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STEM Education and Labor Needs: Engineering Graduates in Ethiopia

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Abstract

This study examined the alignment between the supply of STEM skills by higher education institutions and the demand for these skills in the labor market in Ethiopia, employing a mixed-methods approach. Quantitative data from 275 respondents were analyzed using mean, standard deviation, and paired sample t-tests, while thematic analysis was applied to qualitative data. The results revealed significant mismatches between the skills provided by educational institutions and those required by the labor market, with the greatest disparities found in generic skills, followed by technical and interpersonal skills, and the least in discipline-specific skills. The study highlights the urgent need for higher education institutions to enhance their collaboration with industry stakeholders to develop curricula that effectively address these gaps. Recommendations include conducting regular market needs assessments, integrating external expert lectures, and applying project-based learning to foster critical and innovative thinking skills among students, preparing them more effectively for employment.

Keywords: *engineering graduates, higher education institutes, employers' need, STEM skill match, competences.*

INTRODUCTION

The need for a better understanding of graduates' competence requirements is growing with the increasing demand for fresh STEM graduates from employers (Pang, Wong, Leung, & Coombes, 2019). Academic degrees alone are becoming inadequate because employers need potential STEM graduates with competencies and capabilities in generic skills to meet the demands of the globalization era and make their companies most competitive (Azmi, Kamin, & Noordin, 2018). Individuals' success in transitioning to the labor market and performance in their working lives are closely linked to the process of acquiring these skills and competencies. However, providing a standard curriculum to produce graduates with multi-skills and implicating the curriculum and factors supporting the career development of students are becoming challenges in higher education (Azmi et al., 2018). Notably, higher education institutions in developing countries like Ethiopia are lagging behind in equipping graduates with the necessary STEM skills that would meet the needs of industries (Getahun et al., 2020).

The gap between educational institutions' output and labor market requirements has widened, resulting in a rising incidence and duration of STEM graduates' unemployment (Getahun et al., 2020; Kellow, Ayele, Yusuf, 2010). With increasing the number of higher education institutions and enrollment, the issue of quality and relevance of higher education, a wider mismatch between higher education skill supply and the type of skills required by the labor market (Olkaba & Tamene, 2017; Yibeltal, 2016), and the entry of a limited number of

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graduates into the labor market remain critical challenges in Ethiopia (Fenta, Asnakew, Debele, Nigatu & Muhaba, 2019; Reda & Gebre-Eyesus, 2018). The current higher education system in the country fails to open ways for the graduates' future business and the foundation of their reasonable vocation (Fenta et al., 2019). Most STEM (engineering) graduates are ill-equipped to meet the challenges of life and employment due to a mismatch of skills (Getahun, Mohammed, Mersha, & Deresse, 2020).

Skill mismatch is the discrepancy between skills acquired by graduates through studies at higher learning institutions and the actual skills required in the labor market (Asai, Breda, Rain, Romanello, Sangnier, 2020; Păcurariu, 2019). It denotes a gap between aggregate labor demand and aggregate labor supply (Beyene & Teklesilassie, 2018). The aggregate skill mismatch relates to skill gaps and skill shortages. Skill gaps are situations in which an employer believes that workers do not possess the adequate competencies to successfully discharge their current role (ILO, 2017). It results when the available workforce lacks the skills demanded by firms or when firms fail to use optimally the skills possessed by workers (Asai, Breda, Rain, Romanello, Sangnier, 2020). The study by Andrews and Higson (2008) indicated increasing concern with the widening gap between the skills and capabilities of graduates and the requirements and demands of the work environment across the world. Such a mismatch is considered an important source of inefficiency in the labor market that can hinder productive capacities, which generate unemployment and underemployment (Asai, Breda, Rain, Romanello, & Sangnier, 2020). It harms productivity due to lower output per worker, inflates average labor costs, affects firm-level profitability, and affects the capacity of enterprises to innovate and adapt to changing market conditions (ILO, 2017; Teshome Oumer, 2023); hampers economic growth, competitiveness, and innovative capacity at the macro-economic level (Oluyomi &Adedeji, 2012); and decreases the quality of human capital by discouraging investment in education and training by individuals. As a result, graduates of higher education face challenges in finding jobs suitable for their level and fields of study (Păcurariu, 2019).

