Board 87: Work in Progress WIP Comparing the most demanded skills for Electrical and Computer Engineers (ECE) Graduates in the United States from the Perspective of ECE Academic Department Heads and ECE Professional Engineers

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Work in Progress WIP

Comparing the most demanded skills for Electrical and Computer Engineering (ECE) Graduates in the United States from the Perspective of ECE Academic Department Heads and ECE Professional Engineers

Abstract

When students graduate from Electrical and Computer Engineering (ECE) schools, there is a discrepancy or imbalance between the job-related competencies that companies require and what academic institutions deliver. Due to this skills gap, recently recruited engineers lack what the market dictates and may need more training to gain necessary competencies, costing companies both time and money.

The primary purpose of this study is to compare the skills ECE graduates should have upon graduation from the perspective of industry and ECE academic department heads. In this context, this paper presents the outcomes of two surveys, one distributed to ECE professional engineers and the other to ECE department heads. Both surveys used in this study were obtained from The College and Career Readiness and Success Center at the U.S. Department of Education. The surveys focus on nine major categories: *applied academic skills, critical thinking skills, interpersonal skills, personal skills, resource management skills, information use skills, communication skills, system thinking skills, and technology use skills*. ECE professional engineers and department heads were asked to rank several skills on a 1-5 Likert scale where one is not important and five is vital. This paper compares the perspectives of 45 ECE department heads and 45 ECE professionals regarding the required skills ECE graduates should possess upon graduation and how vital these skills are. Independent sample t-tests was utilized to compare the data from the two surveys and determine whether statistically significant differences existed between the department head's and professional engineers' assessments of the technical aptitude of Electrical and Computer Engineering graduates.

The results of the surveys highlight the gap between academic outcomes and industry expectations for ECE graduates. *System thinking, communication, and resource management skills* are the most important skills for ECE graduates from the ECE professional engineer's point of view, while ECE department heads believed that *applied academic skills, critical thinking skills, and technology use skills* are the most important.

1. Introduction

As knowledge is the backbone of any profession, academic programs strive to improve knowledge in occupation-related disciplines [1]. One of a university's priorities is to equip students with competencies to perform particular tasks once they join the workforce [2], and making sure that the engineering curriculum delivers the outcomes that the company needs is one of its goals. Oftentimes, the development of core knowledge, such as science and mathematics, comes first in an engineering program. The next step is discipline-specific coursework, which concludes with a design project [3] It is essential to impart foundational knowledge and abilities to engineering students, especially at the undergraduate level, and new engineers should have a set of skills pertinent to their future professions [4]. Employers nowadays are finding it challenging to identify and hire engineering graduates who can "hit the ground running" [5]–[7].

Based on the knowledge they learned during engineering school, companies expect their employees to produce outcomes and carry out specific duties [8]. Considering the current dilemma, educational institutions should encourage initiatives to bridge the gap between academia and industry. As the literature review for this paper shows, there is currently a gap between effectively applying knowledge and producing results in the workplace [6].

Although organizations, such as universities, have a role to play in ensuring employability, current research indicates that employers, as well as employees, now see that the primary commitment to employability rests with the individual [9]. The authors [10] indicated that it is the responsibility of employees to acquire abilities, knowledge, skills, and additional characteristics appreciated by prospective and current employers to preserve employability within future and contemporary employment contexts. According to new graduates, this responsibility of employees denotes that employers are currently looking for people who can demonstrate a variety of skills and knowledge relevant to a position, in addition to adaptive behaviors that will allow them to perform in new environments as well as environments that often involve complicated work [11].

One method for graduates to demonstrate that they already have acquired the main employability talents is to demonstrate experiential learning or work-related learning [12]. It is in a nation's cultural, economic, or social interest to ensure that graduates are sufficiently prepared to function as global citizens that are confident and prepared with the appropriate skills for an international context [13]. Learning and innovation skills such as problem-solving and critical thinking abilities [14] are vital for an engineering graduate's success in the field. As per Makki, Salleh, Memon, and Harun [15], engineering graduates must have strong leadership and time-management abilities in order to do well in the workforce. Employers across the world assert that recently hired individuals and university graduates are grossly unprepared in many essential knowledge areas and that many lack the vital skills required for productive employment in the twenty-first century. These abilities are presently crucial to the nation's economic prosperity [3].

