Gap Analysis Between Program Expectations and Competency Outcomes of Students in Industrial Education of Electrical Engineering for Curriculum Improvement

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Abstract
To provide a good curriculum for producing valuable graduated students as technician teachers, the specific skills in engineering, professional teaching ethics, and teacher certification were integrated as the requirements of stakeholders. This study focused on the gap analysis for competency of undergraduate students in the 4th year of Bachelor of Industrial Education program in Electrical Engineering at KMUTT. The questionnaire for self-evaluation with 4-level rubric scales was created to determine the qualitative and quantitative data in 3 domains for a sample group of 39 students For the first domain, teaching management skills with 8 indicators showed that the average scores were at a moderate level (mean=3.13), with weaknesses in competencies of lecturing/explaining, learning outcome assessment and problem-solving which needs to be urgently improved. The second domain related to specific electrical engineering skills with 19 indicators showed that the current competencies were below the expected levels in some skills (mean=2.95) but the students were very good in problem identification. The third domain was related to some important characteristics and professional ethics for teachers with 15 indicators. The students' current competencies were at a good level (mean=3.46), with strength points in honesty and professional responsibility but the areas for improvement were leadership and emotion control. Therefore, the gap of student competencies determined with radar charts were effectively applied for curriculum improvement by applying outcome-based education module (OBEM) and create short courses to match the competencies you want to enhance in various skills.

Keywords: Gap Analysis, Competency Assessment, Industrial Education, Curriculum Development

Introduction

In the 21st century, the Thai population is experiencing rapid changes in politics, the economy, resources, communications, and industrial technology. These developments are happening continuously and play a significant role in our daily lives. They are also key factors in driving the economy toward meeting national development goals. People widely recognize the need to improve and develop education to equip graduates with skills that match the competencies demanded by the labor market and workplaces. Skills gained from vocational or higher education are an important element in determining the structure of the country's workforce. The process of producing and developing industrial labor skills comes from education management, especially vocational education under the Office of the Vocational Education Commission, Ministry of Education. As the main force in education management that focuses on producing personnel by providing knowledge and practical skills to be tools for future careers, it is also a group of labor that the industrial sector needs a lot. Therefore, there is an education management policy to promote more learners in vocational fields, such as organizing dual education programs in collaboration with the industrial sector, enhancing skills in integrating learning with work. Upon graduation, they can immediately work in the workplace, reducing the time spent on teaching and selecting new employees with experience for the workplace. In addition, there is a guideline for developing teaching content to be consistent with the production and development of manpower according to the country's needs. Therefore, industrial teachers are an important cog in the mechanism for producing industrial technicians with sufficient competence to work in the industrial sector. Therefore, technical teachers must have good academic quality, meet standards according to the professional standards of vocational teachers and teacher competence, be knowledgeable in basic skills, specialized skills and being a teacher, which will lead to the effective transfer of knowledge and practice to students in their own educational institutions when they enter the real workforce. Based on the significance and background of the problem, this research aims to study the capability gaps of industrial technical teachers by analyzing the competencies and skills of fourth-year students in the Bachelor of Industrial Education (B.I.Ed.) program, majoring in Electrical Engineering. The study employs McKinsey's Three Horizons of Growth concept, which divides learner competencies into three time periods: Horizon One (current state), Horizon Two (gap between present and future), and Horizon Three (future goals).

The research utilizes questionnaires/interviews to assess students' current competencies and expected competencies, targeting three groups: 1) Fourth-year B.I.Ed. students majoring in Electrical Engineering at KMUTT, and 2) Teachers from the Electrical/Power Engineering departments under the Office of Vocational Education Commission (OVEC).

The research instruments are categorized into three areas consist of core competencies, functional competencies, and discipline, morality, ethics, and professional conduct. Experts validate the instruments' quality through content validity assessment before collecting data from the sample groups.

Upon obtaining the results of current student competencies and expected competencies, a 'competency gap' will be identified, which refers to the distance between the current state and the desired state. The gap analysis begins with setting target goals for development. Next, the current status is analyzed by collecting relevant data through various methods such as questionnaires and interviews.

Once the current and future competency results are obtained, this leads to explaining the gaps that emerge and the factors causing these gaps. Finally, this information is used to formulate recommendations, leading to planning and enhancing the development of personnel capabilities. The goal is to ensure strong academic knowledge that meets vocational education teacher professional standards and teacher competencies.

This involves the development of educational management approaches, the design of training curriculum content, and the creation of student development activities, among other essential tasks for industrial technical teachers. The ultimate goal is to enhance potential through the filling of competency gaps, resulting in the development of authentic knowledge for performing duties as high-quality technical teachers who can propel the nation forward.