The supply side of the Ethiopian labor market is characterized by the existence of a low-quality labor force due to low educational levels and low-quality skills that result from low early human capital development, low quality of training, a lack of entrepreneurial confidence and motivation, and the absence of career advice (Kellow, Ayele, Yusuf, 2010). Therefore, studying the state and trend of STEM skill mismatches enables policymakers to take corrective action (Beyene & Teklesilassie, 2018). Concomitantly, most previous studies used qualification mismatch as a proxy for skills mismatches due to data limitations. Such a measure not only disregards specific skills required by jobs but also the type of education required, as it merely depends on the number of years of education (Beyene & Teklesilassie, 2018). Though collecting and consolidating data on the skill needs of the economy is supposed to be important for proper analysis of skills mismatches, there is a critical shortage of data on the types and levels of STEM skills the economy requires in Ethiopia (Ibid.).

This study investigated the match between higher education STEM skills supply and labor market skill needs by focusing on Engineering Science graduates in Ethiopia**.** The findings of this study are believed to fill some of the existing knowledge gaps on labor market STEM skill needs and higher education supply of the same skills to reduce the current boom in graduates' unemployment in Ethiopia. It assists national and international universities, students, employers, policymakers, and employability stakeholders to critically assess and identify skills demanded in the current dynamic technological era and the increasing internationalization of higher education and employment through designing, implementing, and evaluating policies that enhance their collaborative efforts. It encourages the development of national competence and skills policy frameworks based on stakeholders' needs for the current growing intake and graduation rates in engineering disciplines in Ethiopian public universities that would help guide higher education and employers in tackling the challenges of matching graduate skills with employers' skill needs.

Research Objectives

To achieve its objectives, the study sought answers to the following basic research questions:

1. Do higher education STEM skills supplies match labor market (employers') skill needs?
2. Are there statistically significant mean differences between the higher education supply of discipline-specific, technical, interpersonal, and generic skills (STEM skills) and employers' needs?
3. Do higher education STEM skills supplies match labor market (employers') skill needs as perceived by employees, employers, and instructors?
4. Are there statistically significant mean differences between higher education discipline-specific academic, technical, interpersonal, and generic skills (STEM skills) supplies and labor market (employers) needs as reported by employees, employers, and instructors?

RESEARCH METHOD

Research design

The study employed a mixed-methods research design that involved both quantitative and qualitative sources of data for a complete understanding of the research problem (Creswell, 2014; Maarouf, 2019). A mixed-methods approach has emerged from an integrated view of quantitative and qualitative research (Maarouf, 2019)**.** It helps in harmonizing the shortfalls of exclusively using a single method by triangulating one set of results with another and enhancing the validity of inferences and the representativeness of the findings (Creswell, 2014; Gay, Mills, & Airasian, 2012).

These complementary strengths and triangulation are the two main advantages that encouraged the researcher to employ a mixed-methods approach. Assessing both quantitative outcomes and qualitative processes in mixed research helped the researcher get a full understanding of a complex picture of social phenomena. The embedded type of mixed-methods design was employed in this particular study. Embedded design involves the simultaneous or sequential collection of both quantitative and qualitative data, where one form of data plays a supportive role for the other (Creswell, 2014). Qualitative data was collected to support and provide additional information for the quantitative data. Here, both forms of data were collected roughly at the same time. Both qualitative and quantitative data were merged, integrated, linked, and embedded.

Study population

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 individuals took part in key informant interviews. Employees who took part in filling out the study questionnaire were mainly former graduates of civil, electrical, and mechanical engineering disciplines and are currently working in different economic sectors. Employers were individuals who previously graduated in one of the three engineering disciplines mentioned above and are currently leading companies that are capable of employing STEM (engineering) graduates (e.g., site supervisors of construction companies, human resource managers, personnel, team leaders, and production managers).