This study examines the most desirable abilities for electrical and computer engineering graduates from the viewpoints of those schools' department heads and from the viewpoints of practicing engineers with at least ten years of experience.

2. Literature review

Employers have reported the gaps they perceive between engineering practice and education [10], [16]. Limited studies about novice's perceived efficiency (i.e., early career) as engineers have provided little support for the notion that grades awarded within engineering courses can predict efficiency [17]. The gap between practice and education can also be traumatic to young engineers, contributing to too many seeking different occupations [5]. If a student approaching graduation still lacks the fundamental employability skills which are essential, if not actually required for an internship or a job, problems can arise [2]. The confidence and self-esteem students need to achieve their future objectives and goals may be hampered if they enter the market before, they are competent [3]. Higher education institutions have a commitment to provide students with the skills, information, and professional and personal values they need to succeed in their chosen occupations [8].

Employers worldwide claim that recently hired workers and postsecondary graduates are not sufficiently prepared in many essential knowledge areas, and many lack the primary skills necessary to be successful working in the 21st century. Prominent leading education thinkers, like Howard Gardner from Harvard University, Richard Murnane from Harvard University, and Edgar Morin from UNESCO, agree that these skills are currently critical to the economic success of the country. They support these skills being learned as an element of the education of everyone [7].

Throughout the last twenty-five years, there have been many calls for novel engineering competencies and a related gradual change in pedagogy and the curriculum in engineering education. This has been a universal trend in the United States, Australia, and Europe, and it is currently emerging across the entire world [15]. There are many significant societal challenges that engineering institutions have reacted to related to their graduates' employability skills and the requirements of institutions such as ABET to promote a sustainable approach to engineering pedagogy. These institutional/organizational requirements represent diverse challenges to meet the societal needs for engineering students [16].

The essential employability abilities necessary for job performance, the need for additional training in these skills after graduation, and the college's reaction were all evaluated in a study of faculty, alumni, and recruiters at a business school in southern California [29]. The results of this study showed that the three groups had very different opinions on the abilities required for job performance, the skills graduates had learned in college, and the additional training required. The study's restriction to faculty, alumni, and recruiters at a business school in southern California was acknowledged by the authors as a study drawback. They suggested conducting more research to see if there are any potential discrepancies in issues similar to those raised in the current study [29].

The previous studies have confirmed that there is a gap between engineering education and industrial practices and skills. Much of this gap can be attributed to the lack of the engineering faculty's industrial experience, as most universities focus on research [16]. Other reasons for this gap can be related to differences in the way of thinking and differences in their goals and objectives, as academics strive for recognition from their peers while people in industry just strive to survive [19]. Another important factor is that industry thinks in terms of short-range goals whereas academia has a long-range perspective [24]. The gap also existed as some students have limited vision about their role and dream jobs upon finishing their high school degree [25]. Another critical reason that plays a significant role in increasing the gap between academia and industry is the lack of engineering students seeing the classroom as something that can help them improve their overall skills and abilities [16], [19].

3. Methods

The authors distributed a closed-ended survey to ECE professional engineers and ECE department heads to examine how differently each of the group looks at the demanded skills required for ECE graduates. This was done to gain a more thorough understanding of the skill level that electrical and computer engineering graduates have upon graduation, and the impacts of these skills on reducing the gap among both academia and industry.

3.1. Sample and population

To identify the ideal sample size needed for this research, the authors conducted a power analysis [21]. A power analysis is a metric that aids in determining the minimum sample size for a study. It is made up of four components. If you are aware of or have projections about the first three elements, you can determine the fourth element. The *margin of error* is the number that represents the accuracy of the report. The *confidence level* informs you how convinced you are of the results. It's expressed in the percentage of the time that different samples (drawn repeatedly) would yield this outcome. The *population size* is the overall amount of people in the group. The *standard deviation* shows how much responses deviate from each other as relative to the mean. In this study, 90 percent confidence interval, 126 population size, 10 percent margin of error have been determined resulting in 45 being the minimum sample size [21] for each one of the two groups. In this study, the total number of professional engineers who were approved to participate in the study was 47, but only 45 answered all of the questions. The other two participants were missing responses and were eliminated from the analysis. Furthermore, 57 Electrical and Computer Department Heads were approved to participate in the survey; however, only 45 of them answered all the survey questions and the 12 incomplete surveys were eliminated from the analysis.

