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Engineering Graduates' Skill Acquisition and Employers Skill Need as applied to Science Education in Ethiopia

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Abstract

Demand for relevant skills and competences have increased with changing science and technology, globalization, and the intensity and complexity of the business environment across the world. This study investigated levels of engineering graduate skill acquisition and employers' skill needs as applied to science education. Using a mixed-methods approach, the study employed both primary and secondary sources of data. The study involved 275 participants recruited using simple random and purposive sampling techniques. Data were analyzed using the mean, standard deviation, and one-way ANOVA. The study found a wider mismatch between levels of higher education supply and labor market needs for indicators of academic, technical, interpersonal, and generic skills. While higher education moderately equipped engineering graduates with the majority of indicators of these skill sets, labor market needs for the same skills remain high. The mismatches between the demand and supply of skills have several implications, it compromises firms' productivity, result in market losses, hamper economic growth, competitiveness, and innovative capacity at the macro-economic level, decrease quality human capital by discouraging investment in education and training, and challenge graduates in finding jobs suitable for their field of study. These require universities and employers to conduct real labor market skills' needs assessments before designing training curriculum; shifting curriculum delivery from theory-focused to practical-oriented modes of teaching and ensuring learners' acquisition of skills demanded by employers; and establishing strong and sustainable linkages between industries and training institutes. It is also good if future research focuses on skills employees acquire at work through experience and factors attributed to mismatches between higher education skill supply and employers' skill needs.

Keywords: *engineering graduates, skill acquisition, skill needs, science education*

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INTRODUCTION

Demand for relevant skills and competences have increased with changing science and technology, globalization, and the intensity and complexity of the business environment across the world (Branine & Avramenko, 2015). Within this context, higher learning institutes are entrusted with preparing graduates for the world of work by equipping them with key skills and competencies (Humburg, Velden, & Verhagen, 2013). These skills and competences determine graduates transitions to work life and their productivity levels in the labor market (Mocanu, Zamfir, & Pirciog, 2014). With an increasing number of higher education graduates, priority to STEM education, and a knowledge-driven economy, understanding and adapting graduate skills that could meet the labor market's needs is supposed to achieve sustainable economic growth and development (Yibeltal, 2016).

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Nevertheless, due to a lack of a universally agreed-upon definition, the word 'skill' has different meanings for different scholars and organizations. For example, while scholars (e.g., Strijbos, Engels, & Struyven, 2015; Suleman, 2018) define skill as the ability to perform a task to a predefined level of competence, for scholars like Green (2016), skill is any personal attribute with productive value that would be augmented through some form of investment. Universities have also failed to keep pace with the skill requests of rapidly growing industries (Collet & Hine, 2015). For instance, higher learning institutes in developing countries like Africa have failed to equip their graduates with soft skills such as innovation and creativity, communication skills, and entrepreneurship skills that are highly demanded on the STEM labor market (Azmi, Kamin, & Noordin, 2018; Wongnaa & Boachie, 2018). These competencies and skills are often shaped during their studies in higher education (Azmi et al., 2018). Graduates of higher education on the continent often lack knowledge about the realities of the existing labor market. As part of developing countries and continental Africa, Ethiopia faces similar problems.

The higher education landscape of Ethiopia has shown significant change in terms of enrollment, expansion, and graduate mix programs (Reda & Gebre-Eyesus, 2018); the number of public universities has increased from two at the beginning of the 1990s to 34, while the number of private higher education providers was about 100 in 2015 (Karorsa & Polka, 2015); and the number of public higher learning institutions rose to 46 in 2019. To enhance the human resource base of the country with STEM education, the Ministry of Education launched the professional and program mix intake policy of Ethiopian public higher education in April 2008. The policy clearly articulates the 70:30 undergraduate professional mix in favor of science and technology over the humanities and social sciences. As a result, 70 percent of the students leaving the schools were joining engineering and natural sciences faculties over the last decade. The policy was planned to increase the annual intake of engineering to 212,000 and of natural and computational sciences to 66,000 students at the end of 2013/14 (Abeje, 2014). In the 2nd Gross and Transformational Plan, the government planned to raise regular enrollment to 600,000 while continuing to prioritize STEM education (Demissie & Polka, 2015).