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, Adama Science and Technology, Ambo, and Jimma Universities in Ethiopia. While employees and instructors were selected using simple random sampling techniques, employers were selected using purposive sampling techniques. The relative abundance of the instructors recruited to fill out the study questionnaire was partly due to the large role instructors' play in curriculum development and implementation, equipping graduates with the necessary competencies, and their availability and willingness to take part in the study. In addition, 15 individuals, comprised of 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, were purposefully selected and took part in key informant interviews.

Data gathering tools

The study employed two sets of self-developed questionnaires with the same content. The first set of the questionnaire was designed to ask the extent to which higher learning institutes equip engineering graduates with discipline-specific, technical, interpersonal, and generic skills. The second set of questionnaires was designed to assess the extent to which the engineering labor market requires these skills. To develop data gathering tools, engineering graduate employability skills developed by the Malaysian, Hong Kong, and Japan Ministries of Education, a tool to test the learning and employability framework developed by INCHER (International Centre of Higher Education Research) of the University of Kassel, Germany, CHEERS (Careers after Higher Education: European Research Study Projects), literature, and national policy documents were reviewed. The questionnaires were designed in the form of a 5-point Likert scale (ranging from 1 replacing very low extent to 5 replacing very high extent). The questionnaire consisted of 34 items (10 items related to discipline-specific skills, 6 items related to technical skills, 6 items related to interpersonal skills, and 12 items related to generic skills). Each item was used to assess both levels of engineering graduates skill acquisition during study at higher learning institutes and labor market needs for the same skills after graduation.

A pilot test was conducted on 25 employees, employers, and instructors prior to the commencement of actual data collection to check reliability and validity using the questionnaires. Test-retest reliability has been conducted by administering the questionnaires to the same respondents at two different moments. The closer the findings of the retested survey are to those of the first test, the greater the reliability of the instrument to ensure the validity of the survey questionnaires. The validity of the instruments was checked using a thorough analysis by experts relevant to the fields. Several cognitive interviews (thinking aloud) were conducted with employees, employers, and instructors to improve the survey instruments. A few modifications were made to the questionnaire depending on the results of the pilot study. The questionnaire was administered and collected on a face-to-face basis by the researcher, with the facilitation of paid academic staff from each faculty of the sample universities. Of the 300 questionnaires dispatched to respondents, 260 were duly filled out and returned. Thus, the return rate of the questionnaire was 87 percent.

Unstructured interview guides were prepared and utilized to collect qualitative data to substantiate the data gathered via questionnaires (quantitative data). Key informant interview participants were asked about the kinds of competences acquired by civil, electrical, and mechanical engineering students in higher education institutions and required by employers of graduates of the same departments, and whether competences acquired by graduates of the three departments match competences that the employers require for companies' productivity. The researcher used Amharic to ask interview guide questions. Each interview took an average of

40 minutes, during which a sound recorder was used to capture data. In addition to primary data collected using questionnaires and key informant interviews, the researcher reviewed some purposively selected policy and strategy documents, such as the Ethiopian Higher Education Road Map (2017), the Education Sector Development Program (1997–2017), the Higher Education Proclamation (2009), the Education Policy and its Implementation (2003), and the National Employment Policy and Strategy (2009).

