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Evaluating the Employability Skills of Industrial Engineering Graduates: A Case Study*

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Incorporation of employability skills in the industrial engineering curriculum to bridge the gap between industry and institutions of higher education has become a major issue. This study appraises the employability skills of industrial engineering graduates based on the skills that required additional training, skills that are needed for job performance and skills that are received/emphasized in the curriculum. Two batches of questionnaires are administered to the participants of the study. The first batch is administered online to students, employed alumni and faculty members. The second batch is distributed to instructors of core courses. Thirty-six items of skills are arranged under seven basic employability skills that were previously reported are employed in the evaluation. Of the seven employability skills, following management, leadership and information technology skills are identified as skills that require additional training. The responses toward skills required for job performance and skills that are received/emphasized in the curriculum are ranked higher by participants based on the percentage of agreement. This study advocated that the perception of participants provides greater insight into the skills items that should be emphasized in the industrial engineering curriculum to enhance the employability of graduates.

Keywords: attitudes; curriculum; employability skills; performance skills; training

1. Introduction

The rapidly emerging job-space since the beginning of the 21st era has been conditional on the intrinsic skills possessed by individuals; thus, higher acumen on specific skill sets is needed to secure and retain jobs [1–5]. Because engineering jobs have been substantially influenced by the resultant effects of globalization, continuous appraisal of the skill sets of engineering students is critical for enhancing the employability skills of graduates. The mismatch among important employability skills requirements of the emerging job market, which should be entrenched in the curriculum and graduates that actually need additional training, has been investigated. The study concluded that deciphering stakeholders' perceptions about various employability skills is the key to curriculum restructuring to equip graduates with requisite employability skills to satisfy the vast and changing demands of the industry [5]. Consequently, this demand has placed a considerable onus on institutions of higher education to revamp their curriculum to stay abreast of the adequate skills demand of the industry. A great disparity between the knowledge imparted by the curriculum and that required on the job [6]. The imbalance between the skills garnered at higher institutions and those expected on the job (especially skills that have existed over the years) is due to the larger number of priorities placed on academic learning at the expense of the knowledge required to satisfy the demand of emerging job functions [7]. Considering the evolving job environment, the delivery of basic qualitative and quantitative transferable skills by graduates from various institutions are non-negotiable for the survival of thriving industries. Further studies of the gap perceived between employers and engineering graduates about employability skills have been performed [8] by the modified Secretary's Commission on Achieving Necessary Skills (SCANS). The findings of these studies concluded that employers tend to adduce more credence and importance to specialized skill sets, such as creativity, communication, interpersonal, decision making and problem-solving. Thus, a strong correlation between students' adequate skills set (employability skills) and their level of competency on the job is not the uttermost skill that employers seek in a graduate. Students always consider that the level of their technical skills should be sufficient for securing a job and giving them the required propensity to be effective on the job. This study seeks to decipher this dichotomy by assessing the level at which this technical skill set is being translated into employable skills by the graduates who use the cogent employability skills reported by [9].

Therefore, emphasis should be placed on developing adequate competencies required to secure and retain employment and transfer within different jobs via a well-thought-out curriculum [10]. Note that being employable surpasses the ability to per-

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form well on a job. Employable is also defined as the ability to accomplish assigned tasks in accordance with the missions and objectives of an establishment. Thus, continuous re-design, appraisal and development of the curriculum are germane toward bridging the gap regarding employability skills, including constant review and revitalization of some aspects of the curriculum to remain in tandem with the labor market's demand. Therefore, all parties must collaborate, especially the regulatory boards responsible for the accreditation of higher education institutions and those who regulate various professional bodies. Some studies have described employability skills as values that accompany the demonstration of competency or ability gained by training in educational instructions or apprentices or both [11, 12]. The evolving technology is suggesting to be moving at a pace that is insufficient for academic institutions to stay abreast and cope. Competencies are usually interpreted in various ways according to different fields [13]. A higher institution of learning has been described as an establishment where students must not only learn skills but also to apply and exercise these skills [14]. Employability is defined as either inadequate capacity on the part of the graduates or the inability of graduates to demonstrate thorough understanding of the skill set necessary to perform specific job responsibilities [15]. Two approaches have been proposed to define ways that employability can be taught in universities and colleges. The first approach is the enhancement of the employability of students via the use of a revitalized curriculum. The second approach focuses on equivalent and independent groups geared toward improving generic study skills [16–18].