3.2. Study data collection instrument

The researchers created two comparable questionnaires with information on the participants' demographics and the abilities needed by industry to gather the data most appropriate for this study. One questionnaire was developed for the ECE professional engineers, and the other questionnaire developed for the ECE department heads. Qualtrics was used to generate the questions and build the surveys. The original instrument was developed by the College and Career Readiness and Success Center (CCRSC) at the American Institute for research [1]. This instrument has been used by many colleges in the United States to measure the level of mastery their graduates have in various skills. The instruments used in this study are composed of two main sections. The first section contains demographic information about the professional engineers and department heads, such as gender, race, level of education, employment type, experience, and location of the company. The second section on of the instruments contains the list of skills that are needed for ECE graduates. The ECE professional engineers and ECE department heads have been asked to rank the various skills based on their "*level of importance*" and the "*degree of preparedness*". The focus of this paper is to highlight the differences regarding the level of importance.

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[1] https://ccrscenter.org/

3.3. Statistical analysis

After collecting data from the returned responses, the Statistical Package for the Social Sciences (SPSS) program (version 25) was used for analysis. All of the responses have been exported from the author's University Qualtrics website and imported to the SPSS software. Descriptive and inferential analysis of the collected data has been carried out. Descriptive statistics have been used to analyze the results from the study, as suggested by Johnson and Christensen [22]. The results are presented as *percentages, means, standard deviations, and frequencies*. Inferential statistics have been used to compare the results of the two surveys using sampled t-test.

4. Results

The study's population consisted of ECE professional engineers who are working in US companies and ECE department heads at US universities. The authors obtained the list of contact information for the engineers from: *previous research projects which were performed under one of the authors supervision and social media networks, and the ECE Department Heads list from the Electrical and Computer Department Heads Association (ECEDHA)* and university websites. The demographics of the ECE Department Heads is presented in Table 1.

Table 1: The demographic information for the Electrical and Computer Department Heads

	Variable	Frequency	Percentage
Gender	Male	43	95.6
	Female	2	4.4
	Total	**45**	**100**
Race	White	25	55.6
	Black or African American	4	8.9
	American Indian or Alaska Native	0	0
	Asian	10	22.2
	Native Hawaiian or Pacific Islander	0	0
	Other	4	8.9
	Missing data	2	4.4
	Total	**45**	**100**
Location	Northeast	4	8.9
	Southeast	5	11.1
	West	11	24.4
	Midwest	7	16.7
	Southwest	18	40
	Total	**45**	**100**
Academic rank	Professor	32	71.1
	Associate Professor	4	8.9
	Assistant Professor	5	11.1
	Lecturer	2	4.4
	Other	3	6.7
	Total	**45**	**100**
Experience	Between 1 to 5 years	3	6.7
	Between 6 to 10 years	4	8.9
	More than 10 years	38	84.4
	Total	**45**	**100**
No. of students in the department	less than 100	3	6.7
	From 100-200	4	8.9
	More than 200	38	84.4
	Total	**45**	**100**

The majority of the respondents are males (95.6%), with different races including white (55.6%), Black or African American (8.9%), Asian (22.2%), North African (2.2%), Middle Eastern (2.2%), and Latino (2.2%). The institutions in which the study sample works are distributed in different locations throughout the country. Most of the participants were professors (71.1%), and the majority had an experience of more than 10 years (84.4%) and worked in departments with more than 200 students (84.4%).

Table 2 shows the demographic information for the electrical and computer professional engineers. For this group, 47 Electrical and Computer Professional Engineers were approved to participate in the survey; however, only 45 of them answered the survey questions and the two missing surveys were eliminated from the analysis.

