual	Male	24 10.2%	67 28.5%	97 41.3%	47 20.0%	1.282	.733
	Female	1 4.5%	8 36.4%	8 36.4%	5 22.7%		
Team Teaching	Male	49 20.9%	99 42.1%	65 27.7%	22 9.4%	3.292	.349
	Female	4 18.2%	7 31.8%	10 45.5%	1 4.5%		
Problem solving	Male	15 6.4%	41 17.4%	114 48.5%	65 27.7%	.895	.827
	Female	1 4.5%	4 18.2%	9 40.9%	8 36.4%		
Computer-Aided Instruction	Male	17 7.2%	39 16.6%	90 38.3%	89 37.9%	7.934*	.047
	Female	4 18.2%	7 31.8%	7 31.8%	4 18.2%		
Drama/play	Male	94 40.0%	81 34.5%	47 20.0%	13 5.5%	1.628	.653
	Female	6 27.3%	9 40.9%	6 27.3%	1 4.5%		
Field Trip	Male	32 13.6%	75 31.9%	95 40.4%	33 14.0%	3.524	.318

Teaching Method	Gender	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
	Female	5 22.7%	5 22.7%	11 50.0%	1 4.5%		
Lab Method	Male	19 8.1%	28 11.9%	98 41.7%	90 38.3%	1.460	.691
	Female	1 4.5%	2 9.1%	12 54.5%	7 31.8%		

*p< .05

(2) Age

Results in Table 5 were obtained through the χ2test for independence. Findings show that the teachers of different ages reached significant differences in team teaching and experimental teaching usage. Moreover, the teachers belonging to the age groups of 36-40 years old and 61 years old (or higher) occasionally used team teaching, while the teachers of other ages used it less frequently（χ2=29.256, p< .05）. Most teachers often used experimental teaching, but the teachers belonging to the age groups of 41-45 years old and 51-60 years old only occasionally used it (χ2=30.216, p< .05).

Table 5 Differential analysis of age in teaching method usage

Teaching method	Age	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
Didactic instruction teaching method	35 years old (or less)	0 .0%	0 .0%	3 25.0%	9 75.0%	19.412	.196
	36-40 years old	0 .0%	0 .0%	3 12.0%	22 88.0%		
	41-45 years old	1 2.3%	1 2.3%	9 20.9%	32 74.4%		
	46-50 years old	0 .0%	1 1.5%	16 24.6%	48 73.8%		
	51-60 years old	0 .0%	4 4.0%	14 13.9%	83 82.2%		
	61 years old (or higher)	1 9.1%	0 .0%	2 18.2%	8 72.7%		
Project	35 years old (or less)	0 .0%	2 16.7%	5 41.7%	5 41.7%	11.752	.698
	36-40 years old	0 .0%	2 8.0%	15 60.0%	8 32.0%		
	41-45 years old	2 4.7%	6 14.0%	21 48.8%	14 32.6%		
	46-50 years old	2 3.1%	6 9.2%	30 46.2%	27 41.5%		
	51-60 years old	1 1.0%	13 12.9%	47 46.5%	40 39.6%		
	61 years old (or higher)	1 9.1%	0 .0%	8 72.7%	2 18.2%		
Demonstration	35 years old (or less)	0 .0%	2 16.7%	5 41.7%	5 41.7%	13.756	.544
	36-40 years old	0 .0%	1 4.0%	9 36.0%	15 60.0%		
	41-45 years old	2 4.7%	5 11.6%	22 51.2%	14 32.6%		
	46-50 years old	0 .0%	7 10.8%	30 46.2%	28 43.1%		

Teaching method	Age	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
	51-60 years old	2 2.0%	16 15.8%	39 38.6%	44 43.6%		
	61 years old (or higher)	1 9.1%	1 9.1%	4 36.4%	5 45.5%		
Co-operation	35 years old (or less)	0 .0%	4 33.3%	3 25.0%	5 41.7%	16.864	.327
	36-40 years old	3 12.0%	6 24.0%	10 40.0%	6 24.0%		
	41-45 years old	4 9.3%	16 37.2%	15 34.9%	8 18.6%		
	46-50 years old	1 1.5%	22 33.8%	27 41.5%	15 23.1%		
	51-60 years old	5 5.0%	32 31.7%	51 50.5%	13 12.9%		
	61 years old (or higher)	1 9.1%	2 18.2%	5 45.5%	3 27.3%		
Discussion	35 years old (or less)	0 .0%	3 25.0%	4 33.3%	5 41.7%	18.175	.254
	36-40 years old	1 4.0%	7 28.0%	11 44.0%	6 24.0%		
	41-45 years old	2 4.7%	13 30.2%	23 53.5%	5 11.6%		
	46-50 years old	1 1.5%	8 12.3%	37 56.9%	19 29.2%		
	51-60 years old	2 2.0%	20 19.8%	58 57.4%	21 20.8%		
	61 years old (or higher)	1 9.1%	0 .0%	7 63.6%	3 27.3%		
Workshop	35 years old (or less)	1 8.3%	8 66.7%	0 .0%	3 25.0%	17.559	.87
	36-40 years old	7 28.0%	9 36.0%	8 32.0%	1 4.0%		
	41-45 years old	15 34.9%	12 27.9%	11 25.6%	5 11.6%		
	46-50 years old	15 23.1%	23 35.4%	20 30.8%	7 10.8%		
	51-60 years old	31 30.7%	37 36.6%	25 24.8%	8 7.9%		
	61 years old (or higher)	2 18.2%	3 27.3%	5 45.5%	1 9.1%		
Discovery	35 years old (or less)	0 .0%	7 58.3%	3 25.0%	2 16.7%	15.943	.386
	36-40 years old	9 36.0%	10 40.0%	6 24.0%	0 .0%		
	41-45 years old	9 20.9%	17 39.5%	13 30.2%	4 9.3%		
	46-50 years old	10 15.4%	24 36.9%	24 36.9%	7 10.8%		
	51-60 years old	17 16.8%	42 41.6%	33 32.7%	9 8.9%		
	61 years old (or higher)	2 18.2%	3 27.3%	6 54.5%	0 .0%		
Individual	35 years old (or less)	3	1	4	4	24.072	.064