Research conducted on how to use graduates' skill sets as a yardstick for improving the quality of undergraduate engineering programs concluded that technical expertise and emotional intelligence are necessary [19]. Similar studies have affirmed that technical background, problem-solving skills, formal communication skills and life-long learning abilities were necessary skills required by graduates to be successful in their careers [20]. These findings are propelled by the tendency of a graduate to envision, emerge and evolve employable attributes and nurture the seeds of self-motivation, career management skills, and the willingness to learn and reflect on learning. The employability skill set required by engineering graduates are broadly classified as soft and professional skills. Soft skills include core employability skills, such as integrity, teamwork, self-discipline, reliability, flexibility, empathy, and willingness to learn. Professional skills are skills regarded as communication skills, such as basic computer skills; written, oral, verbal, technical skills; and experimental/data analysis and interpretations [21–22]. Despite their findings, which indicated a large gap in professional skills, soft skills are regarded as the most important skills sought after by employers. Some studies [23] reported the need for research that is geared toward revitalizing an undergraduate curriculum in a way that industry skill needs can be incorporated and emphasized. This research can assist students in developing certain capabilities that are suitable and essential for the skill requirements of this emerging job era. Graduates will be equipped with the tendency needed by them to understand and intuitively determine the skill sets required to solve problems. This study is, therefore, expedient to create the awareness of new Industrial Engineering (IE) students toward an employability skills portfolio [24] that should be developed in readiness for employment.

In a related study, five attributes—personal and working attitudes, skills on communication and engineering knowledge, knowledge of technical standards and specifications, technical skills, and knowledge of basic principles and intellectual skill were assessed [9]. This study further emphasizes the appraisal of the preparedness of IE graduates with the objective of identifying weaknesses of the current curriculum. A study of the assessment of an IE curriculum had discovered that the IE program curriculum was inclusively designed using the fundamentals of engineering and IE training that satisfied the requirements of the Accreditation Board for Engineering and Technology (ABET) [25]. This research assesses the perceptions of various stakeholders of IE based on the employability skill set gained during studies. This research is conducted at the IE department of Eastern Mediterranean University (EMU) which is located in the Turkish Republic of North Cyprus. The aim is to assess participants' perceptions of the IE department regarding their attitudes about seven basic employability skills, which are derivable from each of the core courses taught in the IE department. These recruitment skills are itemized [9] as follows: literacy and numeracy (L&N), critical thinking (CT), leadership (LS), following management (FM), interpersonal (IP), information technology (IT) and work ethic skills (WE). The changes in the attitudes of students are considered in two categories: skills that are received/emphasized in college (SREC) and skills that require additional training (SRT). Additionally, three groups of participants (senior students, employed alumni, and faculty members) from EMU are selected and their attitudes are compared with the three categories of attitudes: SREC, SRT and skills needed for job performance (SNJ).

The following research questions are proposed:

(a) How do the perceptions of respondents differ regarding skills that require additional training, skills needed in job performance and skills received or emphasized in curriculum?
(b) Which of the seven employability skills is highly important based on the attitudes among the three categories of SRT, SNJ and SREC?
(c) Which of the seven employability skills should be the focus and intensively trained in the curriculum of the IE students?

This study only assessed the seven types of employability skills, as listed in Appendix A Table 1, to determine the level of skills gained during studies, the skills that require additional training and skills that should be required for job performance. However, strategies that are needed to enhance these identified skills are not addressed. An innovative process learns-apply-adjust-repeat system that can assist students in rapidly learning and developing these skills is not explained in this study. The study was conducted to assess the employability skills of the IE graduates in EMU.

2. Methods

One hundred and nine (109) respondents participated in the survey. Table 1 lists the demographic data of the participants. Two batches of questionnaires are formulated; the first batch is administered online to students, employed alumni, and faculty members during the academic year 2016–2017. The first part of the first batch of the questionnaires consists of demographic questions; the second part of the first batch is used to assess thirty-six items of skills (refer to Table 1–A Appendix A). These items belong to seven types of basic employability skills that are recorded based on a five-point Likert scale. The second batch of the questionnaires is administered to instructors of industrial engineering who taught the core IE courses. Seventy-four students aged 17–28 years participated in this study. A total of 26 responses from respondents aged 21–39 years are received. In addition, responses from nine (9) faculty members aged 30–60 years are received. The study instruments are obtained from existing research [26, 27] based on an internationally compiled set of skills and knowledge that the graduates are expected to possess at the time of graduation [28].

The IE department is officially accredited by the Accreditation Board for Engineering and Technology (ABET), which has conferred 11 program outcomes (a to k) to the department. This study links these program outcomes with the 36 items of skills (refer to Table 2-A Appendix A). The core courses are distributed across four academic years as follows: 10 courses in the first year, 14 courses in the second year, 10 courses in the third year and 8 courses in the fourth year. A score of 3 given to the instructors (intensive importance) is considered to determine which skills of the seven employability skills are intensively addressed in each course. The