Methodology

Beginning with the study of the Bachelor of Industrial Education program in Electrical Engineering (5-year program), the 2020 revised curriculum focuses on specific curriculum content such as philosophy, significance, objectives, and program-level learning outcomes. Two online questionnaires were designed: Set 1 for fourth-year students to self-assess their current competencies and Set 2 for vocational institution teachers to evaluate expected competencies of program graduates, selected through purposive sampling from schools where students practice teaching and who work closely with students (such as mentor teachers and department heads). This is crucial as program graduates will be key intermediaries in developing a workforce (vocational students) for future labor markets. After tools were validated (IOC) by experts using a 4-level rubric scale and analyzed through radar charts, three competency areas were evaluated: 1) Teaching management (8 indicators), 2) Electrical engineering-specific skills (19 indicators), and 3) Essential characteristics for teacher professional ethics (15 indicators), with scoring criteria and interpretations.

Table 1: Quality Assessment Criteria and Descriptions

Scale	**Opinion for Quality**	**Description**	
4	Excellent	You should be a role model and expect the most	Should set an example, strive for excellence, integrate your knowledge, tackle intricate issues, instruct others, or offer guidance to others.
3	Good	Expect a lot	Analyze or distinguish, visualize connections, practice, and solve simple problems
2	Fair	Expect moderate	Use your knowledge to solve problems, practice, and adhere to the methods and steps independently.
1	Need to develop and improve	Expect very little	Be mindful, keeping in mind your previous studies or experiences. Organize knowledge to be easy to understand, follow the methods and steps clearly, and be supervised.

When analyzing the stakeholder group consisting of 39 fourth-year students and 23 vocational institution teachers, the capabilities were categorized into subgroups as follows:

Interm of teaching management is divided into 2 subgroups:

1. Teaching design and management
2. Assessment and teacher development

Interm of electrical engineering professional skills, divided into 3 subgroups:

1. Basic Electrical and Electronics
2. Computer & Technology
3. Professional Skills and Problem Solving

Interm of essential characteristics for teacher professional ethics:

1. Teaching and Learning Management
2. Professional Ethics and Conduct
3. Collaboration

Result and Discussion

The analysis of competency gaps among fourth-year Industrial Education students in Electrical Engineering revealed significant findings across three areas: teaching management, electrical engineering professional skills, and professional ethics. Through comprehensive data analysis utilizing radar charts and statistical methods, several notable patterns emerged regarding students' current competencies and stakeholder expectations.

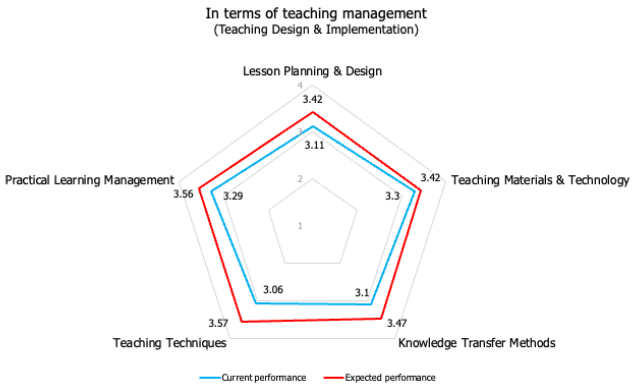

Figure 1: Teaching Design and Management

As shown in Figure 1, the radar chart analysis of teaching design and management competencies reveals distinct patterns between current and expected competencies. The data demonstrates that students exhibit the strongest performance in media/technology usage (3.30) and practical learning management (3.29). However, the most significant gap appears in teaching skills, where current competency (3.06) falls notably below the expected level (3.57), resulting in a gap of 0.51. This visualization effectively highlights areas requiring immediate attention in the curriculum.

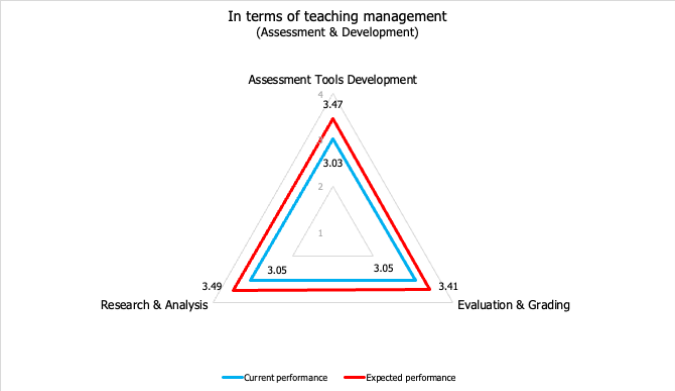

Figure 2: Assessment and Teacher Development

Figure 2 illustrates the assessment and teacher development competencies, where the average current competency (3.04) falls below the teaching design metrics. Notably, while students show relative strength in assessment result analysis (3.05), they demonstrate lower proficiency in assessment tool development (3.03). The radar chart particularly emphasizes the substantial gap in research and analysis capabilities.