Data analysis methods

As a recommendation from Cresswell (2014), the researcher made every attempt to select the statistical procedures that were appropriate for the data analysis rather than merely following the approach used by some other scientists in their field. Both descriptive statistics like mean and standard deviation and inferential statistics like the paired sample t-test were employed to analyze quantitative data gathered using questionnaires. The mean is the most commonly used stable measure of central tendency. It is an arithmetic average of the scores. 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, the standard deviation is the most frequently used index of variability and considers every score in its calculation. In this study, the value of standard deviations was used to compare the variability of higher education supply and employers needs for academic, technical, interpersonal, and generic skills. The smaller the value of the standard deviation, the closer the score around the mean and the less the variability of 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 paired sample t-test was used to check whether or not there was a statistically significant mean difference between employees', employers, and instructors' responses related to higher education skill supply and labor market skill needs and if the difference was a real difference or a difference by chance using respondent categories (employee, employer, and instructor) as independent variables and acquired and required skills as dependent variables. In all inferential statistical tests employed to analyze quantitative data, a preselected probability level (test of significance) of $\alpha = 05$ was employed because such a confidence interval is often used by educational researchers (Gay et al., 2012). In conducting a test of significance, a test value greater than $\alpha = 05$ indicates the existence of a significant difference between comparison groups (real difference), while a test value less than $\alpha = 05$ (preselected probability level) reflects no statistically significant difference between comparison groups (any difference found is attributed to sampling error or chance). The researcher transcribed, translated, and thematically coded the data collected via key informant interviews and document reviews and integrated, supported, substantiated, and checked with the data gathered using questionnaires.

Ethical considerations

Before the commencement of data collection, clearance was guaranteed by the Addis Ababa University Department of Educational Planning and Management. Informed consent was obtained from all eligible respondents before distributing the questionnaire. While obtaining informed consent, the respondents were informed about the anonymity and confidentiality of their responses. Thus, confidentiality issues were properly addressed in all data collection processes.

FINDINGS AND DISCUSSION

The match between higher education skill supply and employers or labor market needs

The match between higher education skill supply and labor market skill needs was investigated in terms of graduate acquisition, employers, and labor market requirements for such skills as discipline-specific academic skills, technical skills, interpersonal skills, and generic skills.

Table 1: Mean difference between acquired and required skills

Skill	Mean of acquired skills	Mean of required skills	Mean difference	Standard deviation	Paired sample t-tests		
					t	df	p
Discipline specific academic skill	3.23	3.98	0.74	0.68	17.51	259	<0.01
Technical skill	3.31	4.16	0.85	0.75	18.19	259	<0.01
Interpersonal skill	3.37	4.11	0.74	0.71	16.68	259	<0.01
Generic skill	3.27	4.14	0.88	0.72	19.38	259	<0.01

Table 2: Comparisons of higher education skill supply and employers and labor market needs as reported by employees, employers, and instructors

Type of skill	Respondent	Catagory	N	Mean	SD	mean difference
Discipline specific skill	Employee	Acquired	90	3.14	0.44	
		Required	90	3.67	0.65	0.53
	Employers	Acquired	40	3.17	0.34	0.74
		Required	40	3.91	0.49	
	Instructors	Acquired	130	3.32	0.34	0.89
		Required	130	4.21	0.56	
Technical skill	Employee	Acquired	90	3.45	0.49	0.51
		Required	90	3.96	0.70	
	Employers	Acquired	40	3.35	0.47	0.92
		Required	40	4.27	0.54	
	Instructors	Acquired	130	3.19	0.39	1.07
		Required	130	4.26	0.59	
Interpersonal skill	Employee	Acquired	90	3.40	0.51	0.42
		Required	90	3.82	0.59	
	Employers	Acquired	40	3.44	0.44	0.76
		Required	40	4.20	0.46	
	Instructors	Acquired	130	3.34	0.49	0.95
		Required	130	4.29	0.52	
Generic skill	Employee	Acquired	90	3.35	0.50	0.65
		Required	90	4.00	0.53	
	Employers	Acquired	40	3.36	0.45	0.88
		Required	40	4.24	0.47	
	Instructors	Acquired	130	3.18	0.46	1.02
		Required	130	4.20	0.59	

Table 3: Paired sample t-test for overall acquired and required skills as reported by employee, employer and instructor

Respondent type	Pair	Mean	Mean difference	S.D	t	df	p
Employee	Required-	3.85	0.59	0.61	9.21	89	<0.01
	Acquired	3.26					
Employer	Required-	4.13	0.85	0.50	10.69	39	<0.01
	Acquired	3.28					
Instructor	Required-	4.24	0.99	0.58	19.32	129	<0.01
	Acquired	3.26					

Discipline specific skills

Discipline-specific skills help graduates perform tasks in the 21st century and are more relevant to one's career (Shivoro et al., 2019). In this study, discipline-specific academic skill was measured in terms of 10 variables, including the 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.