Table 1. Demographic data for IE students, employed alumni and faculty at EMU

Variable	Categories	N	% of participants
Students			
Gender	Male	55	74.32
	Female	19	25.68
Academic level	Senior	18	24.30
	Junior	30	40.54
	Sophomore	11	14.86
	Freshman	15	20.30
Employed alumni students			
Gender	Male	21	80.70
	Female	5	19.30
Date of graduation	2000–2005	13	30.00
	2006–2010	9	34.60
	2011–2016	4	15.40
Do you have a job right now?	Yes	23	88.50
	No	3	11.50
Faculty members			
Gender	Male	8	88.80
	Female	1	11.20
	Full-time	6	66.67
Teaching time	Part-time	3	33.33
Years of teaching experience	1–10	4	44.44
	11–20	2	22.22
	Over 20	3	33.33

Table 2. Descriptive statistics of students' percentages agreement

	Mean		Max		Min		SD	
Statistics	**SREC**	**SRT**	**SREC**	**SRT**	**SREC**	**SRT**	**SREC**	**SRT**
Freshman	55.14	66.67	94.00	93.00	25.00	27.00	17.32	16.73
Sophomore	62.03	59.17	91.00	91.00	27.00	36.00	15.93	15.97
Junior	84.94	52.89	97.00	80.00	70.00	23.00	05.59	15.69
Senior	86.64	41.61	100.0	72.00	56.00	17.00	10.43	14.73

yearly average of the percentages of the IE course contents is calculated by dividing the total number of important responses from the instructors by the total number of core courses taken every academic year.

Each response was coded based on a Likert five-point scale as 1—strongly disagree, 2—disagree, 3—have no idea, 4—agree and 5—strongly agree. The degree of disagreement or agreement is determined for each item of skill, and the percentage of agreement for each item is calculated. According to the requirements of the research, the variables are defined as dependent and independent. The dependent variable is the percentage of agreement that is considered as the participants' percentage agreement for each attitude, which is calculated by dividing the total strongly agree and agree points by the total number of participants for each item. The independent variables are listed as follows:

- Students' level: freshman, junior, sophomore, and senior.
- Participants' group: senior students, employed alumni, and faculty members.
- Seven employability skills: L&N, CT, LS, IP, IT, FM and WE skills.

One-way ANOVA analysis is used to test each factor that is specified.

3. Data analysis and results

Analysis of variance (ANOVA) assumptions are tested and validated using the normal p-plot, frequency histograms and plots of residuals. ANOVA assumptions are maintained. Therefore, a one-way ANOVA with $\alpha = 5\%$ is an appropriate test to be used for the data analysis. The mean and standard deviation of students' responses in each academic year are determined on the basis of both SREC and SRT (Table 2).

Table 3 shows the percentage of students' agreement regarding attitudes SRT and SREC toward the seven employability skills at various academic levels. These percentages show increasing values for SREC and decreasing values for SRT for all categories of students.

The relationship between the students' responses regarding SRT and academic levels is analyzed using a one–way ANOVA model. The results show that the academic level has a significant effect on the percentage of agreements, as shown in Table 4.

The relationship between students' responses about the attitude of the SRT and the seven types of employability skills is tested by a one-way ANOVA (refer to Appendix B, Table1-B). The results show significant differences ($p = 0.00$)

Table 3. Percentage agreement of students' responses

Attitudes	**SRT**				**SREC**			
Seven Types of Employability Skills	**Freshman**	**Sophomore**	**Junior**	**Senior**	**Freshman**	**Sophomore**	**Junior**	**Senior**
Literacy and Numeracy	56.75	45.30	38.00	26.30	76.75	68.5	91.80	95.80
Critical Thinking	77.67	68.30	48.5	42.50	51.17	59.33	87.20	80.50
Leadership	69.20	54.60	52.80	39.00	40.00	52.80	80.00	77.80
Following Management	82.33	58.00	67.70	68.30	48.00	58.00	81.00	79.70
Interpersonal	60.00	52.80	58.00	46.60	51.60	45.40	85.80	84.20
Information Technology	82.60	80.20	75.40	52.20	51.40	61.80	82.80	89.80
Ethics	50.13	53.40	40.90	30.50	64.00	78.63	85.30	94.40

Table 4. ANOVA for percentage of agreements SRT versus academic levels of students

Source	**DF**	**SS**	**MS**	**F**	**P**
Academic Level	3	12138	4046	16.21	0.000
Error	140	34939	250		
Total	143	47077			

Table 5. Ranking of seven employability skills regarding the students' responses

Seven Types of Employability Skills	Percentage of agreement (SRT)
Information Technology	72.60
Following Management	69.08
Critical Thinking	59.25
Interpersonal	54.35
Leadership	53.90
Work Ethics	43.72
Literacy and Numeracy	41.56

between students' responses and types of skills. As a result, these skills are arranged in descending order in Table 5 according to the students' percentage agreement.

For skills that are received and emphasized in the curriculum, significant effects between student levels and their responses (*p = 0.00*) are observed. The Fisher method revealed that responses of both senior levels and junior levels converged with the largest percentage. Conversely, the sophomore and freshman responses are lower and also diverged (refer to Appendix B, Table 2-B).