Teaching method	Age	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
		25.0%	8.3%	33.3%	33.3%		
	36-40 years old	2	9	13	1		
		8.0%	36.0%	52.0%	4.0%		
	41-45 years old	7	17	13	6		
		16.3%	39.5%	30.2%	14.0%		
	46-50 years old	5	15	32	13		
		7.7%	23.1%	49.2%	20.0%		
	51-60 years old	7	30	41	23		
		6.9%	29.7%	40.6%	22.8%		
	61 years old (or higher)	1	3	2	5		
		9.1%	27.3%	18.2%	45.5%		
Team Teaching	35 years old (or less)	0	6	3	3	29.256*	.015
		.0%	50.0%	25.0%	25.0%		
	36-40 years old	6	8	9	2		
		24.0%	32.0%	36.0%	8.0%		
	41-45 years old	12	16	13	2		
		27.9%	37.2%	30.2%	4.7%		
	46-50 years old	11	31	19	4		
		16.9%	47.7%	29.2%	6.2%		
	51-60 years old	23	44	22	12		
		22.8%	43.6%	21.8%	11.9%		
	61 years old (or higher)	1	1	9	0		
		9.1%	9.1%	81.8%	.0%		
Problem solving	35 years old (or less)	0	3	6	3	20.080	.169
		.0%	25.0%	50.0%	25.0%		
	36-40 years old	3	3	10	9		
		12.0%	12.0%	40.0%	36.0%		
	41-45 years old	7	9	18	9		
		16.3%	20.9%	41.9%	20.9%		
	46-50 years old	0	14	32	19		
		.0%	21.5%	49.2%	29.2%		
	51-60 years old	5	15	53	28		
		5.0%	14.9%	52.5%	27.7%		
	61 years old (or higher)	1	1	4	5		
		9.1%	9.1%	36.4%	45.5%		
Computer-Aided Instruction	35 years old (or less)	1	3	4	4	9.431	.854
		8.3%	25.0%	33.3%	33.3%		
	36-40 years old	2	7	10	6		
		8.0%	28.0%	40.0%	24.0%		
	41-45 years old	4	10	16	13		
		9.3%	23.3%	37.2%	30.2%		
	46-50 years old	3	11	23	28		
		4.6%	16.9%	35.4%	43.1%		
	51-60 years old	9	13	40	39		
		8.9%	12.9%	39.6%	38.6%		
	61 years old (or higher)	2	2	4	3		
		18.2%	18.2%	36.4%	27.3%		
Drama/play	35 years old (or less)	2	5	3	2	14.906	.458
		16.7%	41.7%	25.0%	16.7%		
	36-40 years old	10	11	2	2		
		40.0%	44.0%	8.0%	8.0%		
	41-45 years old	20	12	9	2		
		46.5%	27.9%	20.9%	4.7%		

Teaching method	Age	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
	46-50 years old	26 40.0%	23 35.4%	11 16.9%	5 7.7%		
	51-60 years old	40 39.6%	34 33.7%	24 23.8%	3 3.0%		
	61 years old (or higher)	2 18.2%	5 45.5%	4 36.4%	0 .0%		
Field Trip	35 years old (or less)	1 8.3%	4 33.3%	4 33.3%	3 25.0%	11.067	.748
	36-40 years old	6 24.0%	10 40.0%	7 28.0%	2 8.0%		
	41-45 years old	9 20.9%	13 30.2%	14 32.6%	7 16.3%		
	46-50 years old	6 9.2%	21 32.3%	29 44.6%	9 13.8%		
	51-60 years old	14 13.9%	29 28.7%	46 45.5%	12 11.9%		
	61 years old (or higher)	1 9.1%	3 27.3%	6 54.5%	1 9.1%		
Lab Method	35 years old (or less)	3 25.0%	0 .0%	2 16.7%	7 58.3%	30.216*	.011
	36-40 years old	5 20.0%	2 8.0%	8 32.0%	10 40.0%		
	41-45 years old	2 4.7%	9 20.9%	20 46.5%	12 27.9%		
	46-50 years old	2 3.1%	12 18.5%	24 36.9%	27 41.5%		
	51-60 years old	7 6.9%	7 6.9%	51 50.5%	36 35.6%		
	61 years old (or higher)	1 9.1%	0 .0%	5 45.5%	5 45.5%		

*p< .05

(3) Number of Teaching Years

Results in Table 6 were obtained through the χ2test for independence. Findings show that most teachers occasionally used the co-operation learning method, while the teachers belonging to 6-10 working years used it less frequently ($\chi2=26.626$, $p < .01$).

