





# Reviewing the Changes in Core Competencies for Undergraduates in Technological Universities

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**Abstract.** The objectives of this study are to explore the core competency content of electrical engineering & computer science students, as well as the current situation of training. Literature review and focus group methods were adopted to design the questionnaire survey content. In addition, first-year students from the college of electrical engineering & computer science of a university of technology underwent questionnaire surveys before and after 2 years. There were 195 effective questionnaire copies, accounting for the effective recovery rate of 60.9%. Targeting the survey results, paired sample t-test analysis was carried out. The study found that the post-test scores of students after 2 years were lower than those of the first grade, especially in terms of general core abilities, and each ability had significant differences. It is recommended that the teaching objectives and course content be consistent with the core competencies. The curriculum content should also be designed for the core competencies, using situational education, problem-based learning, and integrated teaching methods and integrated teaching methods, so that students can understand the learning goals and the focus of teaching is to promote students to improve their core competencies.

**Keywords:** Core competency · Engineering technology education · Technology university

## 1 Introduction

Departments in the field of electrical engineering & computer science are closely related to high-tech industry development. Improving the core competency of students majoring in electrical engineering & computer science indeed ensures Taiwan's leading status in the global high-tech industry. Therefore, the core competency of students majoring in electrical engineering & computer science is especially important. It can be seen from the MOE's various programs and technical and vocational education policy outline contents that the MOE actively promotes collaboration between technical colleges and the industry, emphasizing the core competency of students studying in technical and vocational education in response to ever-changing future industrial changes. Hence, the purpose of this study is to understand the current situation of the

core competency of students majoring in electrical engineering & computer science. We used a questionnaire related to core competency to investigate the students of the Institute of Electrical Engineering and Technology in a domestic university of science and technology. They surveyed that they had the core competency in the first year and before the end of the sophomore year. In our research, we'd like to explore the following questions:

1. What is the core competency content of electrical engineering & computer science students?
2. Will the core competencies of electrical engineering and computer science students vary by grade?

## 2 Literature Review

In 2014, UNESCO proposed the “2014–2021 Education Strategy”. The strategy emphasizes that the future of the Technical and Vocational Education and Training system should aim to develop the world of work and emphasize evidence-based curriculum design [1]. Currently, countries around the world are emphasizing the importance of students' core competency. They believe that core competencies are related to future employability and combine core competencies with educational goals. They want to build students' ability to meet industry needs and the ability to work immediately.

### 2.1 Higher Educational Goals and Core Competency

The educational objective is to train students to achieve professional and achievements in three to five years after graduation in higher education [2]. Each school and department consider the cultivation of students' professional abilities related to future employment when setting educational goals. It is expected that students will be able to cope with various work problems when they are employed. Core competency refers to the main and important competitiveness that the future environment and society should possess [3]. The educational goal is to train graduates to achieve professional goals. After students study, students are expected to have professional knowledge and abilities, which is the core ability [4].

### 2.2 Core Competency in Engineering Education

The main mission of the *Accreditation Board for Engineering and Technology* (ABET) is to certify engineering and technology related departments and curriculums applied at US education institutions. The ABET led the global engineering education certification towards student learning result orientation in 2000, setting up new certification specifications known as EC2000. At present, the ABET deems the core competency of engineering technology education (TAC) as: demonstrate the ability to solve generalized engineering problems using mathematics, science, engineering, technology, skills, and modern tools, demonstrate the ability to design systems, components, or

processes for broadly defined engineering technology problems, demonstrate the ability to carry out written, oral, and graphical communication in a technical and non-technical environment, demonstrate the ability to perform competency standard tests and measure, conduct, analyze, and explain experiments, demonstrate the ability to perform effective work as a technical team member [5]. The Youth Guidance Committee of the Executive Yuan of our country believes that the employment of college graduates should be based on their work attitude and cooperation ability, career planning and learning progress, and the ability to apply professional knowledge [6]. The Institute of Engineering Education Taiwan (IEET) pointed out at an engineering and technology education seminar in 2019 that the core competency items expected of engineering technology education (TAC) students are: demonstrate familiarity with knowledge, technology, skills, and tool competencies required for engineering practice, demonstrate the ability to properly execute standard operating programs and execute, analyze, explain, and apply experiments in practical skills, demonstrate the ability to apply creativity in engineering practical skills, demonstrate the ability to engage in plan management, effective communication, and teamwork, demonstrate the ability to confirm, analyze, and solve engineering practical and technical problems, recognize current issues, understand the impact of engineering practical technology on the environment, society, and the world, cultivate the habit and ability of continuous learning, understand professional ethics, recognize social responsibility, and respect pluralistic perspectives [7].