However, the country's labor market continues to absorb a limited number of graduates (Fenta, Asnakew, Debele, Nigatu, & Muhaba, 2019); the issue of quality and relevance of higher education and the mismatch between the performance of STEM graduates and the requirements of employers remain as critical challenges (Yibeltal, 2016); and very little attention has been paid to the issue of graduate skills and employers' needs in all higher education policies and strategies in Ethiopia. Previous studies in the country by Fenta et al. (2019), Jote (2017), Reda and Gebre-Eyesus (2018), and Yibeltal (20016) mainly focused on unemployment, graduate tracer studies, enhancing graduates' employability, higher education, and the labor market rather than directly focusing on graduate skills and competencies that are acquired at higher learning institutes and required by employers. They found that graduate skills and competencies have become a serious problem; wider gaps exist between employers' expectations and graduates' performance in terms of quality of work, productivity, and specific job-related skills and competencies. The studies were largely based on a case-study approach and could not be generalized to wider contexts due to a lack of quantitative evidence. These indicate a dearth of literature related to the relationship between skills and competencies acquired by STEM graduates in general and engineering graduates in particular and skills required by employers of the same graduates.

Understanding the skills and competencies that employers expect from graduates helps universities enhance graduates' employability and prepare graduates to increase their competition in the job market

(Kusmawan, 2018, 2022, & Fitriani & Ajayi, 2022). Studying the state and trend of labor market mismatches among engineering graduates as applied to science education enables policymakers to take corrective action in the event of a high mismatch between the skills available in the economy and the skills required by the economy (Beyene & Teklesilassie, 2018). Thus, the current study aimed to fill knowledge gaps related to the skills acquired by engineering graduates at higher learning institutes and the extent to which these skillsets are compatible with the available labor market needs in Ethiopia. The findings of this study shed some light on the importance of frequent assessments of employers' skill needs and considering their needs in designing higher education curricula. The government, employers, and higher education institutions can use the findings of this study to design, implement, and evaluate a policy that enhances their collaborative efforts.

Research Objectives

To achieve its objectives, the study sought answers to the following basic questions and tested the subsequent hypothesis:

1. To what extent do graduates of engineering from Ethiopian higher learning institutes acquire academic, technical, interpersonal, and generic skills?

   H0: No statistically significant difference between employees, employers, and instructors in terms of perceptions of graduates' acquisition of academic, technical, interpersonal, and generic skills.

2. To what extent do employers of engineering graduates in Ethiopia need discipline-specific, technical, interpersonal, and generic skills?

   H0: No statistically significant difference between employees, employers, and instructors in terms of perception of the labor market's need for academic, technical, interpersonal, and generic skills is statistically significant or not.

RESEARCH METHOD

Research Design

This study employed an embedded type of mixed-methods research design that involves the simultaneous or sequential collection of both quantitative and qualitative data, where one form of data plays a supporting role for the other. Based on the recommendation of Creswell (2016), qualitative data was collected to support and provide additional information to the quantitative data. Both forms of data were collected roughly at the same time. Finally, both qualitative and quantitative data were merged, integrated, linked, and embedded, from which conclusions were drawn.

Sample size and sampling techniques

A total of 275 research participants, comprising employees, employers, higher education instructors, and decision-makers, took part in the study. While 260 respondents (90 employees, 40 employers, and 130 higher education instructors) took part in filling out the study questionnaire, 15 participants (four college deans, one from each sample university, one policymaker and one expert from the Ministry of Education, one expert from the Ministry of Labor and Skills, two team leaders from each construction and road authority bureau of both Addis Ababa City Administration and Oromia National Regional States, one technical team leader from BelayAB Motors, and two construction supervisors from Etete and Sunshine construction companies) took part in key informant interviews. Both employees and employers were recruited from construction bureaus, road authorities, and electric utilities of Addis Ababa City Administration and Oromia National Regional State, as well as private companies capable of employing large engineering graduates (Etete Construction, Sunshine Construction, and Belayab Motors). Similarly, instructors of civil engineering, electrical engineering, and mechanical engineering who took part in filling out the study questionnaire were recruited from Addis Ababa Science and Technology University, Adama Science and Technology University, Ambo University, and Jimma University. Employees and instructors were selected using simple random sampling techniques, while employers and key informant interview participants were selected using purposive sampling.

Data gathering tools and procedures.