Table 6 Differential analysis of number of teaching years in teaching method usage

Teaching method	Age	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
Didactic instruction teaching method	5 years (or less)	0 .0%	0 .0%	7 26.9%	19 73.1%	18.080	.113
	6-10 years	0 .0%	0 .0%	6 14.6%	35 85.4%		
	11-20 years	1 1.3%	4 5.1%	19 24.1%	55 69.6%		
	21-30 years	0 .0%	2 2.1%	14 14.9%	78 83.0%		
	30 years (or more)	1 5.9%	0 .0%	1 5.9%	15 88.2%		
Project	5 years (or less)	0	2	15	9	8.136	.774

		.0%	7.7%	57.7%	34.6%		
	6-10 years	1	7	16	17		
		2.4%	17.1%	39.0%	41.5%		
	11-20 years	3	11	39	26		
		3.8%	13.9%	49.4%	32.9%		
	21-30 years	1	8	48	37		
		1.1%	8.5%	51.1%	39.4%		
	30 years (or more)	1	1	8	7		
		5.9%	5.9%	47.1%	41.2%		
Demonstration	5 years (or less)	0	3	11	12	6.083	.912
		.0%	11.5%	42.3%	46.2%		
	6-10 years	1	3	17	20		
		2.4%	7.3%	41.5%	48.8%		
	11-20 years	2	11	37	29		
		2.5%	13.9%	46.8%	36.7%		
	21-30 years	1	13	36	44		
		1.1%	13.8%	38.3%	46.8%		
	30 years (or more)	1	2	8	6		
		5.9%	11.8%	47.1%	35.3%		
Co-operation	5 years (or less)	0	7	10	9	26.626**	.009
		.0%	26.9%	38.5%	34.6%		
	6-10 years	6	12	11	12		
		14.6%	29.3%	26.8%	29.3%		
	11-20 years	3	33	34	9		
		3.8%	41.8%	43.0%	11.4%		
	21-30 years	3	27	48	16		
		3.2%	28.7%	51.1%	17.0%		
	30 years (or more)	2	3	8	4		
		11.8%	17.6%	47.1%	23.5%		
Discussion	5 years (or less)	0	7	13	6	12.892	.377
		.0%	26.9%	50.0%	23.1%		
	6-10 years	2	10	19	10		
		4.9%	24.4%	46.3%	24.4%		
	11-20 years	3	21	40	15		
		3.8%	26.6%	50.6%	19.0%		
	21-30 years	1	12	57	24		
		1.1%	12.8%	60.6%	25.5%		
	30 years (or more)	1	1	11	4		
		5.9%	5.9%	64.7%	23.5%		
Workshop	5 years (or less)	4	14	5	3	13.495	.334
		15.4%	53.8%	19.2%	11.5%		
	6-10 years	14	15	6	6		
		34.1%	36.6%	14.6%	14.6%		
	11-20 years	25	21	27	6		
		31.6%	26.6%	34.2%	7.6%		
	21-30 years	24	35	27	8		
		25.5%	37.2%	28.7%	8.5%		
	30 years (or more)	4	7	4	2		
		23.5%	41.2%	23.5%	11.8%		
Discovery	5 years (or less)	5	11	7	3	12.939	.373
		19.2%	42.3%	26.9%	11.5%		
	6-10 years	10	19	7	5		

		24.4%	46.3%	17.1%	12.2%		
	11-20 years	16	30	29	4		
		20.3%	38.0%	36.7%	5.1%		
	21-30 years	13	38	33	10		
		13.8%	40.4%	35.1%	10.6%		
	30 years (or more)	3	5	9	0		
		17.6%	29.4%	52.9%	.0%		
Individual	5 years (or less)	3	4	13	6	20.632	.056
		11.5%	15.4%	50.0%	23.1%		
	6-10 years	7	19	10	5		
		17.1%	46.3%	24.4%	12.2%		
	11-20 years	7	24	36	12		
		8.9%	30.4%	45.6%	15.2%		
	21-30 years	7	24	41	22		
		7.4%	25.5%	43.6%	23.4%		
	30 years (or more)	1	4	5	7		
		5.9%	23.5%	29.4%	41.2%		
Team Teaching	5 years (or less)	3	11	9	3	9.381	.670
		11.5%	42.3%	34.6%	11.5%		
	6-10 years	11	18	8	4		
		26.8%	43.9%	19.5%	9.8%		
	11-20 years	15	35	25	4		
		19.0%	44.3%	31.6%	5.1%		
	21-30 years	21	37	25	11		
		22.3%	39.4%	26.6%	11.7%		
	30 years (or more)	3	5	8	1		
		17.6%	29.4%	47.1%	5.9%		
Problem solving	5 years (or less)	1	5	11	9	10.538	.569
		3.8%	19.2%	42.3%	34.6%		
	6-10 years	6	8	17	10		
		14.6%	19.5%	41.5%	24.4%		
	11-20 years	6	15	37	21		
		7.6%	19.0%	46.8%	26.6%		
	21-30 years	2	15	48	29		
		2.1%	16.0%	51.1%	30.9%		
	30 years (or more)	1	2	10	4		
		5.9%	11.8%	58.8%	23.5%		
Computer-Aided Instruction	5 years (or less)	3	7	8	8	15.903	.196
		11.5%	26.9%	30.8%	30.8%		
	6-10 years	0	11	14	16		
		.0%	26.8%	34.1%	39.0%		
	11-20 years	9	13	34	23		
		11.4%	16.5%	43.0%	29.1%		
	21-30 years	8	11	33	42		
		8.5%	11.7%	35.1%	44.7%		
	30 years (or more)	1	4	8	4		
		5.9%	23.5%	47.1%	23.5%		
Drama/play	5 years (or less)	9	9	6	2	15.593	.211
		34.6%	34.6%	23.1%	7.7%		
	6-10 years	20	14	2	5		
		48.8%	34.1%	4.9%	12.2%		