Table 2: The demographic information for the Electrical and Computer Professional Engineers

Variable		Frequency	Percentage
Gender	Male	32	71.1
	Female	13	28.9
	Total	**45**	**100**
Race	White	27	60
	Black or African American	3	6.7
	Asian	10	22.2
	Other	5	11.1
	Total	**45**	**100**
Level of education	Bachelor's degree	8	17.8
	Master's degree	16	35.6
	Doctoral degree	21	46.7
	Total	**45**	**100**
Employment	Private company	39	86.7
	Government employee	2	4.4
	Self-employed	1	2.2
	Other	3	6.7
	Total	**45**	**100**
Experience level	Between 6 to 10 years	7	16.6
	More than 10 years	38	84.4
	Total	**45**	**100**
Location	Northeast	10	22.2
	Southeast	4	8.9
	West	19	42.2
	Midwest	7	16.6
	Southwest	5	11.1
	Total	**45**	**100**
No. of full-time employees in the company	less than 100	8	17.8
	From 100-500	9	20
	More than 500	28	62.2
	Total	**45**	**100**

Variable		Frequency	Percentage
What was your major area of study?	Computers and digital systems	13	20
	Microelectronics	5	8
	Photonics	2	3
	Materials and control	6	2
	Communication systems and signal processing	10	16
	Energy conversion and power distribution	7	11
	Antenna design and electromagnetic	3	5
	Robotics in manufacturing	4	6
	Networks and Security	14	22
	Total	**64**	**100**
Role in the company	Management	3	5.6
	Administrative Staff	0	0
	Consultant	1	1.9
	Researcher	16	29.6
	Trained Professional Engineer	30	55.6
	Technical, Non-Engineer	0	0
	Other	4	7.4
	Total	**54**	**100**

Out of 45 Electrical and Computer Professional Engineers who answered the survey, 71.1% are males, with different races including white (60%), Black or African American (6.7%), Asian (22.2%), Middle eastern (4.4%), North African (2.2%) and Arab (4.4%). The majority of the respondents hold a higher education certificate (82.3%), including Computers and Digital Systems (21.7%), Communication Systems and Signal Processing (15%), Networks and Security (11.7%), and Energy Conversion and Power Distribution (10%) among others. Moreover, 86.7% of the participants are working in the private sector, and experience of more than 10 years (64.4%). The companies in which the study sample works are distributed in different locations. Nearly half of the participants are trained professional engineers (55.6%), and work in departments with more than 500 employees (62.2%).

4.1 Comparing the two questionnaires

To compare the data collected in the two quantitative questionnaires, independent samples t-test was performed to find if there were statistically significant differences between the department head's and professional engineers' answers for the technical skills that Electrical and Computer Engineering graduates have upon graduation. The result of this test is presented in Tables 3 through 11.

It can be seen in Table 3 that there are statistically significant differences ($\alpha \leq 0.05$) between the DHs and PEs regarding the *applied academic skills* of new graduates. The differences in the means show that the department heads focused more on the importance of these skills.
In Table 4, there are statistically significant differences ($\alpha \leq 0.05$) between the DHs and PEs regarding the *critical thinking skills* of new graduates, where the apparent differences in the means show that the department heads focused more on the importance of these skills.
In Table 5, there are statistically significant differences ($\alpha \leq 0.05$) between the DHs and PEs regarding the *interpersonal skills* of new graduates, where the apparent differences in the means

show that the department heads focused more on the importance of these skills. In Table 6, there are no statistically significant differences (α≥0.05) between the DHs and PEs regarding the *personal qualities* of new graduates.

Table 3[2]: Results of the Independent Samples t-test for the importance of the applied academic skills for new graduates

Skills	**Perspective**	**Mean**	**Std. Deviation**	**t**	**df**	**Sig.**
Students apply or demonstrate reading skills by interpreting written instructions.	Industry perspective	3.62	1.26	5.29	88	0.00*
	Academia perspective	4.71	0.54			
Students rely on writing skills to construct lab reports, posters, and presentation materials.	Industry perspective	3.38	1.21	5.91	88	0.00*
	Academia perspective	4.58	0.62			
Students use computational skills appropriately and make logical choices when analyzing and differentiating among available procedures.	Industry perspective	3.87	1.34	3.88	88	0.00*
	Academia perspective	4.69	0.46			
Students follow procedures, experiment, infer, hypothesize, and construct processes to complete a task.	Industry perspective	3.89	1.44	3.25	88	0.00*
	Academia perspective	4.64	0.57			

* indicates statistically significant (0.05 level)