The study employed acquired and required skill questionnaires with similar content, in-depth interviews, and document analysis. The questionnaires were self-developed, and pilot tested using test-retest reliability, administered to 25 employees, employers, and instructors. The validity was also confirmed using a thorough analysis by experts relevant to the fields, which led to the modification of a few questionnaires. The researchers briefed all respondents on the ethical issues and objectives of the study prior to administering the questionnaires. Of the 300 questionnaires dispatched to respondents, 260 were duly filled out and returned with an 84 percent return rate. Unstructured interview guides were employed for KII, which was conducted with 15 participants and took an average of 40 minutes. The Ethiopian Higher Education Road Map (2017), the Higher Education Proclamation (2009), and the National Employment Policy and Strategy (2009) were purposefully selected and reviewed as policy and strategy documents to substantiate data gathered via questionnaires and interviews.

Data analysis methods

Both descriptive statistics like mean and standard deviation and inferential statistics like the one-way ANOVA test were employed to analyze quantitative data. For the purpose of analysis, the five-point Likert scales were taken as interval data, and mean scores ranging from 1–1.8 represent skills not acquired or required at all; 1.8–1.60 represent skills acquired or required at a little extent; 2.61–3.4 represent skills acquired or required at a moderate level; 3.4–4.20 represent skills acquired at a high extent; and 4.21–5 represent skills acquired or required at a very high extent. Similarly, standard deviation was used to compare the variability of higher education supply and employers needs for the four skills under scrutiny. The smaller the value of the standard deviation, the closer the score is to the mean and the less the variability between higher education skill supply and employers' needs, while the highest standard deviation value indicates the existence of a wider gap between higher education skill supply and employers' needs. A one-way ANOVA test was used to check whether the mean difference between higher education skill supply and the need for engineering labor markets was statistically significant or not, using respondent categories (employee, employer, and instructor) as independent variables and acquired and required skills as dependent variables (Creswell, 2016). The researcher transcribed, translated, and thematically coded data collected via key informant interviews and document reviews and integrated, substantiated, and checked with the quantitative data.

FINDINGS AND DISCUSSION

Graduates' acquisition and employers need for discipline-specific skills

Discipline-specific skill was measured in terms of 10 observed variables: foundation of engineering, manufacturing, and construction; operation, measurement, and control technology; applying technical fields, planning, design, calculation, and construction; quality control and assurance; environmental safety, health, and security; applying knowledge of science and engineering principles; skill in a specific engineering discipline; and skill in application and practice. Respondents were asked to express the extent to which higher learning institutes supply engineering graduates with these indicators of discipline-specific skills and the extent to which employers need the same skills (see Table 1).

Table 1: Graduate acquisition and labor market needs for discipline-specific skills.

R/N	Levels of graduates Acquisition		Type of skill	Levels of labor market needs	
	Mean	SD	Discipline specific skills	Mean	SD
1	3.19	0.61	Foundation of engineering	4.00	1.01
2	3.23	0.67	Manufacturing and construction	3.92	1.03
3	3.14	0.96	Operation, measurement and control technology	4.01	0.95
4	3.25	1.03	Applying technical fields	3.87	0.96
5	3.68	1.03	Planning, designing, calculating and construction	3.86	1.01
6	3.23	0.99	Quality control and quality assurance	3.92	1.05
7	2.98	0.96	Safety, health, security and environment	4.04	1.12
8	3.47	0.88	Applying knowledge of science and engineering principles	4.07	1.12
9	2.92	0.69	Specific engineering discipline skills	4.02	1.13
10	3.22	0.73	Application and practical skill	4.05	1.10

Table 2: One-way ANOVA test to compare the difference between the mean responses of employees, employers, and instructors against the acquisition of discipline-specific skills

	Sum of squares	**df**	**Mean square**	**F**	**Sig.**
Between groups	2.20	2	1.10	7.65	0.00
Within groups	36.91	257	0.14		
Total	39.11	259			

Table 3: One-way ANOVA test to compare the difference between the mean responses of employees, employers, and instructors against labor market needs for discipline-specific skills

	Sum of squares	**df**	**Mean square**	**F**	**Sig.**
Between groups	15.33	2	7.67	22.74	0.00
Within groups	86.6	257	0.34		
total	101.96	259			

Table 1 shows engineering graduates from sample universities in Ethiopia acquire indicators of discipline-specific skills such as planning, designing, calculating, and construction skills (mean = 3.68; SD = 1.03) and skills of applying knowledge of science and engineering principles (mean = 3.47; SD = 0.88) to a greater extent, with the mean value lying between 3.4 and 4.20. Skills of applying technical fields (technical sets, machine systems, installations and connections) (Mean= 3.25; SD=1.03), quality control and quality assurance (Mean=3.23; SD=0.99), manufacturing and construction (Mean=3.23; SD=0.67), application and practice (Mean=3.22; SD=