	11-20 years	34 43.0%	25 31.6%	18 22.8%	2 2.5%		
	21-30 years	31 33.0%	34 36.2%	24 25.5%	5 5.3%		
	30 years (or more)	6 35.3%	8 47.1%	3 17.6%	0 .0%		
Field Trip	5 years (or less)	5 19.2%	7 26.9%	10 38.5%	4 15.4%	17.048	.148
	6-10 years	7 17.1%	18 43.9%	8 19.5%	8 19.5%		
	11-20 years	12 15.2%	25 31.6%	34 43.0%	8 10.1%		
	21-30 years	10 10.6%	27 28.7%	43 45.7%	14 14.9%		
	30 years (or more)	3 17.6%	3 17.6%	11 64.7%	0 .0%		
Lab Method	5 years (or less)	5 19.2%	2 7.7%	9 34.6%	10 38.5%	13.597	.327
	6-10 years	4 9.8%	9 22.0%	13 31.7%	15 36.6%		
	11-20 years	5 6.3%	10 12.7%	34 43.0%	30 38.0%		
	21-30 years	5 5.3%	8 8.5%	46 48.9%	35 37.2%		
	30 years (or more)	1 5.9%	1 5.9%	8 47.1%	7 41.2%		

**$p < .01$

(4) Field of Teaching

Results in Table 7 were obtained through the χ2test for independence. Findings show that the teachers from different fields of teaching reached significant differences in team teaching, computer-aided teaching, drama/play, and experimental teaching usage.

Moreover, the teachers for electrical and electronics and design fields frequently used topic production; the teachers in the machinery and power, chemical engineering and material, civil engineering and architecture, and information and information engineering fields occasionally used topic production (χ2=36.412, p< .01); teachers in design and information and information engineering fields occasionally used team teaching; the teachers in machinery and power, electrical and electronics, chemical engineering and material, and civil engineering and architecture fields seldom used team teaching (χ2=33.406, p< .05); teachers in the field of chemical engineering and materials seldom used the computer-aided teaching method, but the teachers in electric and electronics and information and information engineering fields occasionally used it.

Among them, the teachers in machinery and power, civil engineering and architecture, and design fields most frequently used the computer-aided teaching method (χ2 = 52.454, p< .001)； teachers in electrical and electronics, chemical engineering and material fields never use the drama/play teaching method, while the teachers in design, information and information engineering fields occasionally used it (χ2 = 32.220, p< .05); the teachers in electrical and electronics, chemical engineering and materials, civil engineering and architecture, and design fields frequently used the experimental teaching method, while teachers in machinery and power, and information and information engineering fields occasionally used it ($\chi2$ = 35.415 , p< .01).

Table 7 Differential analysis of field of teaching in teaching method usage

Teaching method	Field	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
Didactic instruction teaching method	Machinery and power	0	1	17	74	20.057	.330
	Electrical and electronics	.0%	1.1%	18.5%	80.4%		
	Chemical engineering and material	0	2	12	55		
	Civil engineering and architecture	.0%	2.9%	17.4%	79.7%		
	Design	0	0	4	21		
	Information and information engineering	.0%	.0%	16.0%	84.0%		
	Other	0	2	5	15		
	Machinery and power	.0%	9.1%	22.7%	68.2%		
	Electrical and electronics	0	0	1	2		
	Chemical engineering and material	.0%	.0%	33.3%	66.7%		
	Civil engineering and architecture	1	0	6	14		
	Design	4.8%	.0%	28.6%	66.7%		
	Information and information engineering	1	1	2	21		
		4.0%	4.0%	8.0%	84.0%		
Project	Machinery and power	0	14	49	29	36.412**	.006
	Electrical and electronics	.0%	15.2%	53.3%	31.5%		
	Chemical engineering and material	1	5	30	33		
	Civil engineering and architecture	1.4%	7.2%	43.5%	47.8%		
	Design	1	3	11	10		
	Information and information engineering	4.0%	12.0%	44.0%	40.0%		
	Other	0	3	13	6		
	Machinery and power	.0%	13.6%	59.1%	27.3%		
	Electrical and electronics	0	0	1	2		
	Chemical engineering and material	.0%	.0%	33.3%	66.7%		
	Civil engineering and architecture	0	3	13	5		
	Design	.0%	14.3%	61.9%	23.8%		
	Information and information engineering	4	1	9	11		
		16.0%	4.0%	36.0%	44.0%		
Demonstration	Machinery and power	0	12	42	38	18.919	.397
	Electrical and electronics	.0%	13.0%	45.7%	41.3%		
	Chemical engineering and material	2	5	28	34		
	Civil engineering and architecture	2.9%	7.2%	40.6%	49.3%		
	Design	1	4	12	8		
	Information and information engineering	4.0%	16.0%	48.0%	32.0%		
	Other	0	3	6	13		
	Machinery and power	.0%	13.6%	27.3%	59.1%		
	Electrical and electronics	0	0	1	2		
	Chemical engineering and material	.0%	.0%	33.3%	66.7%		
	Civil engineering and architecture	0	3	8	10		
	Design	.0%	14.3%	38.1%	47.6%		
	Information and information engineering	2	5	12	6		
		8.0%	20.0%	48.0%	24.0%		
Co-operation	Machinery and power	1	28	41	22	17.669	.478
	Electrical and electronics	1.1%	30.4%	44.6%	23.9%		
	Chemical engineering and material	5	23	28	13		
	Civil engineering and architecture	7.2%	33.3%	40.6%	18.8%		
	Design	2	8	9	6		