Based on the previous findings, only senior students are selected because the perception of their attitudes is the most appropriate perception for a comparison with those of employed alumni and faculty. The percentage of agreement listed in Table 6 reveals that:

1. For skills needed in job performance, the participants' agreement with the highest percentage ranged from 98% to 77.8%.
2. Based on skills that require additional training, the participants' agreement ranged between 66% and 74%. Therefore, management skills will require additional training. Similarly, faculty members with a higher percentage agreement suggested that the students need additional training.
3. In terms of skills received/emphasized in college, the percentage agreement for both senior students and employed alumni exceed 73%. Faculty members agreed with a minimum percentage agreement of 35.6% that leadership skills are the least emphasized skill in the curriculum.

Table 7. ANOVA reveals a significant difference in the percentage of agreement for the participants' level (p = 0.00).

Participants' responses in term of SRT indicates a significant difference between all skill items at p = 0.002 (refer to Appendix B Table 3-B). As a result, we arranged the seven skills in descending order of the percentage of agreement for skills that require training, as shown in Table 8.

For the attitude of seniors, employed alumni and faculty members regarding SREC and SNJ, significant differences in the percentage of agreement for the participants at (*P = 0.000*) and (*P = 0.034*) are observed (refer to Appendix B Tables 5-B, 6-B). In terms of the seven types of employability skills regarding SREC (*p = 0.003*), a significant difference exists among the participants; however, a different result was obtained with regard to SNJ (*p = 0.18*) (refer to Appendix B Tables 9-B and 11-B). The ranking of SNJ and SREC have been sorted and grouped (refer to Appendix B Table 12-B, 10-B).

According to these outputs, the skills that require additional training with a percentage agreement above 50% are selected as common skills by the participants. The Venn diagram Fig. 1 shows the skills intersections among these groups. Seven items of skills among the groups are identified, as described in Appendix B Table 13-B.

Table 6. Percentage agreement of senior, employed alumni and faculty members on the employability skills

	SNJ			SRT			SREC		
Seven Types of Employability Skills	**Senior**	**Employed alumni**	**Faculty**	**Senior**	**Employed alumni**	**Faculty**	**Senior**	**Employed alumni**	**Faculty**
Literacy and Numeracy	94.30	94.30	86.10	26.30	31.70	66.70	95.80	88.50	75.00
Critical Thinking	80.30	86.60	87.00	42.50	60.20	50.00	80.50	82.70	50.00
Leadership	77.80	95.40	77.80	39.00	59.20	60.00	77.80	73.10	35.60
Following Management	98.00	92.30	88.90	68.30	66.70	74.10	79.70	76.90	66.70
Interpersonal	85.40	87.70	80.00	46.60	46.90	53.30	84.20	85.40	53.30
Information Technology	93.00	86.90	86.70	52.20	66.10	51.10	89.80	80.00	73.30
Ethics	88.10	89.00	80.60	30.50	43.80	65.30	94.40	77.90	72.20

Table 7. One-way ANOVA Percentage of agreement SRT versus participants' Levels

Source	DF	SS	MS	F	P
Participants' Level	2	5738	2869	13.27	0.000
Error	105	22711	216		
Total	107	28449			

Table 8. Ranking the skills regarding participants' response (Faculty, Employees and Seniors)

Seven Types of Employability Skills	Percentage of agreement (SRT)
Following Management	69.69
Information Technology	56.48
Leadership	52.74
Critical thinking	50.91
Interpersonal	48.95
Work Ethics	46.51
Literacy and Numeracy	41.55

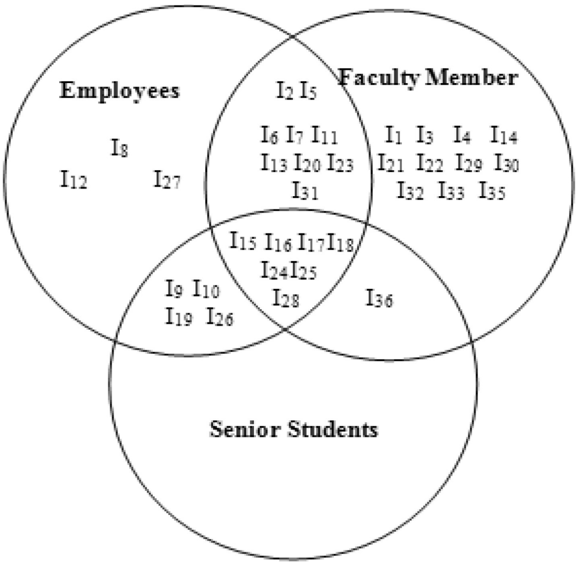

Fig. 1. Common skills that required additional training.