As seen in Table 1, higher learning institutes moderately equip graduates with discipline-specific skills, with a mean value of 3.23 lying between 2.61 and 3.4, while it is highly required in engineering graduate labor markets, with a mean value of 3.98 lying between 3.4 and 4.20. Compared to generic, interpersonal, and technical skills, the gap between the higher education supply of discipline-specific skills and the engineering labor market need for the same skill was narrowest (mean difference =0.74; SD = 0.68). The mean of required discipline-specific academic skills was also higher than the mean of acquired academic skills. A paired sample t-test in Table 1 also confirms the existence of a statistically significant mean difference between acquired and required discipline-specific skills (mean =0.74, SD =0.68, t = 17.51, p = 0.01) at the 0.05 level of confidence.

As indicated in Table 2, attempts were made to identify the match between higher education skill supply and employers/labor market needs based on the reports of employees, employers, and instructors. Employees (mean = 3.14; SD = 0.44), employers (mean = 3.14; SD = 0.34), and instructors (mean = 3.32; SD = 0.34) reported that higher learning institutes moderately equip graduates with discipline-specific skills. However, the requirement for the same skills by employers and the labor market was high, as reported by employees (mean = 3.67; SD = 0.65), employers (mean = 3.91; SD = 0.49), and instructors of higher learning institutes (mean = 4.21; SD = 0.56). When compared to employees (mean difference = 0.53) and employers (mean difference = 0.74), instructors reported that graduates acquire more discipline-specific academic skills during studies at higher learning institutes, and employers and labor market needs for the same skill were very high. Yet, the report of the instructors (mean difference 0.89) revealed the existence of a significant mismatch between discipline-specific academic skills acquired at higher learning institutes (mean = 3.32; SD = 0.34) and the requirements of the same skills by employers and the labor market (mean = 4.21; SD = 0.56).

A study by Wongnaa and Boachie (2018) underscores the importance of discipline-specific skills in the fields of science, technology, engineering, and math. In contrast, the commitment of Ethiopian higher learning institutes to equip learners with discipline-specific skills was seemingly low. This might be due to the fact that countries value discipline-specific skills and generic skills differently. Academic institutions often fail to provide the right skillsets for graduates due to weak collaboration between universities, employers, and professional accreditation bodies (Fitriani & Ajayi, 2022). As discussed above, scholars argued that discipline-specific skills are crucial in hard science fields like engineering and technology, enable graduates to secure employment in their

field of studies and receive higher wages, and help graduates perform tasks in the 21st century. The findings of this study also disclosed that the need for discipline-specific skills in the engineering labor market was high while the supply of graduates with the same skills was low. The differences between scholars arguments and the findings of this study might be attributed to higher learning institutes' negligence in considering the importance of such skills in engineering graduates labor markets, the declining quality of higher education with the current increasing enrollment and graduation rates, and the absence of assessment of employers' skill needs by higher learning institutes in curriculum design, delivery, and evaluation. Such a mismatch between higher education discipline-specific skill supply and employer needs results in a scarcity of well-qualified engineers capable of applying, testing, and improving existing engineering-related scientific theories and knowledge that fit the changing technological environment. It also increases the rate of graduate unemployment, and employers opt to recruit new employees from non-graduates and are exposed to the additional cost of training.

Technical skills

Technical skills are among the employability skills required by most employers. Graduates acquisition of these skills indicates their proficiency to perform highly in a particular job (Fitriani & Ajayi, 2022). For the purpose of this study, computer skills, the skill of planning and organizing tasks, problem-solving skills, decision-making skills, professional skills, and the skill of seeking and developing opportunities were indicators used to measure technical skills. As shown in Table 1, graduates moderately acquire technical skills, with a mean value of 3.31 lying between 2.61 and 3.4. However, its requirement in the engineering labor market is high, with a mean value of 4.16 lying between 3.4 and 4.20. The gap between the higher education supply of technical skills and the engineering labor market need for the same skills was widest (mean difference =0.85; SD = 0.75) next to generic skills. A paired sample t-test result depicts a statistically significant mean difference between technical skills acquired at higher learning institutes and employers' needs for the same skills (mean difference =0.85; SD = 0.75; t = 18.19; p =0.01) at a 0.05 level of confidence.