[2] We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital

Table 4 [3]**:** Results of the Independent samples t-test for the importance of the critical thinking skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students create innovative and novel ideas or solutions and display divergent thinking.	Industry perspective	3.80	1.29	3.36	88	0.00*
	Academia perspective	4.51	0.58			
Students display analytical and strategic thinking.	Industry perspective	3.91	1.31	3.51	88	0.00*
	Academia perspective	4.67	0.60			
Students assess problems involving the use of available resources and review multiple strategies for resolving problems.	Industry perspective	3.80	1.30	3.18	88	0.00*
	Academia perspective	4.49	0.62			
Students negotiate the pros and cons of ideas, approaches, and solutions and analyze options using an "if-then" rationale.	Industry perspective	3.82	1.37	2.81	88	0.00*
	Academia perspective	4.47	0.69			
Students plan steps, procedures, or approaches for addressing tasks.	Industry perspective	3.84	1.41	3.31	88	0.00*
	Academia perspective	4.60	0.58			

[3] We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital

Table 5 [4]: Results of the Independent Samples t-test for the importance of the interpersonal skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students participate in cooperative groups or with a partner, contribute fairly to the task, and show respect to others.	Industry perspective	3.78	1.33	2.57	88	0.00*
	Academia perspective	4.36	.712			
Students help fellow students understand tasks, find resources, and fulfill assigned roles.	Industry perspective	3.71	1.23	1.44	88	0.00*
	Academia perspective	4.02	0.75			
Students participate as team leaders or effective team members in project assignments and organize work and utilize team roles to meet project goals.	Industry perspective	3.69	1.29	2.44	88	0.00*
	Academia perspective	4.24	0.80			
Students keep team members on track, suggest alternatives, and discuss options.	Industry perspective	3.62	1.19	1.80	88	0.00*
	Academia perspective	4.00	0.73			
Students listen to and consider all team members' ideas, respond supportively to ideas given in class or in teams, and work well with all teammates.	Industry perspective	3.91	1.25	1.74	88	0.01*
	Academia perspective	4.29	0.72			

* indicates statistically significant (0.05 level)

[4] (We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital)

Table 6 [5]**:** Results of the Independent Samples t-test for the importance of the personal qualities of new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students actively participate in class, asking questions, volunteering answers, completing and submitting assignments, and working well in groups	Industry perspective	3.80	1.25	1.67	88	0.72
	Academia perspective	3.38	1.13			
Students adapt easily to different modes of instruction and different types of assignments.	Industry perspective	3.78	1.27	1.90	88	0.68
	Academia perspective	3.29	1.16			
Students commit to time-on-task during class and begin work without hesitation.	Industry perspective	3.91	1.24	1.40	88	0.93
	Academia perspective	3.56	1.15			
Students are cooperative and noticeably engaged.	Industry perspective	3.78	1.27	0.89	88	0.50
	Academia perspective	3.56	1.07			
Students demonstrate integrity.	Industry perspective	3.93	1.33	0.08	88	0.54
	Academia perspective	3.96	1.29			
Students treat others with respect and consider all ideas.	Industry perspective	3.84	1.27	0.89	88	0.27
	Academia perspective	3.60	1.32			
Students takes initiative	Industry perspective	3.73	1.40	0.89	88	0.24
	Academia perspective	3.49	1.18			

[5] (We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital)

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students display a positive attitude and sense of self-worth	Industry perspective	3.82	1.26	1.21	88	0.73
	Academia perspective	3.51	1.16			
Students takes responsibility for professional growth	Industry perspective	3.96	1.33	0.65	88	0.63
	Academia perspective	3.78	1.25			

* Indicates statistically significant (0.05 level)

Table 7[6]: Results of the Independent Samples t-test for the importance of the resource management skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students demonstrate time management when organizing and planning project activities with a team.	Industry perspective	4.49	0.66	4.16	88	0.00*
	Academia perspective	3.67	1.14			
Students manage money in group projects requiring the allocation of limited finances and resources.	Industry perspective	4.31	0.79	5.05	88	0.00*
	Academia perspective	3.27	1.13			
Students manage resources in projects requiring the allocation of limited finances, resources (e.g., materials), and personnel.	Industry perspective	4.36	0.77	5.13	88	0.00*
	Academia perspective	3.31	1.12			
Students gain experience managing personnel (i.e., each other) in group projects requiring allocation of limited finances, resources (e.g., materials), and role assignments.	Industry perspective	4.31	0.79	6.69	88	0.59
	Academia perspective	3.07	0.96			

* Indicates statistically significant (0.05 level)

[6] (We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital)

In Table 7, there are statistically significant differences (α≤0.05) between the DHs and PEs regarding the *resource management skills* for new graduates, where the apparent differences in the means show that the professional engineers focused more on the importance of these skills. However, there are no statistically significant differences (α≥0.05) between the DHs and PEs regarding the resource management skills for new graduates in the last sub-skill (Students gain experience managing personnel (i.e., each other) in group projects requiring allocation of limited finances, resources (e.g., materials), and role assignments).