Teaching method	Field	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
	Information and information engineering	8.0%	32.0%	36.0%	24.0%		
	Other	0	9	10	3		
	Machinery and power	.0%	40.9%	45.5%	13.6%		
	Electrical and electronics	0	0	2	1		
	Chemical engineering and material						
		.0%	.0%	66.7%	33.3%		
	Civil engineering and architecture	3	6	11	1		
	Design	14.3%	28.6%	52.4%	4.8%		
	Information and information engineering	3	8	10	4		
		12.0%	32.0%	40.0%	16.0%		
	Machinery and power	1	21	51	19		
	Electrical and electronics	1.1%	22.8%	55.4%	20.7%		
	Chemical engineering and material	2	10	42	15		
	Civil engineering and architecture	2.9%	14.5%	60.9%	21.7%		
	Design	1	7	11	6		
	Information and information engineering	4.0%	28.0%	44.0%	24.0%		
Discussion	Other	1	5	10	6	10.205	.925
	Machinery and power	4.5%	22.7%	45.5%	27.3%		
	Electrical and electronics	0	0	2	1		
	Chemical engineering and material	.0%	.0%	66.7%	33.3%		
	Civil engineering and architecture	0	4	12	5		
	Design	.0%	19.0%	57.1%	23.8%		
	Information and information engineering	2	4	12	7		
		8.0%	16.0%	48.0%	28.0%		
	Machinery and power	23	35	23	11		
	Electrical and electronics	25.0%	38.0%	25.0%	12.0%		
	Chemical engineering and material	16	26	22	5		
	Civil engineering and architecture	23.2%	37.7%	31.9%	7.2%		
	Design	10	7	5	3		
	Information and information engineering	40.0%	28.0%	20.0%	12.0%		
Workshop	Other	5	12	4	1	20.839	.288
	Machinery and power	22.7%	54.5%	18.2%	4.5%		
	Electrical and electronics	0	0	2	1		
	Chemical engineering and material	.0%	.0%	66.7%	33.3%		
	Civil engineering and architecture	6	4	8	3		
	Design	28.6%	19.0%	38.1%	14.3%		
	Information and information engineering	11	8	5	1		
		44.0%	32.0%	20.0%	4.0%		
	Machinery and power	12	39	32	9		
	Electrical and electronics	13.0%	42.4%	34.8%	9.8%		
	Chemical engineering and material	11	27	26	5		
	Civil engineering and architecture	15.9%	39.1%	37.7%	7.2%		
	Design	5	11	5	4		
	Information and information engineering	20.0%	44.0%	20.0%	16.0%		
Discovery	Other	4	11	7	0	21.800	.241
	Machinery and power	18.2%	50.0%	31.8%	.0%		
	Electrical and electronics	0	1	1	1		
	Chemical engineering and material	.0%	33.3%	33.3%	33.3%		
	Civil engineering and architecture	5	6	7	3		
	Design	23.8%	28.6%	33.3%	14.3%		
	Information and information engineering	10	8	7	0		
		40.0%	32.0%	28.0%	.0%		