The reports of employers (mean = 3.35; SD = 0.47) and instructors (mean = 3.19; SD = 0.39) in Table 2 revealed that higher learning institutes moderately equip engineering graduates with technical skills, while employees (mean = 3.45; SD = 0.49) reported that higher learning institutes highly equip graduates with the same skill. While the report of employees revealed that technical skills (mean = 3.96; SD = 0.70) are highly required in the engineering labor market, employers (mean = 4.27; SD = 0.54) and instructors (mean = 4.26; SD = 0.59) confirmed that the employers and labor market's need for technical skills is very high. Therefore, the reports of employees (mean difference = 0.51), employers (mean difference = 0.92), and instructors (mean difference = 1.07) confirmed the existence of a mismatch between technical skills acquired at higher learning institutes and those required by the labor market among engineering graduates. The mean difference between technical skills acquired at higher learning institutes and those required by the graduate labor market was highest for instructors, followed by employers and employees.

Corroborating the findings of this study, Fitriani and Ajayi (2022) reported that employers prefer and value graduates with high technical skills, including skill in manipulating computers, problem-solving skills, decision-making skills, and skill in organizing and planning tasks. The study by Siraye, Abebe, Melese, and Wale (2018) identified technical skills such as problem-solving skills, information technology skills, adapting to change, and risk-taking skills as the skills most demanded by employers, and graduates acquisition of such skills is an indication of their proficiency to perform highly in a particular job. However, employees, employers, and instructors holding different views about graduate acquisition of interpersonal skills and its requirement in the engineering graduate labor market indicate the existence of a mismatch between graduates' acquisition of interpersonal skills and employers' needs. The mismatch between higher education supply and employers need for technical skills indicates that higher learning institutes and employers are not closely working together in the

identification of technical skills demanded by the world of work and integrating them into both curricular and extracurricular activities.

Interpersonal skills

Interpersonal skills are the abilit*y* to work in a team, communicate, and cooperate effectively with diverse colleagues and clients (Velasco-Martínez & Tójar-Hurtado, 2018**)**. In this study, interpersonal skills were measured in terms of teamwork, client/stakeholder focus, working with people from different cultures, communication skills (both written and verbal), interpersonal skills, empathy, adaptability, and flexibility. The findings of this study reveal that graduates moderately acquire interpersonal skills, with a mean value of 3.37 lying between 2.61 and 3.4, though the requirement in the current Ethiopian engineering labor market is high, with a mean value of 4.11 lying between 3.4 and 4.20. The gap between the higher education supply of interpersonal skills and the engineering labor market need for the same skill was the third widest (mean difference =0.74; SD = 0.71), next to technical skills. The paired sample test in Table 1 confirms the prevalence of statistically significant mean differences between required interpersonal skills (mean =4.11) and acquired interpersonal skills (mean = 3.37), with a mean difference of 0.74, S.D. = 0.71, t = 16.68, p =0.01 at the 0.05 level of confidence.

As depicted in Table 2, employees (mean = 3.4; SD = 0.51) and instructors (mean = 3.34; SD = 0.49) reported that interpersonal skill was moderately acquired at higher learning institutes, while employers (mean = 3.44; SD = 0.76) confirmed that higher learning institutes highly equip graduates of engineering disciplines with the same skill. For both employees (mean = 3.82; SD = 0.59) and employers (mean = 4.20; SD = 0.59), interpersonal skills were highly required by employers. Instructors (mean = 4.29; SD = 0.52), on their part, reported that the requirement for interpersonal skills in the engineering labor market was very high. Employees (mean difference = 0.42), employers (mean difference = 0.76), and instructors (mean difference = 0.95) hold different views about graduate acquisition of interpersonal skills and the requirement of the same skill in the engineering labor market. These indicate the existence of a mismatch between interpersonal skills acquired at higher learning institutes and employers or labor market needs for the same skill.