Table 8[7]: Results of the Independent Samples t-test for the importance of the information use skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students use analytical strategies to determine the best medium for finding the necessary information.	Industry perspective	4.49	0.62	4.73	88	0.10
	Academia perspective	3.76	0.83			
Students use any graphic organizer (e.g., outline, concept map, organization chart, or tables) to sort information or data.	Industry perspective	4.27	0.68	6.40	88	0.26
	Academia perspective	3.22	0.85			
Students use classification and analytic skills to determine the necessary information to complete a task.	Industry perspective	4.22	0.76	4.01	88	**0.00***
	Academia perspective	3.42	1.09			
Students assess information to determine which is relevant.	Industry perspective	4.16	0.76	2.61	88	**0.00***
	Academia perspective	3.62	1.13			
Students summarize information to compose written or oral presentations, posters, reports, or slides.	Industry perspective	4.42	0.72	4.04	88	**0.00***
	Academia perspective	3.62	1.11			

* Indicates statistically significant (0.05 level)

[7] (We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital)

In Table 8, there are no statistically significant differences (α≥0.05) between the DHs and PEs regarding the first two skills from *information use skills* for new graduates. Namely, (Students use analytical strategies to determine the best medium for finding the necessary information) and ((Students use any graphic organizer (e.g., outline, concept map, organization chart, or tables) to sort information or data)). On the other hand, there are statistically significant differences (α≤0.05) between the DHs and PEs regarding the other three skills from the information use skills for new graduates, where the apparent differences in the means show that the professional engineers focused more on the importance of these skills. In Table 9, there are no statistically significant differences (α≥0.05) between the DHs and PEs regarding the *communication skills* of new graduates.

Table 9[8]: Results of the Independent samples t-test for the importance of the communication skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students provide oral responses.	Industry perspective	4.58	0.65	2.04	88	0.26
	Academia perspective	4.27	0.78			
Students are noticeably engaged through notetaking, questioning, and responding.	Industry perspective	4.40	0.72	1.87	88	0.57
	Academia perspective	4.09	0.84			
Students use or demonstrate reading skills by following written instructions or project directions, reviewing print and digital resources, and asking questions about what they have read.	Industry perspective	4.36	0.74	0.56	88	0.91
	Academia perspective	4.44	0.75			
Students rely on writing skills to organize lab reports, posters, and presentation materials.	Industry perspective	4.49	0.69	0.82	88	0.18
	Academia perspective	4.36	0.83			
Students interpret the verbal and nonverbal communication efforts of others and follow and take directions from teachers or peers.	Industry perspective	4.47	0.69	2.37	88	0.33
	Academia perspective	4.07	0.88			

[8] (We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital)

Table 10[9]: Results of the Independent samples t-test for the importance of the systems thinking skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students understand their roles and assignments when collaborating as a team and contribute to the organizational structure and function of the team.	Industry perspective	4.62	0.57	5.63	88	0.01*
	Academia perspective	3.76	0.85			
Students devise methods to assess team (e.g., system) progress.	Industry perspective	4.38	0.71	6.51	88	0.06
	Academia perspective	3.22	0.95			
Students negotiate midcourse corrections and adaptations to team (e.g., system) tasks if necessary.	Industry perspective	4.38	0.77	4.78	88	0.40
	Academia perspective	3.53	0.89			

* Indicates statistically significant (0.05 level)

Table 11: Results of the Independent samples t-test for the importance of the technology use skills for new graduates

Skills	Perspective	Mean	Std. Deviation	t	df	Sig.
Students often rely on various digital technologies for calculating, collecting, and displaying data, conducting research, creating presentations, and writing reports.	Industry perspective	4.36	0.64	0.30	88	0.29
	Academia perspective	4.31	0.73			