0.73); foundation of engineering (Mean=3.19; SD=0.61), competence in operation, measurement and control technology (mean=3.14; SD=0.96), competence in maintaining safety, health, security and environment (Mean=2.98; SD=0.96), and competence in specific engineering discipline (Mean=2.92; SD=0.69) were moderately acquired by engineering graduates during study at higher learning institutes with mean value lying in between 2.61 to 3.4. The one-way ANOVA test result also shows a statistically significant difference between employees, employers, and instructors in acquiring discipline-specific skills (F = 7.65; p = 0.00) at the 0.05 level of confidence (see table 2).

In contrast, skills of applying knowledge of science and engineering principles (mean=4.07; SD=1.12); application and practical skill (Mean=4.05; SD=1.10), competence in safety, health, security and environment (Mean=4.04; SD=1.12), competence in specific engineering disciplines (Mean=4.02; SD=1.13), competence in operation, measurement and control technology (Mean= 4.01; SD= 0.95), foundation of engineering (Mean=4.00; SD=1.01), competence in manufacturing and construction (Mean=3.92; SD=1.03), competence in quality control and quality assurance (Mean=0.92; SD=1.05), skills of applying technical fields (Mean=3.87; SD=0.96), and planning, designing, calculating and construction skills (Mean=3.8; SD=1.01) were required by employers to the higher extent with mean value lying in between 3.4-4.20 (see table 1). The differences between employees, employers, and instructors in responding to labor market needs for discipline-specific skills were statistically significant (F = 22.74; p 0.00) at $\alpha \leq 0.05$ level of confidence (see table 3).

This study reveals that graduates of engineering disciplines acquired more planning, designing, calculating, and construction skills; skills of applying knowledge of science and engineering principles; skills of applying technical fields; and competence in quality control and quality assurance, while competence in manufacturing and construction, application, and practical skills; competence in operation, measurement, and control technology; competence in safety, health, security, and the environment; and competence in specific engineering disciplines are the least acquired skills. For Wongnaa and Boachie (2018), discipline-specific skills are more important in STEM. Supporting the findings of scholars (e.g., Azmi et al., 2018; Shukla & Garg, 2016) argue that skills of applying knowledge of science and engineering principles, application and practical skill, competence in safety, health, security, and the environment, and competence in specific engineering disciplines had very high demand on the labor market, while competence in operation, measurement, and control technology, competence in the foundation of engineering, competence in manufacturing and construction, and competence in quality control and quality assurance were highly required. However, competence in applying technical fields like planning, designing, calculating, and construction was least required by employers of engineering graduates.

These indicate a slight mismatch between the supply of discipline-specific skills in higher education and labor market needs for the same skills. The study reveals that only the skill of applying knowledge of science and engineering principles was highly supplied by higher education institutions and most demanded on the engineering labor market. Consistent with existing literature, competence in the application of practical skills and specific engineering disciplines was highly demanded among employers and yet least supplied by Ethiopian higher learning institutes. However, the demand in the engineering labor market for most indicators of discipline-specific skills was seemingly inconsistent with the current findings. The differences might be due to differences in the context of the current and previous studies.

Graduates' acquisition and employers need for technical skills

Technical skills are the second type of skill students are supposed to acquire during their studies at higher learning institutes. In this study, technical skill was measured in terms of the skills of manipulating computers, planning and organizing tasks, solving problems, making appropriate decisions, scheduling and coordinating, and seeking and developing opportunities.

Table 4: Graduates' acquisition and employers need for technical skills

R/N	Levels of graduates Acquisition		Type of skill	Levels of labor market needs	
	Mean	SD	Technical skills	Mean	SD
1	3.65	0.87	Computer skills	4.35	0.83
2	3.32	0.85	Planning and organizing	4.10	1.12
3	3.28	0.87	Problem solving	4.18	0.91
4	3.20	0.77	Decision making	4.18	0.97
5	3.37	0.91	Skills in scheduling and coordinating	4.17	1.03
6	3.04	0.77	Seeking and developing opportunities	3.97	0.86

Table 5: One-way ANOVA test for testing the mean difference between employees, employers, and instructors in the acquisition of technical skills