Table 9 provides the responses obtained from the second batch of questionnaires. These responses are considered to be the percentage importance of employability skills inherent in the IE core courses. The percentage importance of management skills for the freshman year is the lowest; however, the percentage increased in the third and fourth years. Generally, literacy and numeracy skills recorded the largest percentage of importance among the seniors.

The relationship between the seven common skill items that are listed in Table 13-B (refer to Appendix B) and the courses that were taught in the junior and senior years were identified, as shown in Table 10. The intensive order of importance for these skills are determined based on the instructors' responses to the second batch of questionnaires.

4. Discussion

An evaluation of the percentages agreement via the students' perceptions regarding skills that require additional training and skills received or emphasized in college courses is conducted. The results show that students' responses are significantly different. The attitude of the senior students regarding SRT exhibited the lowest percentage agreement compared with the remaining academic levels. This finding reflects the level of confidence of this set of students; they seem well trained and ready for

Table 9. Percentage of importance of employability skills in the contents of IE core courses

	Percentage of contents of courses with employability skills			
Seven Types of Employability Skills	**Freshman**	**Sophomore**	**Junior**	**Senior**
Literacy and Numeracy	40.00	36.50	33.50	63.50
Critical Thinking	28.17	22.63	38.50	55.50
Leadership	10.00	6.50	21.00	20.50
Management	6.00	14.00	39.00	25.50
Interpersonal	6.50	30.00	40.00	36.00
Information Technology	8.00	24.00	60.00	59.50
Work Ethics	39.00	48.00	59.50	36.00

Table 10. Skills' items that require additional training in each course

Year	Code	Course Name	Items of Skills
Junior	MATH322	Probability & Statistical Methods	I_{25}, I_{28}
	IENG355	Ethics in Engineering	I_{15}
	IENG313	Operations Research - I	I_{24}, I_{25}
	IENG323	Engineering Economy	I_{17}, I_{24}
	IENG372	Information Systems and Technology	I_{24}, I_{25}, I_{28}
	IENG 310	Industrial Training II	I_{15}, I_{24}, I_{28}
	IENG301	Fundamentals of Work Study and Ergonomics	I_{16}, I_{18}, I_{24}, I_{25}
	IENG 314	Operations Research - II	I_{16}, I_{17}, I_{24}, I_{25}
	IENG332	Production Planning - I	I_{24}, I_{25}
Senior	IENG385	Statistical Applications in Engineering	I_{24}, I_{25}, I_{28}
	IENG 410	Industrial Training III	I_{17}, I_{24}, I_{28}
	IENG441	Facilities Planning and Design	I_6, I_7, I_{10}, I_{25}
	IENG461	Systems Modeling and Simulation	I_{15}, I_{16}, I_{24}, I_{25}, I_{28}
	IENG490	Introduction to Manufacturing	I_{15}, I_{25}, I_{28}

the challenges of the workplace. This finding corroborates the previous results, which indicated that a majority of engineering graduates seemed to have fully imbibed the technical training taught and are always confident that they will perform well as engineers [29]. In addition, their responses toward SREC is the highest, which reveals that they are learning the most needed skills according to their program's objectives and student outcomes (a to k), as envisaged by the Department of IE at EMU. Most of the students agreed that additional training in FM and IT skills is required. The largest percentage of agreement regarding literacy and numeracy skills and work ethic indicates that these skills are well emphasized in the curriculum.

The findings reveal that the responses of the faculty members and employed alumni converged in terms of the attitude toward SRT (refer to Appendix B Table 4-B). This convergence may be attributed to their vast experience and awareness in evaluating undergraduates' needs for additional training. The percentage agreements of senior students and employed alumni regarding their attitudes toward SREC are high and show no significant difference. This finding implies that these seven types of employability skills are received and learned in college. Conversely, the responses of the faculty members regarding L&N and IT skills are different, which indicates that these skills should be emphasized in the curriculum. [30] stressed the necessity for numeracy skills to be emphasized in the engineering curriculum. Additionally, the faculty members did not consider emphasizing leadership skills in the curriculum because it received the lowest percentage score. The participants' responses regarding SNJ receive the largest percentage of agreement, which indicates that these seven employability skills are essential for the success of industrial engineers. The highest percentage of agreement is obtained from the responses related to following management skills and literacy and numeracy skills, which is consistent with the expectations of many employers. Employers have always maintained that technicians and managers with excellent management skills are scarce, and interpersonal and generic skills are lacking. The majority of salespersons are deficient in communication skills [31]; some of these sets of skills are essential for optimum performance in the field of engineering [32]. In another study [33], an assessment of the skills requirements of IE graduates in South Africa concluded from the largest agreement of the perceptions of participants that the essential skill items are supply chain management, business process analysis, optimization and management. This conclusion is in tandem with this study because the item of the previously mentioned skills falls under following management and literacy and numeracy (refer to Appendix A Table 1). This study described these skills as the most importance employability skills necessary for enhanced job performance.