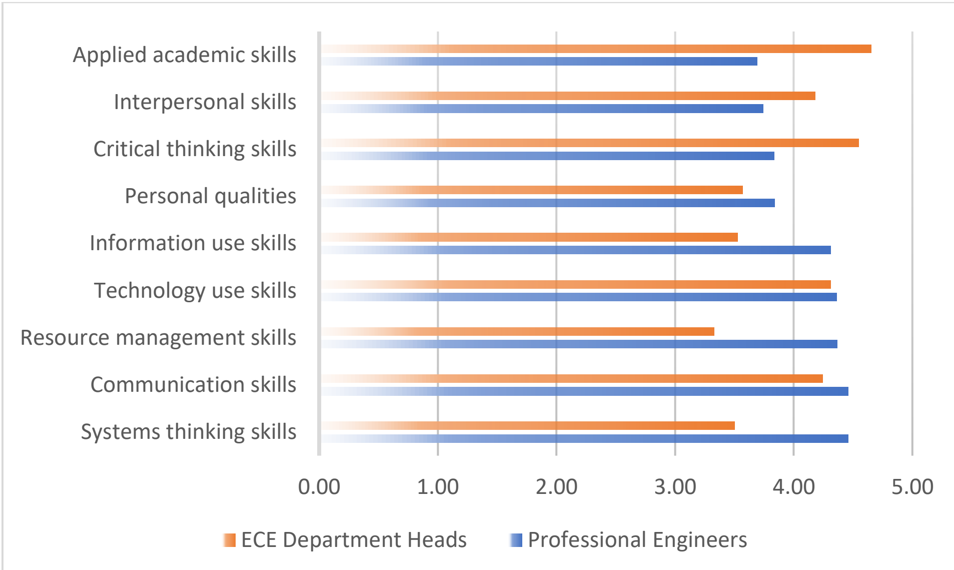
* Indicates statistically significant (0.05 level)

In Table 10, there are statistically significant differences (α≤0.05) between the DHs and PEs regarding the first skill from the *systems thinking skills* for new graduates (students understand their roles and assignments when collaborating as a team and contribute to the organizational structure and function of the team), where the apparent differences in the means show that the professional engineers focused more on the importance of this skill. On the other hand, there are no statistically significant differences (α≥0.05) between the DHs and PEs regarding the other two

[9] (We have used the following scale: 1. Not Important 2. Somewhat Important 3. Important 4. Very Important 5. Vital)

skills from the systems thinking skills for new graduates. In Table 11, there is no statistically significant differences (α≥0.05) between the DHs and PEs regarding the *technology use skills* of new graduates.

Figure 1: Comparing the results for both ECE department heads and ECE professional engineers



In Figure 1, the different viewpoints for ECE department heads and professional engineers is displayed. Systems thinking skills are the most important skills from professional engineers' point of view followed by communication skills, and resource management skills. ECE department heads believe applied academic skills are the most important skills, followed by critical thinking skills. It is clear that both groups have similar perspectives when it comes to technology use skills as they both believe it is so important for graduates.

5. Discussion

Industry and academia may have different goals and philosophies but can work collaboratively to solve and address many of the world's practical problems [15]. Some companies work with academia to address curricular needs to meet workforce demands, but since companies and academic institutions function on their own terms, with little collaboration or coordination, academia ends up producing graduates that industry cannot fully utilize to advance their workforce needs [3].

Some of the principal factors creating the gap between what academia produces and what industry needs include lack of interactions between the two entities, lecturers or faculty lacking industrial exposure, the examination or evaluation process used in assessing students' performance, industry not getting involved in curriculum review and development, and students lacking employability skills, amongst other factors [10], [16], [19]. Understanding employer demands, varying sector-specific skills, training needs that boost business performance, articulating corporate expectations in educational institutions, and involving business leaders with higher education institutions are all topics that have a high demand [5].

Having well-prepared ECE graduates equipped with the most needed skills will increase their employment chances and help in the prosperity of the industrial institutions [3]. The data collected in this study confirms the gap between the importance level for ECE graduates as determined by professional engineers and departments heads. Despite the resources educational institutions have, ECE graduates are still lacking the most demanded skills that are needed from industry. According to literature, the gap between the importance level as determined by professional engineers and department heads are related to the lack of innovative teaching styles and project-based learning [23], [24].