Teaching method	Field	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
Individual	Machinery and power	6	30	40	16	21.678	.247
	Electrical and electronics	6.5%	32.6%	43.5%	17.4%		
	Chemical engineering and material	6	14	36	13		
	Civil engineering and architecture						
		8.7%	20.3%	52.2%	18.8%		
	Design	1	10	7	7		
	Information and information engineering	4.0%	40.0%	28.0%	28.0%		
	Other	3	7	8	4		
	Machinery and power	13.6%	31.8%	36.4%	18.2%		
	Electrical and electronics	0	1	0	2		
	Chemical engineering and material	.0%	33.3%	.0%	66.7%		
	Civil engineering and architecture	5	6	6	4		
	Design	23.8%	28.6%	28.6%	19.0%		
		4	7	8	6		
	Information and information engineering	16.0%	28.0%	32.0%	24.0%		
Team Teaching	Machinery and power	19	39	27	7	33.406**	.015
	Electrical and electronics	20.7%	42.4%	29.3%	7.6%		
	Chemical engineering and material	14	28	20	7		
	Civil engineering and architecture	20.3%	40.6%	29.0%	10.1%		
	Design	5	12	4	4		
	Information and information engineering	20.0%	48.0%	16.0%	16.0%		
	Other	2	14	3	3		
	Machinery and power	9.1%	63.6%	13.6%	13.6%		
	Electrical and electronics	0	1	1	1		
	Chemical engineering and material	.0%	33.3%	33.3%	33.3%		
	Civil engineering and architecture	2	6	13	0		
	Design	9.5%	28.6%	61.9%	.0%		
		11	6	7	1		
	Information and information engineering	44.0%	24.0%	28.0%	4.0%		
Problem solving	Machinery and power	5	14	47	26	13.534	.759
	Electrical and electronics	5.4%	15.2%	51.1%	28.3%		
	Chemical engineering and material	4	8	38	19		
	Civil engineering and architecture	5.8%	11.6%	55.1%	27.5%		
	Design	1	7	11	6		
	Information and information engineering	4.0%	28.0%	44.0%	24.0%		
	Other	1	5	8	8		
	Machinery and power	4.5%	22.7%	36.4%	36.4%		
	Electrical and electronics	0	0	1	2		
	Chemical engineering and material	.0%	.0%	33.3%	66.7%		
	Civil engineering and architecture	2	4	8	7		
	Design	9.5%	19.0%	38.1%	33.3%		
		3	7	10	5		
	Information and information engineering	12.0%	28.0%	40.0%	20.0%		
Computer-Aided Instruction	Machinery and power	6	14	36	36	52.454***	.000
	Electrical and electronics	6.5%	15.2%	39.1%	39.1%		
	Chemical engineering and material	1	7	31	30		
	Civil engineering and architecture	1.4%	10.1%	44.9%	43.5%		
	Design	7	10	3	5		
	Information and information engineering	28.0%	40.0%	12.0%	20.0%		
	Other	1	3	9	9		
	Machinery and power	4.5%	13.6%	40.9%	40.9%		
	Electrical and electronics	0	1	0	2		

Teaching method	Field	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
	Chemical engineering and material	.0%	33.3%	.0%	66.7%		
	Civil engineering and architecture	0	4	9	8		
	Design						
		.0%	19.0%	42.9%	38.1%		
	Information and information engineering	6	7	9	3		
		24.0%	28.0%	36.0%	12.0%		
Drama/play	Machinery and power	33	38	17	4	32.220*	.021
	Electrical and electronics	35.9%	41.3%	18.5%	4.3%		
	Chemical engineering and material	28	23	16	2		
	Civil engineering and architecture	40.6%	33.3%	23.2%	2.9%		
	Design	10	6	5	4		
	Information and information engineering	40.0%	24.0%	20.0%	16.0%		
	Other	7	11	1	3		
	Machinery and power	31.8%	50.0%	4.5%	13.6%		
	Electrical and electronics	0	1	2	0		
	Chemical engineering and material	.0%	33.3%	66.7%	.0%		
	Civil engineering and architecture	8	3	9	1		
	Design	38.1%	14.3%	42.9%	4.8%		
	Information and information engineering	14	8	3	0		
		56.0%	32.0%	12.0%	.0%		
Field Trip	Machinery and power	11	27	41	13	21.050	.277
	Electrical and electronics	12.0%	29.3%	44.6%	14.1%		
	Chemical engineering and material	8	27	26	8		
	Civil engineering and architecture	11.6%	39.1%	37.7%	11.6%		
	Design	3	6	12	4		
	Information and information engineering	12.0%	24.0%	48.0%	16.0%		
	Other	2	7	7	6		
	Machinery and power	9.1%	31.8%	31.8%	27.3%		
	Electrical and electronics	0	1	2	0		
	Chemical engineering and material	.0%	33.3%	66.7%	.0%		
	Civil engineering and architecture	5	8	8	0		
	Design	23.8%	38.1%	38.1%	.0%		
	Information and information engineering	8	4	10	3		
		32.0%	16.0%	40.0%	12.0%		
Lab Method	Machinery and power	9	10	42	31	35.415**	.008
	Electrical and electronics	9.8%	10.9%	45.7%	33.7%		
	Chemical engineering and material	1	5	29	34		
	Civil engineering and architecture	1.4%	7.2%	42.0%	49.3%		
	Design	1	3	9	12		
	Information and information engineering	4.0%	12.0%	36.0%	48.0%		
	Other	0	5	8	9		
	Machinery and power	.0%	22.7%	36.4%	40.9%		
	Electrical and electronics	0	0	1	2		
	Chemical engineering and material	.0%	.0%	33.3%	66.7%		
	Civil engineering and architecture	2	2	11	6		
	Design	9.5%	9.5%	52.4%	28.6%		
	Information and information engineering	7	5	10	3		
		28.0%	20.0%	40.0%	12.0%		

$*p < .05$; $**p < .01$; $***p < .001$

(5) Industrial Experience

Results in Table 8 were verified using the χ2test for independence. Findings show that the teachers without industrial experience reached significant differences in topic production and co-operation learning method usage. Moreover, the teachers with industrial experience occasionally used the topic production method, while the teachers without industrial experience frequently used it (χ2=10.013, p< .01). With or without industrial experience, the teachers all occasionally used the co-operation learning method (χ2=10.498 , p< .01).