	Sum of squares	**df**	**Mean square**	**F**	**Sig.**
Between groups	4.43	2	2.21	11.15	<0.00
Within groups	51.01	257	0.20		
Total	55.44	259			

Table 6: One way ANOVA for testing the mean difference between employees, employers, and instructors in responding to employers needs for technical skill

	Sum of squares	**df**	**Mean square**	**F**	**Sig.**
Between groups	5.49	2	2.74	6.99	0.00
Within groups	100.91	257	0.04		
Total	106.39	259			

While skill in manipulating computers (mean = 3.65; SD = 0.87) was acquired to a high level with a mean value lying between 3.4 and 4.20, all indicators of technical skills such as skills in scheduling and coordinating (mean = 3.37; SD = 0.91), planning and organizing (mean = 3.32; SD = 0.85), problem-solving skills (mean = 3.28; SD = 0.87), decision-making skills (mean = 3.20; SD = 0.77), and seeking and developing opportunities (mean = 3.04; SD = 0.77) were moderately acquired by engineering graduates with a mean value lying between 2.6 and 4.20 (see table 4). The one-way ANOVA test shows a statistically significant difference between employees, employers, and instructors in acquiring technical skills (F = 11.15; p< 0.00) at a ≤ 0.05 level of confidence (see table 5). Skill in manipulation of computers (mean = 4.35; SD = 0.83) was required to a very high extent among employers of engineering graduates with a mean lying between 4.21 and 5.00. Similarly, all indicators of technical skills such as problem solving (mean = 4.18; SD = 0.91), decision-making (mean = 4.18; SD = 0.97), scheduling and coordinating (mean = 4.17; SD = 1.03), planning and organizing skills (mean = 4.10; SD = 1.12) skills and skill in seeking and developing opportunities (mean = 3.97; SD = 0.86) were required to a very high extent among employers (see Table 4). One-way ANOVA test results show a statistically significant difference between employees, employers, and instructors in responding to labor market needs for technical skills (F = 6.99; p = 0.00) at α ≤ 0.05 (see table 6).

Despite scholars (e.g., Fitriani & Ajayi, 2022) arguing that technical skills are often valued among employers and required to solve complex engineering problems at the workplace, this study identified skill in manipulating computers as the only technical skill acquired to a high extent by graduates, while skill in seeking and developing opportunities, decision-making, and problem solving were the least acquired. Consistent with previous local studies by Siraye, Abebe, Melese, and Wale (2018) and Fanta et al., 2019), this study identified skillful manipulation of computers and problem-solving as the most demanded skills by employers. Skill in making appropriate decisions, and scheduling and coordinating, and seeking and developing opportunities were the most required technical skill by employers. Both existing literature and the findings of this study underscore the importance of computer, problem-solving, and decision-making skills, as well as skills in seeking and developing opportunities for the success of graduates in the engineering labor market.

Graduates' acquisition and employers need for interpersonal skills.

Interpersonal skill is the third dimension of skill graduates of civil, mechanical, and electrical engineering disciplines are supposed to have in the current knowledge-driven economy. The latent variable, interpersonal skill, was measured in terms of measurable indicators such as teamwork, client/stakeholder focus, ability to work with people from various cultural backgrounds, communication skill, empathy, adaptability, and flexibility (see Table 7).

Table 7: Graduates' acquisition and employers need for interpersonal skills

R/N	Levels of graduates Acquisition		Type of skill	Levels of labor market needs	
	Mean	SD	Interpersonal skills	Mean	SD
1	3.77	0.78	Team work	4.34	0.95
2	2.97	0.94	Client/ stakeholder focus	4.11	0.88
3	3.58	1.05	Ability to work with people from different cultural backgrounds	4.13	1.02
4	3.43	0.97	Communication skill	4.15	1.00
5	3.34	0.88	Empathy	4.14	0.99
6	3.28	0.92	Adaptability and flexibility	3.95	0.92

Table 8: One-way ANOVA for testing the mean difference among employees, employers, and instructors in the acquisition of interpersonal skills

	Sum of squares	df	Mean square	F	Sig.
Between groups	1.73	2	0.86	4.78	0.00
Within groups	46.45	257	0.18		
Total	48.17	259			

Table 9: One-Way ANOVA for testing the mean difference among employees, employers, and instructors against labor market needs for interpersonal skills