### 3 Research Method

In order to gain insight into the core competency of electrical engineering & computer science students and whether or not their core competency is enhanced after course learning, this study used document analysis, focus group, questionnaire survey, and other methods to carry out relevant research. The research methods and research design are described in detail below.

#### 3.1 Document Analysis

Literature analysis is a form of qualitative research that uses systematic analysis of literature evidence and answers specific research questions [8]. Through data compilation and analysis of the current status of the core competency development of my country's Institute of Electricity and Information Technology, the teaching objectives of the Institute of Electricity and Technology of the four universities of science and technology are summarized, corresponding to the core competency that students of engineering technology education should have after graduation. Among them, the School of Electrical Engineering includes four departments: electrical engineering, electronic engineering, optoelectronic engineering, and information engineering.

### 3.2 Focus Group Interview

The focus group interview method refers to group interviews by selecting members who meet specific research conditions, with the purpose of collecting qualitative information [9]. Through the use of the “Focus Group,” to collect and integrate the opinions of people with academic and practical experience in this field, analyze and discuss the content of the questionnaire in the form of a focus group. In order to ensure the appropriateness of the core competency questionnaire of the Institute of Electrical Engineering, the content of the questionnaire was organized through data analysis, and professors in the field of electrical engineering were invited to hold an expert meeting based on the core competency summary table of the Institute of Electrical Engineering, and confirm the questionnaire through discussion and exchange Content, developed the “Core Competency” scale. After pre-examination by 90 students from the University of Science and Technology in the field of electric capital, experts, and scholars from different fields of electric capital are invited to confirm the final content of the questionnaire.

### 3.3 Questionnaire Survey

This study took the first-year freshmen of the four technical day department of the 107th academic year of the School of Electrical Engineering (Department of Electrical Engineering, Department of Electronic Engineering, Department of Information Engineering, and Department of Optoelectronic Engineering) of T University as the research object, and used a seven-point scale to investigate. This time, 320 questionnaires were issued and 294 valid questionnaires were recovered in the pretest. The effective recovery rate was 91.9%, 241 valid questionnaires were recovered in the posttest, and the effective recovery rate was 75.3%. According to the before and after test data, there were a total of 195 before and after the test. Based on the survey results, a paired sample t test analysis was performed.

## 4 Research Results and Discussion

The Cronbach  $\alpha$  values measured before and after this questionnaire were .946 and .969, indicating that the content had good internal consistency (Table 1).

**Table 1.** Reliability analysis of core competency questionnaire.

	Cronbach $\alpha$	
	Pretest	Posttest
Core competency	.946	.969

According to the results of the questionnaire, after 2 years of study, students of the School of Electrical Engineering and Technology of T University of Science and Technology clearly dissatisfied with their performance in terms of Generic core competency, such as competitiveness regarding effective communication and teamwork, competency in discovering, analyzing, and handling problems, recognize current

issues, understanding the impact of engineering practical technology on the environment, society, and the world, cultivate the habit and ability of continuous learning, competency in understanding professional ethics and social responsibility, work ethics, and attitude cultivation, competency in understanding new knowledge and new products, these core competency projects show that students feel that their performance is worse than that in the first grade. In Professional core competency, there are Competencies in mathematics, science, and engineering knowledge application, Competency in analysis and explanation, Competency in techniques, skills, and tools required for executing engineering practices, Competency in computer operations, and other items up to a significant difference (Table 2).

**Table 2.** Table of core competency paired sample t-test ( $N$ : 195).

Core competency Item	Paired sample $t$ -test				
	Pretest		Posttest		$t$ value
	$M$	$SD$	$M$	$SD$	
Generic core competencies					
5. Competency in effective communication and teamwork	5.49	1.03	5.09	1.35	3.53**
6. Competency in discovering, analyzing, and handling problems	5.51	0.98	5.13	1.32	3.51**
7. Recognize current issues, understand the impact of engineering practical technology on the environment, society, and the world, cultivate the habit and ability of continuous learning	5.35	1.13	5.01	1.27	3.11**
8. Competency in understanding professional ethics and social responsibility	5.42	1.13	5.03	1.31	3.63***
10. Work ethics and attitude cultivation	5.63	1.07	5.11	1.40	4.61***
14. Competency in understanding new knowledge and new products	5.48	1.2	5.08	1.37	3.90***
Professional core competencies					
1. Competency in mathematics, science, and engineering knowledge application	5.31	1.23	4.88	1.33	3.76***
2. Competency in experiment design and execution	5.06	1.26	4.89	1.27	1.42
3. Competency in analysis and explanation	5.17	1.16	4.93	1.25	2.11*
4. Competency in techniques, skills, and tools required for executing engineering practices	5.25	1.11	4.94	1.30	2.64**
9. Ability to design systems, components, or processes for broadly defined engineering technology problems	4.73	1.38	4.56	1.34	1.29
11. Competency in computer operations	5.39	1.22	5.15	1.33	2.15*
12. Document processing and reference reading	5.13	1.23	4.90	1.32	1.96
13. Competency in a foreign language in the professional domain	4.68	1.40	4.64	1.30	0.37
15. Competency in intermediate and advanced program language and data structure and algorithm and software equipment	4.49	1.08	4.53	1.33	-0.34