The study reveals leadership, following management and information technology skills as three of the seven employability skills that require additional improvement. Leadership skills are crucial, especially in the areas of goal setting and responsibilities [34]. The reason for the dearth of leadership skills among engineers is attributed to the fact that ideas for blending various skills—soft and professional skills—at all levels for successful job performance are lacking. Thus, engineering students have to be taught inside and outside the classroom, which requires a judicious balance of technical skills and non-technical skills to guarantee an enduring engineering practice. This balance is achievable when the objectives of the curriculum include the development of both professional skills and soft skills. If engineers understand this early in their careers, they would be able to assume leadership roles and seamlessly achieve the transition from project engineer to project manager [33]. As correctly posited, an engineering career requires the ability to work in a leadership role within a team; unfortunately, these skills are not particularly developed in the existing curriculum [29].

Management skills also need improvement and should be emphasized in the college curriculum, specifically in the areas of selecting goal-relevant activities, preparing a budget, assessing other skills and distributing duties. However, embedding these skills in the syllabus may not yield the needed results even though it has because embedding them renders teaching tedious [35]. For this reason, this study proposes an open awareness for all parties involved in the teaching and learning of these skills. This study corroborates one of the conclusions in the previous studies of [36]. The skills of information technology should be improved, particularly in the areas in which computers are used to arrange, evaluate, analyze, share information, recognize and resolve problems. Some studies urged the use of the 'Big 6' skills method, which the most commonly known and extensively employed approach for training information technology skills in many high schools, higher institutions, and adult teaching programs [37].

The percentage of emphasis on the importance of IE courses for the following management, information technology, interpersonal and leadership skills is very low in the first and second years but slightly increased in the third and fourth years. This study discovered that IENG372, which is taught in the third year, is the only course that demonstrated all

IT skills set of I_{24}, I_{25} and I_{28}. No special courses intensively focus on all items of FM (I_{16}, I_{18} and I_{17}) and leadership skills (I_{15}) in the last two years of study but appear scanty in certain courses, such as IENG301, IENG441, IENG461, and IENG314. Institutions must prioritize the allocation of resources toward the enhancement of employment-oriented training and learning to effectively inculcate employer-driven courses in the curriculum [16]. Qualitative and quantitative methodologies have been applied to determine if a gap exists. Institutions have been saddled with the responsibility of enhancing human capital development for improved productivity and economic growth [38]. This era proposes a shift from the traditional classroom-focused graduate employability to long-life learning. This level of employability skills and experience would positively impact graduates' propensity to secure, manage and retain jobs in the labor market.

Models that tend to make engineering studies more innovative, relevant, practicable and flexible have to be continuously improved via the faculty curriculum designing process. First, the models have to identify the stakeholders, define and analyze the requirements, conduct preliminary design and create the detailed design. The model must be validated by an advisory board of the University [39]. As a general recommendation, the curriculum should be enhanced by adding real-life industrial projects to the courses. This finding conforms to a report on reinforcing engineering education [40], which expressly stated that the curriculum can be revitalized by emphasizing project and problem-based learning, just-in-time techniques, information and communication experiences and real-time hands-on applications. Note that graduates must be professionally capable of bridging the gap between the competencies obtained at universities and those required of societies, industries and services [41–45]. This study, therefore, suggests that an IE curriculum should be revitalized to accommodate specialized courses to further enhance these important skills that have been overlooked by IE graduates.

5. Conclusion

This research unearthed different perceptions and priorities for the necessary employability skills among IE students, employed alumni and faculty members of EMU. A convergence between the attitudes of faculty members and employed alumni regarding skills that require additional training was observed. These convergences may be caused by their vast experience. The attitudes of both students and employed alumni toward the skills received/emphasized in the curriculum were close to each other.

This study includes an assessment the importance of employability skills of IE graduates; how these skills are learned during academic sessions, and how they can be enhanced in the curriculum to satisfy the employability skills set demanded by stakeholders. Thus, the perceptions of the participants provide a comprehensive understanding of the skill items that should be addressed in the IE curriculum to enhance the employability of the graduates. In terms of the participants' attitudes related to the skills received or emphasized in the curriculum, literacy, ethics and information technology skills are highly important and must be received/emphasized in the IE curriculum. Using the participants' attitudes toward the skills needed for job performance, following management, literacy and numeracy, and information technology are highly important for IE graduates to be successful in the workplace.

The study provides insight regarding how the curriculum of an IE department can synergize with industry practices and needs to position graduates for enhanced employability. The best approach is to focus on pedagogically integrating the existing curriculum with germane employability skills to be in agreement with the expectations of and skills required by the industry. In this research, the authors suggest that information technology, following management and leadership skills, should be improved in the IE curriculum. A reduction in the gap can only be facilitated by the development of competencies via an innovation-driven idea. Hence, a more structured approach to the assessment can converge to alleviate problems and offer better graduate outcomes.