Scholars (e.g., Ahmed, Philbin, & Cheema, 2020) argue that aspects of interpersonal skills, together with other skills, determine the success of graduates in the labor market. For instance, teamwork, communication skills, the ability to work with people from different cultures, and empathy were components of interpersonal skills highly required by employers (Collet and Hine, 2015). Contrasting a previous study by Getahun et al. (2020), engineering graduates of Ethiopian higher learning institutes better develop the ability to work in teams and communication skills than other skills. Nevertheless, according to the report from reviewed documents, graduates of Ethiopian higher learning institutes lack oral and written communication skills in English, a medium of instruction in higher learning institutions. Thus, higher learning institutes and employers properly identify interpersonal skills and integrate them into higher education curricular and extracurricular activities that positively contribute to engineering graduates' and organizational success.

Generic skills

Scholars (e.g., Asai, Breda, Rain, Romanello, Sangnier, 2020; Green, 2016) argue that generic skills are general skills that could apply to a whole range of industries and are increasingly important in modern economies. In this study, creative thinking, willingness to learn, leadership skill, integrity, sense of responsibility, innovativeness, determination, loyalty to the institution and its objectives, ability to assert oneself, self-confidence, and sense of independence are observable indicators used to measure generic skills. The aggregate mean response in the above Table 1 confirms that generic skills (mean = 3.27) were moderately acquired during

university studies, with mean values lying in between 2.6 and 3.4. Nevertheless, the need for generic skills in the Ethiopian engineering labor market was high, with a mean value of 4.14 lying between 3.4 and 4.20. The gap between higher education supply and engineering labor market need for generic skills was the widest (mean difference =0.88; SD = 0.72) of all skill types under scrutiny. A paired sample t-test result affirms evidence of a statistically significant mean difference between generic skills acquired at higher learning institutes and those required by employers or the labor market (mean difference = 0.87; SD = 0.72; t = 19.38; p = 0.01) at a 0.05 level of confidence.

As shown in Table 2, Employees (mean = 3.35; SD = 0.50) and employers (mean = 3.36; SD = 0.45) who took part in the study reported that higher learning institutes moderately equip graduates with generic skills, while the instructors affirmed that universities equip graduates with the same skills to a very high extent. With regard to employers and labor market needs, employees (mean = 4.00; SD = 0.53) and instructors (mean = 4.20; SD = 0.59) believed that generic skills were highly required in the engineering labor market. Interestingly, employers (mean = 4.24; SD = 0.47) reported that the needs for generic skills among employers and the labor market were very high. The reports of employees (mean difference = 0.65), employers (mean difference = 0.88), and instructors (mean difference = 1.02) confirmed the existence of wider gaps between generic skills acquired during studies at the university and the requirements of generic skills in the engineering labor market.

Paired sample t-tests were computed to test mean differences among employees, employers, and instructors in responding to levels of skills acquired at higher learning institutes and levels of labor market needs for the same skills. As seen in Table 3, there is a statistically significant mean difference between skills acquired at higher learning institutes and the mean requirement of the same skills in the labor market ($p = 0.01$; $\alpha \leq 0.05$). The mean difference was highest for instructors (mean difference = 0.99 SD = 58; t = 19.32; df = 129; p = 0.01), followed by employers (mean difference = 0.85 SD = 0.50; t = 10.69; df = 39; p = 0.01), and the lowest difference among employees (mean difference = 0.59 SD = 0.561; t = 9.21; df = 89; p = 0.01). Thus, the mean responses of employees, employers, and instructors revealed the existence of a significant mismatch between the skills supplied by higher learning institutes and the skills required by employers in the Ethiopian context.