	Sum of squares	df	Mean square	F	Sig.
Between groups	11.87	2	5.93	20.90	0.00
Within groups	72.94	257	0.28		
Total	84.803	259			

As shown in Table 7, teamwork (mean = 3.77; SD = 0.78), ability to work with people from different cultural backgrounds (mean = 3.58; SD = 1.05), and communication skills (mean = 3.43; SD = 0.97) were acquired to a greater extent with a mean value lying between 3.4 and 4.20, while empathy (mean = 3.34; SD = 0.88), adaptability and flexibility skills (mean = 3.28; SD = 0.92), and client/stakeholder focus (mean = 2.97; SD = 0.94) were moderately acquired by graduates with a mean value lying between 2.6 and 3.4. One-way ANOVA test results also indicate a statistically significant difference between employees, employers, and instructors in acquiring interpersonal skills (F = 4.78; p = 0.01) at the 0.05 level of confidence. Except teamwork skill (mean = 4.34; SD = 0.95), which is required by employers to a very high extent with a mean value lying between 4.21 and 5.00, all indicators of interpersonal skills like communication skill (mean = 4.15; SD = 1.00), empathy (mean = 4.14; 0.99), ability to work with people from different cultural backgrounds (mean = 4.13; SD = 1.02), stakeholder focus (mean = 4.11; SD = 0.88), and adaptability and flexibility skill (mean = 3.95; SD = 0.92) were required to a higher extent with a mean value lying between 3.41 and 5.00. The outputs of a one-way ANOVA show a statistically significant difference between employees, employers, and instructors (F = 20.90; p< 0.00) (table 9).

21st century engineering graduates should be well equipped with a broader knowledge base and diverse personal and interpersonal key skills that help them succeed in the labor market (Collet & Hine, 2015). This study reveals that graduates of engineering disciplines are highly equipped with indicators of interpersonal skills such as the ability to work with people from different cultural backgrounds and communication skills, while the ability to focus on stakeholders' needs and empathy were the least acquired. In addition to teamwork skills, written and verbal communication skills, empathy, and the ability to work with people from different cultural backgrounds were the most required, while adaptability and flexibility were the least required interpersonal skills among engineering graduates employed by companies,. A previous local study by Getahun et al. (2020) and a study conducted by Kaushal (2016) affirmed that teamwork and communication skills are among the interpersonal skills most demanded by employing companies. Yet for scholars such as Keneley and Jackling (2011), communication and collaboration skills are least developed during university studies. Results of key informant interviews and document reviews revealed that employers often need well-rounded graduates with both hard and soft skills obtained through education. Among the other things, they need employees with punctuality, motivation, and good work ethics; good communication skills; high commitment; hard work; being capable of managing his or her time; and being able to complete work assignments on time. Employers need graduates who can easily communicate, agree, and create a positive team spirit with others.

These indicate that higher education institutions equip graduates with communication skills and the ability to work with people from different cultural backgrounds. Nevertheless, there is inconsistency between existing literature and the acquisition of communication skills at higher learning institutes. While this study reported that engineering graduates are best equipped with communication skills at higher learning institutes, previous literature claims that such skills are least acquired at higher learning institutes. Both existing literature and this study indicated that teamwork, communication and collaboration skills, and the ability to work with people from different cultural backgrounds were indicators of interpersonal skills highly demanded in the engineering labor market.

Graduates' acquisition and employers need for generic skills

Generic skills are the fourth type of skills students are supposed to acquire during their studies and are needed by potential employers. Generic skills were measured in terms of creative thinking, willingness to learn, leadership qualities, integrity, willingness to perform or commit, sense of responsibility, innovativeness, determination, loyalty to the institution and its objectives, ability to assert oneself, self-confidence, and independence.

Table 10: Graduates' acquisition and employers need for interpersonal skills

R/N	LEVELS OF GRADUATES ACQUISITION		TYPE OF SKILL	LEVELS OF LABOR MARKET NEEDS	
	MEAN	SD	GENERIC SKILLS	MEAN	SD
1	3.28	0.87	CREATIVE THINKING	4.03	0.89
2	3.55	0.83	WILLINGNESS TO LEARN	4.04	1.12
3	3.16	1.04	LEADERSHIP QUALITIES	4.13	0.82
4	3.19	1.02	INTEGRITY	4.14	0.79
5	3.64	0.81	WILLINGNESS TO PERFORM/COMMITMENT	4.10	1.13
6	3.41	0.97	SENSE OF RESPONSIBILITY	4.17	1.03
7	2.80	1.16	INNOVATIVENESS	4.15	1.03
8	3.01	0.97	DETERMINATION	4.22	0.98
9	3.31	0.93	LOYALTY TO INSTITUTION AND ITS OBJECTIVES	4.36	0.86
10	3.27	0.91	ABILITY TO ASSERT ONESELF	4.22	0.93
11	3.30	098	SELF CONFIDENCE	4.28	0.93
12	3.29	0.95	INDEPENDENCE	4.09	1.08