Table 8 Differential analysis of with or without industrial experience in teaching method usage

Teaching method	Industrial practice	Never	Seldom	Occasionally	Frequently	χ^2 value	p value
Didactic instruction teaching method	Yes	1 .6%	6 3.4%	32 18.3%	136 77.7%	3.167	.367
	No	1 1.2%	0 .0%	15 18.3%	66 80.5%		
Project	Yes	1 .6%	22 12.6%	91 52.0%	61 34.9%	10.013*	0.18
	No	5 6.1%	7 8.5%	35 42.7%	35 42.7%		
Demonstration	Yes	1 .6%	22 12.6%	76 43.4%	76 43.4%	5.470	.140
	No	4 4.9%	10 12.2%	33 40.2%	35 42.7%		
Co-operation	Yes	5 2.9%	63 36.0%	76 43.4%	31 17.7%	10.498*	.015
	No	9 11.0%	19 23.2%	35 42.7%	19 23.2%		
Discussion	Yes	3 1.7%	36 20.6%	97 55.4%	39 22.3%	2.397	.494
	No	4 4.9%	15 18.3%	43 52.4%	20 24.4%		
Workshop	Yes	44 25.1%	71 40.6%	42 24.0%	18 10.3%	6.549	.088
	No	27 32.9%	21 25.6%	27 32.9%	7 8.5%		
Discovery	Yes	32 18.3%	70 40.0%	57 32.6%	16 9.1%	.260	.967
	No	15 18.3%	33 40.2%	28 34.1%	6 7.3%		
Individual	Yes	17 9.7%	48 27.4%	73 41.7%	37 21.1%	.902	.825
	No	8 9.8%	27 32.9%	32 39.0%	15 18.3%		
Team Teaching	Yes	31 17.7%	75 42.9%	54 30.9%	15 8.6%	3.209	.360
	No	22 26.8%	31 37.8%	21 25.6%	8 9.8%		
Problem solving	Yes	8 4.6%	33 18.9%	80 45.7%	54 30.9%	4.669	.198
	No	8 9.8%	12 14.6%	43 52.4%	19 23.2%		
Computer-Aided	Yes	14	29	64	68	1.840	.606

Instruction		8.0%	16.6%	36.6%	38.9%		
	No	7	17	33	25		
		8.5%	20.7%	40.2%	30.5%		
Drama/play	Yes	65	65	35	10	1.321	.724
		37.1%	37.1%	20.0%	5.7%		
	No	35	25	18	4		
		42.7%	30.5%	22.0%	4.9%		
Field Trip	Yes	24	55	73	23	.226	.973
		13.7%	31.4%	41.7%	13.1%		
	No	13	25	33	11		
		15.9%	30.5%	40.2%	13.4%		
Lab Method	Yes	11	22	72	70	3.050	.384
		6.3%	12.6%	41.1%	40.0%		
	No	9	8	38	27		
		11.0%	9.8%	46.3%	32.9%		

*$p < .05$

Descriptive analysis of "frequently" and "never" in teaching method usage

In this study, "frequently" and "never" in teaching method usage of teachers from engineering colleges of UST were summarized, as shown in Table 9. The total number of valid teacher samples is 257. Didactic instruction is the frequently used teaching method, accounting for 202 (78.6%) people, followed by demonstration teaching method, accounting for 111 people (43.2%), and experimental teaching method, accounting for 97 people (37.7%).

Drama/play is the teaching method never used by teachers from engineering colleges of UST in teaching professional subjects, accounting for 100 people (38.9%), followed by workshop teaching method, accounting for 71 people (27.6%), and team teaching, accounting for 53 people (20.6%).

Table 9 Usage frequency of frequently use and never use different teaching methods

Teaching method	Frequently (%)	Never (%)
Didactic instruction teaching method	78.6	.8
Project	37.4	2.3
Demonstration	43.2	1.9
Co-operation	19.5	5.4
Discussion	23.0	2.7
Workshop	9.7	27.6
Discovery	8.6	18.3
Individual	20.2	9.7
Team Teaching	8.9	20.6
Problem solving	28.4	6.2
Computer-Aided Instruction	36.2	8.2
Drama/play	5.4	38.9
Field Trip	13.2	14.4
Lab Method	37.7	7.8

Conclusions

In this study, the teaching method usage of engineering colleges of UST was explored. Through the questionnaire survey, the important conclusions and recommendations are as follows:

Teachers from engineering colleges of UST most commonly use didactic instruction.

It was found in this paper that the teachers from engineering colleges of UST most frequently used conventional didactic instruction. UST on the other hand should emphasize on combining school education and occupation sites in order to cultivate students' technical and practical ability (Hui-lan Li, Ren-jia Zhang, 2005). Institute of Engineering Education Taiwan (IEET) pointed out that engineering college students should cultivate their professional knowledge, practical operations, team communication coordination, diversified development, and other macroscopic abilities. This being said, didactic instruction is a rather unidirectional way of teaching, which may lead to students' passive, static, and slack learning attitudes, unable to engage in action judgment and creative thinking. Without an opportunity for students to practical oral communication skills, teaches will not be able to correctly determined students' comprehension.