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APPENDIX A

Table 1-A. Thirty-six items of skills arranged under seven types of employability skills

Items	Skill Description	Type of skills
I_1	Performing basic mathematical calculations.	Literacy and Numeracy
I_2	Organizing basic ideas and communicating verbally to present a task.	
I_3	Sharing simple opinions, ideas, and letters in the text, such as creating reports, letters, flowcharts and graphs.	
I_4	Ability to interpret and understand the basic printed information in documents, such as schedules graphs, charts, and manuals.	
I_5	Coming up with innovative ideas.	Critical Thinking
I_6	Identifying goals, limitations to generating alternatives and choosing the most appropriate alternative.	
I_7	Recognizing problems and analyzing them.	
I_8	Organizing and processing pictures, symbols, objects, graphs and additional information.	
I_9	Getting and using innovative knowledge and skills from several digital and print sources.	
I_{10}	Identifying a principle or rule at the core of the correlation between two or more objects and applying it when resolving a problem.	
I_{11}	Exerting a high intensity of effort for the objectives accomplishment.	Leadership
I_{12}	Having confidence in one's self and maintaining a positive view of own self.	
I_{13}	Setting individual goals, monitoring development, and taking responsibility for one's actions.	
I_{14}	Deciding on ethical ways of action.	
I_{15}	Communicating ideas to justify a position and convince others, responsibly challenge existing procedures, and policies.	
I_{16}	Selecting goal-relevant undertakings, prioritizing them, apportioning time, organizing and following agendas.	Following Management
I_{17}	Following or preparing budgets, making forecasts, keeping accounts and making amendments to achieve goals.	
I_{18}	Evaluating skills and allocating tasks accordingly, assessing performance and giving feedback.	
I_{19}	Joining in team efforts.	Interpersonal
I_{20}	Working for helping others to learn.	
I_{21}	Working with individuals from different backgrounds.	
I_{22}	Establishing understanding, adaptability, friendliness, politeness and empathy in a group setting.	
I_{23}	Joining forces with group members to brainstorm, so as to provide solutions to problems.	
I_{24}	Choosing processes, implementations or components, such as computers and allied technological equipment.	Information Technology
I_{25}	Recognizing, or resolving difficulties and problems through tools such as computers and allied technological equipment.	
I_{26}	Identifying the necessity of data, getting data from available sources or generating it, and evaluating its significance and accurateness.	
I_{27}	Organizing, processing, maintaining, and preserving computerized or written records and other kinds of information.	
I_{28}	Using computers to get, arrange, evaluate, analyze and share information, and show some level of skill with typical software.	
I_{29}	Attending the required lectures and events.	Work Ethic
I_{30}	Respecting the laws and regulations within the organization.	
I_{31}	Being prompt for meetings, events and lectures.	
I_{32}	Completing all required assignments without cheating or employing unauthorized means.	
I_{33}	Completing the work on-time and carrying out the tasks promptly.	
I_{34}	Understanding the protocols of the organization and procedures.	
I_{35}	Showing a positive attitude at work.	
I_{36}	Individual dependability and reliability.	

Table 2-A. Connection between student outcomes (a to k) and 36 skills items

Students Outcomes	36 of Items, Skills
(a) Ability to apply knowledge of mathematics, science, and engineering.	I_1, I_6, I_{11}, I_{16}, I_{17}, I_{18}, I_{27}, I_{28}, I_{36}
(b) Ability to design and conduct experiments, as well as to analyze and interpret data.	I_6, I_7, I_{10}, I_{11}, I_{16}, I_{18}, I_{24}, I_{26}
(c) Ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.	I_5, I_6, I_{11}, I_{12}, I_{13}, I_{16}, I_{17}, I_{18}, I_{19}, I_{36}
(d) Ability to function on multidisciplinary teams.	I_{11}, I_{19}, I_{21}, I_{22}, I_{23}
(e) Ability to recognize, formulate, and solve engineering problems.	I_6, I_7, I_{10}, I_{11}, I_{13}, I_{15}, I_{16}, I_{24}, I_{25}, I_{26}
(f) Ability to understand the professional and ethical responsibility.	I_{12}, I_{14}, I_{16}, I_{22}, I_{27}, I_{29}, I_{30}, I_{31}, I_{32}, I_{33}, I_{34}, I_{35}, I_{36}
(g) Ability to communicate effectively.	I_2, I_3, I_4, I_8, I_9, I_{15}, I_{19}, I_{20} I_{22}, I_{23}
(h) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	I_{10}, I_{13}, I_{16}, I_{18}, I_{21}, I_{24}, I_{36}
(i) The ability for the recognition of the need for, and an ability to engage in life-long learning.	I_5, I_{18}, I_{25}, I_{29}, I_{31}
(j) A knowledge of contemporary issues.	I_5, I_9, I_{24}, I_{25}, I_{29}, I_{31}
(k) Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.	I_7, I_{10}, I_{12}, I_{13}, I_{16}, I_{17}, I_{20}, I_{24}, I_{25}, I_{26}, I_{27}, I_{28}