Table 11: One-way ANOVA for testing the mean difference among employees, employers, and instructors in the acquisition of generic skills

	SUM SQUARES	**DF**	**MEAN SQUARE**	**F**	**SIG.**
BETWEEN GROUPS	2.54	2	1.27	7.60	0.00
WITHIN GROUPS	42.87	257	0.17		
TOTAL	45.41	259			

Table 12: One-Way ANOVA for testing the mean difference among employees, employers, and instructors against employers need for generic skills

	SUM SQUARES	**DF**	**MEAN SQUARE**	**F**	**SIG.**
BETWEEN GROUPS	4.17	2	2.09	6.65	0.00
WITHIN GROUPS	80.53	257	0.31		
TOTAL	84.70	259			

As shown in Table 10, graduates are highly equipped with indicators of generic skills such as willingness to perform or commitment (mean = 3.64; SD = 0.81), willingness to learn (mean = 3.55; SD = 0.83), and sense of responsibility (mean = 3.41; SD = 0.97), with the mean value lying between 3.4 and 4.20. Nevertheless, most indicators of generic skills such as loyalty to the institution and its objectives (mean = 3.31; SD = 0.93), self-confidence (mean = 3.30; SD = 0.98), independence (mean = 3.29; SD = 0.95), creative thinking (mean = 3.28; SD = 0.87), ability to assert oneself (mean = 3.27; SD = 0.91), integrity (mean = 3.19; SD = 1.02), leadership qualities (mean = 3.16; SD =1.04), determination (mean = 3.01; SD = 0.97), and innovativeness (mean = 2.80; SD = 1.16) were acquired to a moderate extent, with the mean value lying between 2.61 and 3.4. The one-way ANOVA test result reveals a statistically significant difference between employees, employers, and instructors in acquiring generic skills ($F = 7.60$; $p = 0.00$) at $\alpha \leq 05$.

However, loyalty to the institution and its objectives (mean = 4.36; SD = 0.86), self-confidence (mean = 4.28; SD = 0.93), determination (mean = 4.22; SD = 0.98), and ability to assert oneself (mean = 4.22; SD = 0.93) were required on the labor market to a very high extent, with a mean value lying in between 4.21 and 5.00 while sense of responsibility (mean = 4.17; SD = 1.03), innovativeness (mean = 4.15; SD = 1.03), integrity (mean = 4.14;

SD = 0.79), leadership skill (mean = 4.13; SD = 0.82), willingness to perform/commitment (mean = 4.10; SD = 1.13), independence (mean = 4.09; SD = 1.08), willingness to learn (mean = 4.04; SD = 1.12), and creative thinking (mean = 4.03; SD = 0.89) were required to a higher extent by employers, with a mean value lying between 3.4 and 4.21. One-way ANOVA outputs also show a statistically significant difference between employees, employers, and instructors ($F = 6.65$; $p = 0.00$) in employers need for generic skills (see table 8).

This study revealed that the higher education supply and employers needs for indicators of generic skills like willingness to perform or commitment, sense of responsibility, and willingness to learn were high. For scholars (e.g., Asai et al., 2020; Green, 2016) the acquisition of general skills will translate into higher earnings and the key to personal employability and employment security in a competitive labor market. Nevertheless, loyalty to the institution and its objectives, the ability to assert oneself, determination, and self-confidence were acquired to a moderate extent but required to a very high extent by employers of engineering graduates. Supporting the findings of scholars (e.g., Kaushal, 2016; Pang et al., 2019), indicators of generic skills such as independence, creative thinking, leadership qualities, integrity, and innovativeness were moderately supplied by higher learning institutes but highly required by employers.