In teaching management, the study revealed that students demonstrated generally satisfactory performance with a mean score of 3.17, which fell short of stakeholder expectations (mean = 3.49). Within this domain, students exhibited particularly strong capabilities in media and technology usage (3.30) and practical learning management (3.29), suggesting the successful integration of modern educational tools into their teaching practice. However, a significant gap emerged in fundamental teaching skills (0.51), indicating a need for enhanced pedagogical development. The assessment and teacher development component showed lower overall performance (mean = 3.04) compared to teaching design, with research and analysis capabilities presenting the most substantial gap (0.52).

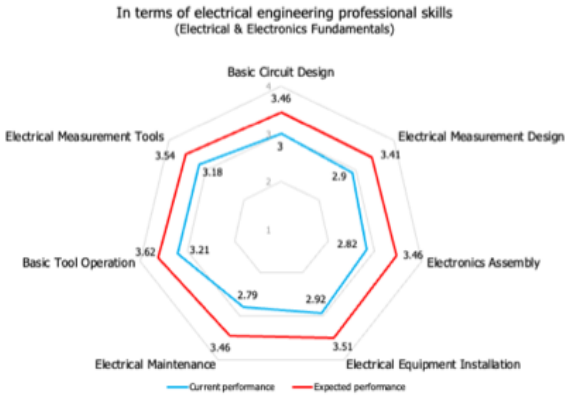

Figure 3: Basic Electrical and Electronics

In Figure 3, the analysis of basic electrical and electronics skills presents a concerning pattern. The visualization clearly shows that while students demonstrate competency in basic tools usage (3.21) and electrical measurement tools (3.18), there is a significant weakness in maintenance skills (2.79). The radar pattern suggests a need for enhanced practical training in equipment maintenance and handling.

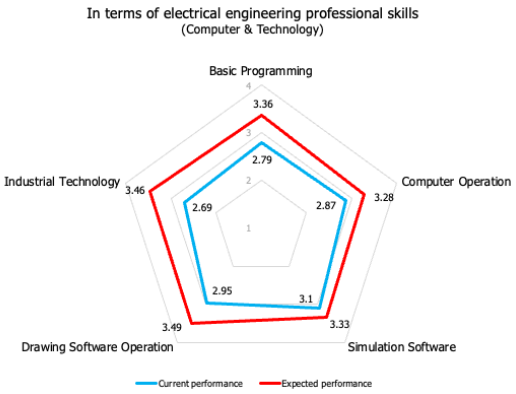

Figure 4: Computer and Technology

Next, figure 4's representation of computer and technology skills indicates a current competency average of 2.88, with virtual program usage emerging as a relative strength (3.10). The chart effectively demonstrates the gap between current capabilities and industry expectations, particularly in advanced industrial technology applications.

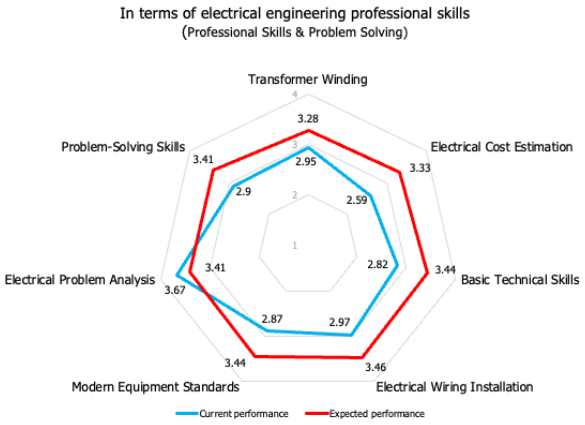

Figure 5: Profrssional Skill and Problem Solving

As depicted in Figure 5, professional skills and problem-solving competencies show an interesting distribution. The radar pattern highlights exceptional performance in problem identification (3.67), while revealing significant gaps in blueprint reading and cost estimation (gap: 0.74). This visualization effectively demonstrates the disparity between analytical and practical implementation skills.

The evaluation of electrical engineering professional skills revealed more concerning gaps in technical competencies. Basic electrical and electronics skills showed a current competency mean of 2.97 against an expected level of 3.49. While students demonstrated proficiency in basic tools usage (3.21), equipment maintenance skills (2.79) fell significantly below stakeholder expectations. Computer and technology skills presented a similar pattern, with a current competency mean of 2.88 against expected levels of 3.38. Notable strength was observed in virtual program usage (3.10), though advanced industrial technology applications showed substantial room for improvement.