\*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ .

In 2010, Haishan, Xue conducted a questionnaire survey on 742 students from five universities in China and found that there were significant differences between students in schools and grades. With the increase of grades, students' self-study quality shows a downward trend [10]. Juan, Yu conducted a self-directed learning questionnaire on 362 college students in 2005. Senior students' self-directed learning was lower than that of first-year students [11]. They consider that freshmen who have just entered college have expectations of college life and are more willing to try than senior students. As they grow older and adapt to university life, students' interest and expectations for learning will decrease. From the results of this study and other related research, we can know that the students in the upper grades often feel that their learning performance is lower than that of the first grades. In terms of Professional core competency, although the students of the Institute of Electrical Engineering do not have too many significant differences in projects, they also have no increased performance. It can be seen that students still have insufficient self-confidence in the study of professional fields, and they do not think they can learn effectively the Core competencies in their professional field (Fig. 1).

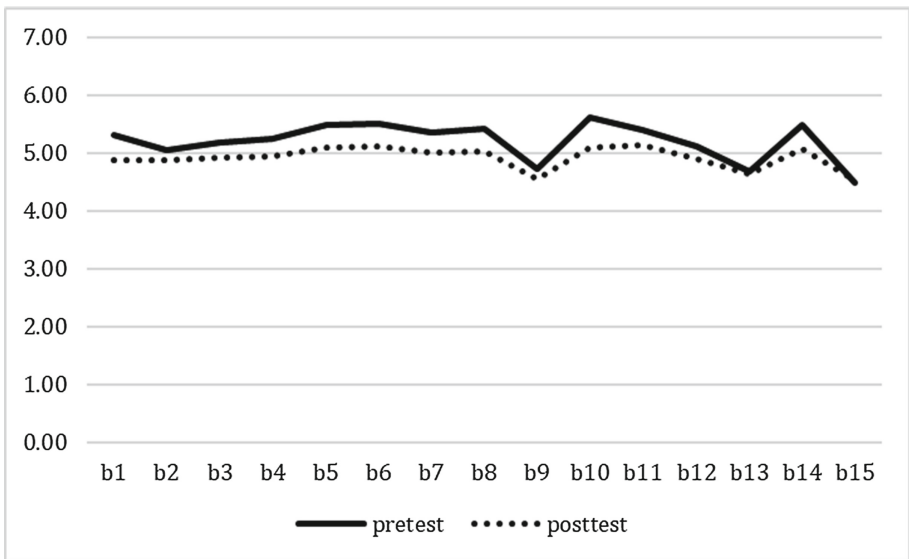


Fig. 1. Pretest and posttest results of core competency.

## 5 Conclusions and Recommendations

This study divides the Core competency of students from the School of Electrical Engineering into Generic core competency and Professional core competency. In the research results, the performance of the Generic core competency of sophomore students has a significantly lower self-evaluation than in the first grade. Professional core

competency also had 4 items with lower scores than the first grade, and obtained significant differences. The results of this study are similar to those of scholars such as Xue and Yu. With age, students' learning and expectations will decrease. The research results are different from our expectations. We think that after nearly two years of study, students will think that their general core competency and professional core competency have improved. Students are clearly dissatisfied with their performance. This may be because the first-year freshmen believe that they can enter T Tech University because of their excellent grades, so they are very confident in their performance. After 2 years of study, students may become increasingly dissatisfied with their performance, so the post-test scores are lower than the pre-test scores. In addition, university courses will gradually become more difficult, especially in professional courses, the second year courses are obviously more difficult than the first year, so students will not be satisfied with their performance after 2 years.

The teaching objectives and core competencies of the School of Electrical Engineering should be as close as possible. The curriculum content should also be designed for the core competencies, using situational education, problem-based learning, and integrated teaching methods and integrated teaching methods, so that students can understand the learning goals and the focus of teaching is to promote students to improve their core competencies.

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