For scholars (e.g., Asai et al., 2020), individuals with stronger generic competences are more widely employed outside their own field of study and easily adapt to tasks and requirements with which they are not familiar. It has also been argued that the acquisition of general skills will translate into higher earnings in a competitive labor market (Asai, Breda, Rain, Romanello, & Sangnier, 2020). Thus, generic skills are core employability skills that are more or less equally required in all organizations and critical for graduate success in the labor market and organizational competitiveness. However, higher learning institutes in Ethiopia seemingly failed to identify these key employability skills to incorporate into curricular and extracurricular tasks in the current booming higher education enrollment, graduation, and unemployment rates. Such a mismatch between higher education skill supply and employers' skill need is an indication of inefficiency in the labor market that can hinder productive capacities, which generate unemployment and underemployment, harm organizational productivity due to lower output per worker, inflate average labor costs, affect firm-level profitability, and affect the capacity of enterprises to innovate and adapt to changing market conditions.

Key informant interviews and reviews of policy document reports also revealed that the recent higher learning institutes in Ethiopia give minimal attention to equipping learners with most aspects of discipline-specific, technical, interpersonal, and generic skills. Weak university-industry linkage, limited students' exposure to the real world of work, and the absence of teaching by practitioners from industry result in a lack of technical and practical skills among engineering graduates. Higher learning institutes also marginalized strategies and tactics to prepare programs requiring intensive use of IT in teaching and learning tasks. The quality of education has shown a sharp decline; competences are not well identified in higher education curricula; the organization of modules is found to be weak; the teaching methods employed are highly dominated by the traditional lecture

method; the world of work is not yet aware of the movement of HEIs towards competence-based curricula; and higher education institutions have neglected the development of employability and other lifelong learning skills in graduates.

However, there is increasing policy and strategic emphasis on producing qualified engineers and natural scientists capable of understanding and utilizing appropriate technologies in growing manufacturing and service providing enterprises; developing science and technology institutions to produce highly qualified technicians, engineers, and scientists in line with the demand of the national economy; modifying the balance of the enrollment of higher education in favor of the science and technology needs of the country and conducting practical training in cooperation and collaboration with industries; and enabling the establishment of a workforce in manufacturing and service-provider enterprises with the knowledge and skills necessary to learn, adapt, and utilize technology. Ethiopia has witnessed the implementation of a modular approach that requires changing the old knowledge-based curriculum to a contemporary competency-based type of curriculum. The competency-based curriculum emphasizes the identification of professional and vocational skills, job-specific skills, and transferable skills that higher education graduates may have after completing the curriculum.

CONCLUSION

This study investigated the match between higher education STEM skill supply and employers' skill needs in Ethiopia using a mixed-methods design. The study found a wider mismatch between the higher education STEM skill supply and the labor market needs. The gap between the higher education skill supply and labor market need was widest for generic skills, followed by technical skills and interpersonal skills, but narrowest for discipline-specific skills. A paired sample t-test result also confirmed the existence of a statistically significant mean difference between higher education STEM skills supplies and employers' needs.

The study further disclosed that employees, employers, and instructors have different views related to graduates' acquisition and employers' need for all types of skills under scrutiny. While employers and instructors believe that engineering graduates moderately acquire technical skills, employees believe that higher learning institutes well equip graduates with the same skill. For employers and instructors, technical skills are highly required in the engineering graduate labor market.

Similarly, paired sample t-test results depicted a statistically significant mean difference between higher education and the labor market (employers' need for discipline-specific, technical, interpersonal, and generic skills as reported by employers, employees, and instructors). Such mismatches between STEM skills supply and need hinder productive capacities, generate unemployment and underemployment, inflate average labor costs, affect firm-level profitability, and affect the capacity of enterprises to innovate and adapt to changing market conditions.

Strengthening collaboration with all stakeholders, including employers, in designing and implementing appropriate STEM curricula, conducting firm surveys to assess the skill needs, exposing students to lectures held by professionals outside universities, and implementing project-based and problem-oriented project-based learning to promote students' creativity and innovative, critical, and analytical thinking for future employment prospects should get prime priority in higher education. Future research should focus on the skills employees acquire at work through experience and the factors that contribute to the mismatch between the supply of higher education skills and labor employers' needs by including prospective graduates in sample selection.

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