The introduction of a 70:30 enrolment mix target where 70% of students enroll in science and technology and the remaining 30% enroll in social sciences beginning in 2008 was a landmark for the beginning of priority for science, technology, engineering, and mathematics education in Ethiopia. Since then, the country initiated a number of guidelines and strategies like the Concept Paper and Strategies for Improving Science and Mathematics Education in Ethiopia by Curriculum Development and Implementation Core Process; the document Strategies for Improving the Teaching and Learning of Science and Mathematics in Ethiopia; the National Pilot Project for Strengthening Mathematics and Science Education in Ethiopia; the Action Plan for Improving the teaching and Learning of Science and Mathematics in Ethiopia; SMASEE Teacher In-Service Education and Training (InSET) Guidelines prepared by the National Mathematics and Science Improvement Centre; ESDP-IV that underscores the need to strengthen the focus on sciences and technology. Nevertheless, the National Learning Assessment results for STEM subjects in grades 4, 8, and 10 are low and below the national standard of 50%.

Poor learning facilities, lack of laboratory equipment; insufficient teaching resources; poor pedagogical centers (Abdulbasit & Seyoum, 2021; Bekele, 2014); absence of student-centered learning; poor culture of continuous tutorials, worksheets, and feedback provision (Hunde & Tegegne, 2010); failure to address learners learning needs; lack of higher-order thinking skills (Tesfaye, Yitbarek & Tesfaye, 2010); negative attitudes toward science; negative academic self-concept, poor teachers' capacity (Negassa, 2014); difficulty of reorienting the educational system towards problem solving and critical-thinking approaches (Abate, Michael, Angel, 2021) are causes of students' poor achievement in STEM education. Persistent mismatch between demand and supply of skills among STEM graduates is the result of insufficient attention given to equip learners with most aspects of discipline-specific, technical, interpersonal, and generic skills; weak university-industry linkage; inadequate use of IT in teaching and learning tasks; failure to properly identify competency-based curricula; weak organization of modules; domination of traditional teaching methods; low awareness of the world of work about the movement of HEIs towards competence-based curricula; and negligence of employability and other lifelong learning skills in higher education curricula.

Therefore, the identified skill mismatch positively influences the quality and effectiveness of STEM education by informing the need to design viable strategies to mitigate the prevailing negative attitudes towards STEM education, reform the existing curricula to make science and engineering more accessible and attractive, improve the learner-centered teaching approach, force the government to allocate sufficient budget to equip science and technology laboratories, libraries, and workshop rooms with equipment, and strengthen public-private partnerships between industry, primary and secondary schools, and tertiary institutions. It also strengthens the focus on the expansion of science and technology institutions to produce highly qualified technicians, engineers, and scientists in line with the demands of the national economy. It pinpoints higher education to conduct real practical training in cooperation and collaboration with industries and evaluate whether or not the existing competency-based curriculum emphasizes professional and vocational skills, job-specific skills, and transferable skills that higher education graduates need for labor market entry. The mismatch between demand and supply of skills could also have negative impacts and implications for companies employing STEM graduates. For instance, it impacts workers or firms that are currently employing STEM graduates. It results in unemployment, underemployment and market losses, higher wages, increased recruitment costs, investment in current personnel, a greater workload, and pressure on current personnel; reduces the competitiveness of companies employing STEM graduates; hinders economic growth and investment; and hinders the growth and development of knowledge-intensive and innovative industries and innovative capacity at the macro-economic level. It also decreases the quality of human capital by discouraging investment in education and training by individuals.

CONCLUSION

This study assessed the levels of higher education skill supply and employers' skill demand for engineering graduates as applied to science education in Ethiopia. The study employed an embedded mixed-methods design that involved the collection of quantitative and qualitative data from both primary and secondary sources. The findings disclosed wider mismatches between levels of higher education supply and labor market needs for indicators of academic, technical, interpersonal, and generic skills. While higher education moderately equips engineering graduates with the majority of indicators of these skillsets, labor market needs for the same skills remain high. Such mismatches between the demand and supply of skills have several implications. Among other things, such mismatches compromise firms' productivity, result in market losses, hamper economic growth, competitiveness, and innovative capacity at the macro-economic level, decrease quality human capital by discouraging investment in education and training, and challenge graduates in finding jobs suitable for their field of study. However, this research excluded skills employees acquire at work through experience, prospective graduates in sample selection, and factors attributed to mismatches between higher education skill supply and employers' skill needs. Thus, future research is suggested to consider all these limitations. Higher education institutes could also conduct real employers' needs assessments before preparing training curricula for different fields of study and updating training styles and contents based on the needs of employers.

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