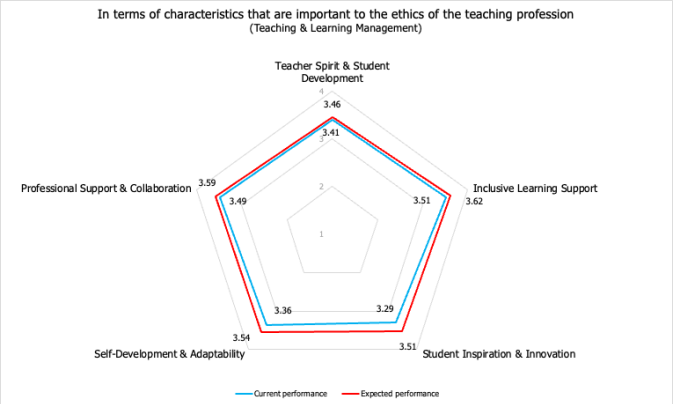

Figure 6: Teaching and Learning Management

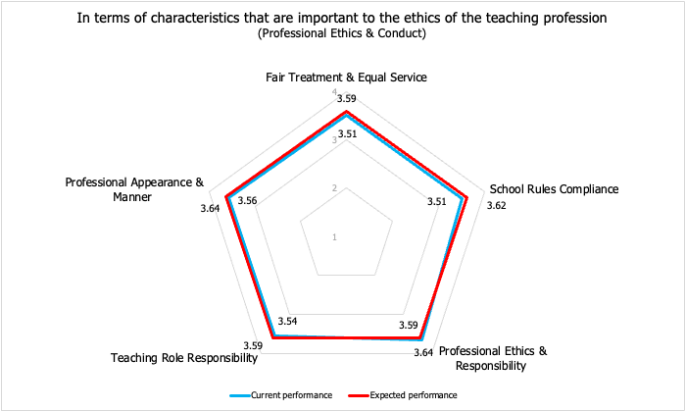

Figure 7: Professional Ethics and Conduct

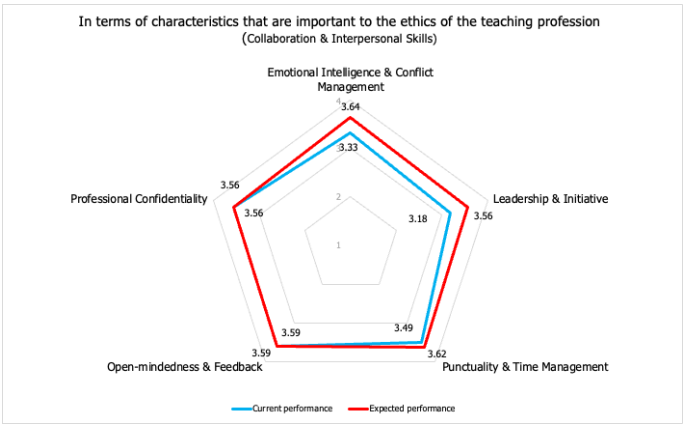

Figure 8: Collaboration and Interpersonal Skills

Figures 6, 7, and 8 present the analysis of professional ethics and characteristics, revealing the strongest overall performance among all domains. Figure 6 demonstrates that teaching and learning management competencies ranged from 3.26 to 3.51 (mean=3.41), with particularly strong showings in learning promotion and diversity acceptance. The radar pattern in Figure 7 displays notably high performance in professional ethics and conduct (mean=3.55), while Figure 8 illustrates strong collaboration skills with some room for improvement in leadership capabilities. Professional ethics and conduct demonstrated the highest performance (mean=3.55) with the smallest gap (0.06) between current and expected competencies, highlighting students' strong foundation in professional integrity and ethical

practice. Collaboration and leadership skills showed robust development (mean=3.48), with particular strength in receptiveness to opinions (3.59), though leadership capabilities presented growth opportunities (gap=0.38).

Conclusions and Implications

The comprehensive analysis of student competencies has revealed a clear hierarchical pattern in performance levels, with professional ethics emerging as the strongest domain (mean=3.55), followed by teaching management (mean=3.17), and technical skills (mean=2.97) requiring the most significant development. This pattern suggests that while the program has successfully instilled strong professional values and basic pedagogical capabilities, technical skill development requires additional attention in the curriculum.

Based on these findings, the curriculum revision implements an Outcome-based education module (OBEM) framework structured around four key components. The Technical Skills Enhancement Module focuses on developing mastery in basic operations, maintenance, and advanced technological applications through intensive laboratory practice and industry-based learning experiences. The Industrial Technology Integration Module addresses the need for modern industrial system understanding and digital transformation competencies through industry collaboration projects and technology simulation exercises.

The implementation of these modules is supported by a robust assessment framework that emphasizes authentic evaluation methods, including practical demonstrations, project-based assessments, and industry partner feedback. This comprehensive approach ensures that assessment practices align with both academic standards and industry requirements.

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