APPENDIX B

Table 1-B. ANOVA for students' percentage agreements for SRT versus employability skills

Source	**DF**	**SS**	**MS**	**F**	**P**
Academic Level	6	16002	2667	11.76	0.000
Error	137	31075	227		
Total	143	47077			

Table 2-B. Grouping Information for students' level by Using Fisher Method

Academic level	**Mean of Percentage of agreement (SREC)**	**Grouping**
Senior	86.64	A
Junior	84.94	A
Sophomore	62.06	B
Freshman	55.14	C

Table 3-B. One-way ANOVA participants' percentage agreement SRT versus seven types of skills

Source	**DF**	**SS**	**MS**	**F**	**P**
Seven types of skills	6	5254	876	3.81	0.002
Error	101	23195	230		
Total	107	28449			

Table 4-B. Grouping Information for participants' level by Using Fisher Method

Participants' level	**Mean of Percentage of agreement (SRT)**	**Grouping**
EMU faculty members	59.26	A
Employed alumni students	52.77	A
Senior level	41.61	B

Table 5-B. ANOVA for participants' response SREC versus academic level

Source	DF	SS	MS	F	P
Participants' Level	2	13102	6551	34.30	0.000
Error	105	20053	191		
Total	107	33155			

Table 6-B. Grouping Information for participants' level by Using Fisher Method for their responses SREC

Participants' level	Mean of Percentage of agreement (SREC)	Grouping
Senior level	86.64	A
Employed alumni students	80.46	A
Faculty member	60.80	B

Table 7-B. One-way ANOVA: participants' percentage of agreement SNJ versus academic level

Source	DF	SS	MS	F	P
Participants' Level	2	777	388	3.49	0.034
Error	105	11690	111		
Total	107	12467			

Table 8-B. Grouping Information for participants' level by Using Fisher Method for their responses SNJ

Participants' level	Mean of Percentage of agreement (SNJ)	Grouping
Employed alumni students	89.87	A
Senior	87.19	A B
Faculty member	83.34	B

Table 9-B. One-way ANOVA: % of agreement SREC versus Type of skills

Source	DF	SS	MS	F	P
Seven types of employability skills	6	5787	965	3.56	0.003
Error	101	27368	271		
Total	107	33155			

Table 10-B. Ranking the seven employability skills toward SREC by using Fisher Method

Seven Types of Employability Skills	Percentage of agreement (SREC)	Grouping
Literacy and Numeracy Skills	86.41	A B
Ethic Skills	81.49	A
Information Technology Skills	81.05	A
Following Management Skills	74.42	A B
Interpersonal Skills	74.31	A B
Critical Thinking	71.07	A B
Leadership skills	62.14	B

Table 11-B. One-way ANOVA: participants'' percentages of agreement SNJ versus Type of skills

Source	DF	SS	MS	F	P
Seven types of employability skills	6	1028	171	1.51	0.181
Error	101	11438	113		
Total	107	12467			

Table 12-B. Ranking the seven employability skills toward SNJ by using Fisher Method

Seven Types of Employability Skills	Percentage of agreement (SNJ)	Grouping
Following Management	93.07	A
Literacy and Numeracy Skills	91.54	A B
Information Technology Skills	88.87	A B
Ethic Skills	85.88	A B
Critical Thinking Skills	84.64	A B
Interpersonal Skills	84.37	A B
Leadership skills	83.66	B

Table 13-B. Description of the seven common skill items related to the three groups of participants

Skill items	Skill description	Type of skills	% of Senior	% of Employee	% of Faculty
I_{15}	Communicating ideas to justify a position, and convincing others, responsibly challenge existing procedures and policies.	Leadership	67.00	69.20	66.67
I_{16}	Selecting goal-relevant undertakings, prioritize them, apportion time, organize and follow agendas.	Following Management	72.00	57.70	66.67
I_{17}	Following or preparing budgets, making forecasts, keeping accounts and making amendments to achieve goals.	Following Management	72.00	69.20	77.78
I_{18}	Evaluating skills and allocating tasks accordingly, assessing performance and giving feedback.	Following Management	61.00	73.10	77.78
I_{24}	Choosing processes, implementations or components, such as computers and allied technological equipment.	Information Technology	50.00	73.10	66.67
I_{25}	Recognizing, or resolving difficulties and problems through tools such as computers and allied technological equipment.	Information Technology	61.00	69.20	55.56
I_{28}	Using computers to get, arrange, evaluate, analyze and share information, and show some level of skill with typical software.	Information Technology	50.00	61.50	55.56

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