In this study, the authors completed a statistical t-test to measure the quantitative differences between the ratings of both ECE academic department heads and ECE professional engineers. Results revealed that there was no statistical difference between some of the skills, but a statistical difference did exist between other skills. For example, system thinking skills and communication skills were most important from a professional engineer's point of view and applied academic skills and critical thinking skills were the most important from the ECE department heads perspectives.

The results show that there is a gap between the industry and academia in their perspective on the level of importance ECE engineering students have toward technical skills. However, this gap did not exist in all the skills. In the following discussion, the justifications and explanations for such differences are explained.

The results, as seen in Table 3, indicate that applied academic skills have a higher degree of importance from ECE department heads in comparison to ECE professional. Furthermore, the results showed that communication skills were one of the primary skills that were highlighted by the professional engineers, and many studies confirm that communication skills are one of the priorities for employers. Although academia focuses on the importance of communication skills, its meaning may or may not align with the ascribed meaning by professional engineers [15]. This may affect recently graduated engineers as they seek new jobs. Many studies have analyzed typical university communication curricula where they asked employees, employers, teachers, or students about the communication skills employees and students should improve [26]. When the independent sample t-test was run to compare communication skills between the two groups, the results showed that no statistical difference was found between the subskills, which means that both ECE department heads and ECE professional engineers' responses were similar. Identifying the subtle differences in the subskills and collaborating with professional engineering firms may be the key to establishing the communication skillset industry wants.

In addition, the results revealed a mismatch in interpersonal skills between the two groups. It can be seen from Table 5 that all the subskills were significantly different, which means that both groups differed in their thinking about the degree of preparedness electrical and computer engineering graduates have upon graduation regarding the interpersonal skills of new graduates.

Overall, there were different perspectives of both ECE academic department heads and ECE professional engineers in terms of the various skills. Although the results showed some similarities between the two groups in some skills, the overarching trend in this research revealed how different these two groups are. Both groups indicated how important collaboration is to equip ECE graduates with the skills, as these skills are vital to their success and prosperity when they join industry.

6. Conclusion, recommendations, and future works

This research could help to bring about real, long-term improvement in the Electrical and Computer Engineering curriculum, which could be beneficial to other engineering fields. Additionally, the findings may have an impact on other organizations that stand to benefit from such advancements. An effective partnership between industry and academia could help to identify commonalities to meet each other's demands and be a win-win scenario for all.

Considering the results mentioned in this research, it is highly recommended that both visionary educational and industry leaders should conduct regular meetings to discuss the needs of industrial companies. Discussions should revolve around possible collaborations to increase the chances of employability for ECE graduates through understanding the demands and requirements in the field and its implication for entry-level jobs. Once the needs of industry are understood, educational institutions should foster innovative teaching approaches that aim to equip engineering graduates with the demands of industry. It is academia’s responsibility to prepare engineering graduates to meet the demands of industry to assist them in securing long-term employment. Communication channels should exist between industry and academic institutions through attending advisory board meetings. Educational leaders are responsible for developing new programs and updating existing ones to meet the demands of industry. These newly developed or updated programs should be flexible to meet the needs of the ever-changing industry.

Engineering curricula should foster the use of the various professional skills mentioned in this research, such as communication and system thinking skills, as they are considered highly demanded and needed for new ECE graduates to become successful in industry. Furthermore, contemporary resource management methods like strategy implementation, budgeting, quality enhancement, performance evaluation, professional development, public relations, cultural and institutional change, marketing, and resource mobilization have all become critical ingredients for a great engineering manager. Engineering students must acquire these skills during and after their education.

This study has generated a number of recommendations for strengthening the most crucial abilities from the viewpoints of ECE professional engineers and ECE department heads. It is recommended that all educational institutions adapt their delivery strategies to better suit business needs. The ECE curriculum should be altered to convey and promote the abilities required by industry in order to generate ECE graduates who are likely to succeed there. The most necessary skills for the success of ECE graduates in industry will be fostered through the application of new teaching methods that engage students more in the classroom.

To globalize the findings of this study, new efforts will be required to gather additional information from both groups with a wide range of experiences and boost the study's sample size. Future publications will take into consideration the implications of the findings discussed in this research on the ECE curricula and how the outcomes affect the instruction.

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