Teachers from engineering colleges of UST seldom use drama/play

The results in this paper show that the teachers from engineering colleges of UST least frequently used drama/play, followed by workshops and teamwork teaching.

Teachers from engineering colleges of UST used drama/play the least, while this teaching method stresses learners' interpretation of cooperation in real life (Sung, 2010). Due to the globalization in the workplace, cross-border cooperation has become increasingly common. In the face of global competitiveness, students must respect and acknowledge cultural background differences. In other words, they must be able to adjust their own behaviors and integrate the ideas of others. The drama/play teaching method encourages students to simulate differ cultural backgrounds to engage in exchanges with other students in order to discuss and resolve global issues in real life (Wold & Moore, 2013). Flikkema, Franklin, Frolik, Haden, Shiroma, & Weller (2010) pointed out the workshop is a learner-centered environment intended for students and teachers in the engineering profession today who engage in discussion and analysis of certain aspects of problems, develop solutions, express their ideas, share results.

The teamwork teaching method involves two or more teachers who integrate and put their specialties to full swing in one or multiple disciplines. They put various teaching tools and materials to good uses and guide a group or student to apply different teaching methods (Kun-qiong Li, 2001). Teachers complement each other on one subject from different perspectives, which is conducive to students' active involvement in courses and the cultivation of students' independent thinking.

In view of the above, if UST teachers use the various teaching methods above more often, the teaching effectiveness, quality, and development of engineering colleges will also improve by leaps and bounds.

Research Recommendations and Limitations

Recommendations for Future Teaching Methods Adopted by Engineering Colleges of UST

Technical and vocational education should not only be a tool for improving the national economy, it should return to the learning body and cover abilities pertaining to professional development and job change (Chin-Kuo, Wu, Teng-Chiao Lin, 2010). Research and analysis of teaching methods adopted by teachers will give teachers a chance to understand their own teaching pattern and student needs, and they can even serve as a reference for schools when devising training courses for incoming teachers (Yi-jun Chen, 2000). Kose, Sahin, & Aysegul (2010) proposed new teaching methods and strategies that enable students to effectively learn professional knowledge and skills. Learning is a kind of change arising from environment and interaction. In a rigorous and routine learning, the inclusion of course-related innovative thinking strategies will help enhance learning effectiveness (Ming-ta Wu, Pei-wen Liao, 2007). Teacher can create conditions and environments beneficial to innovation, which will in turn elicit teachers' creative teaching and cultivate students' effective abilities (Yukl, 2002).

As far as school education is concerned, if conventional didactic instruction continues to be used, student's diverse ability development may be limited, making it impossible to cope with demands of future trends (Campisi &Finn, 2011). In order to achieve learning efficiency, it is suggested that teachers apply situational learning in courses and teaching where possible and that they change their role from traditional knowledge imparters into advisors that actively construct knowledge, so that students will put their senses and keen observation to good uses and combine their life experiences and knowledge.

The Collaborative Problem Solving, CPS ability is one of the key abilities receiving world's attention. The Ministry of Education (2015) will develop diverse CPS units and teaching materials and a CPS system to provide a comprehensive problem-solving teaching platform for access by teachers and students. It is recommended that teachers incorporate CPS into existing courses and teach students to cultivate CPS ability. On the other hand, team-based learning requires students to spend time in class "applying" knowledge, rather than "absorbing" new course contents. It is recommended that teachers use "team-based learning" to enable students to learn the spirit of teamwork and cultivate their self-learning ability, and take responsibility for the learning effectiveness of themselves and their team.

In addition, it is recommended that teachers participate in Professional Learning Community, (PLC) to engage in re-thinking through educational professionalism, thereby breaking through the old "independent teaching" culture known to teachers, thus applying teaching exchange and group learning in teacher organizations. By helping teachers improve, substantial effectiveness in helping students will be seen (Ministry of Education, 2013). Not only teachers' abilities will be improved, teaching and students' learning status will also change for the better. It is expected that teachers will promote structural and cultural transformation in schools.

Research Limitations

(1) Differences of Research Participants

The questionnaire survey method was adopted in this study to take random samples of teaching methods used by full-time teachers from engineering colleges of UST in their professional subjects. Since the attributes of the departments in the engineering colleges of UST are not the same, during the research conduction, only UST colleges with "engineering" wording were adopted as research participants. In order to reduce classification errors, cross matching with the databases of the Technological and Vocational Education, Ministry of Education and Statistics Department in order to search the department rosters, course attributes of engineering colleges in different schools and classify the departments under the engineering collages in our country.

(2) Limitations of Teaching Methods

The identification of teaching methods in this study is based on the 14 common teaching methods in university education summarized by Regina, Emmanuel, & Josiah (2010), which serve as references for studying teachers' perception of innovation and teaching methods. In this study, only the 14 teaching methods were used to develop questionnaires for surveys. However, in order to avoid omissions, the option "other" is available in the questionnaire under teaching methods. Nevertheless, after the research investigation, it was found that all the teachers only chose the teaching methods mentioned in this study.

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