

STEM-TVET Education, Employability Skills and Industry Readiness: Evidence from Engineering Undergraduates in Malaysia

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ABSTRACT

STEM-TVET education plays an important role in preparing engineering graduates for contemporary industry demands by integrating technical learning with transferable employability skills. This study examines the relationship between STEM-TVET education and perceived employability skills and industry readiness among engineering undergraduates in Malaysia. A quantitative survey design was employed with 220 engineering undergraduates from a public technical university. A structured questionnaire measured four employability-skill dimensions—technical skills, critical thinking and problem-solving, teamwork and collaboration, and communication skills—and four industry-readiness indicators: internship preparedness, perceived usefulness of internship, skills relevance to industry, and confidence entering industry. Responses were measured using a five-point Likert scale. Descriptive statistics, standard deviation, Cronbach's alpha, and Pearson correlation analysis were used to examine perceived skill development, measurement reliability, and relationships between employability skills and industry readiness. The findings indicate high perceived levels across all employability-skill dimensions, with technical skills recording the highest mean ($M = 4.21$, $SD = 0.58$), followed by critical thinking and problem-solving ($M = 4.15$, $SD = 0.61$), teamwork and collaboration ($M = 4.02$, $SD = 0.65$), and communication skills ($M = 3.89$, $SD = 0.69$). Industry-readiness indicators were also rated highly, including internship preparedness ($M = 4.18$, $SD = 0.57$), perceived internship usefulness ($M = 4.24$, $SD = 0.54$), skills relevance to industry ($M = 4.22$, $SD = 0.60$), and confidence entering industry ($M = 4.05$, $SD = 0.63$). Reliability analysis produced Cronbach's alpha values of 0.89 for employability skills and 0.87 for industry readiness. Pearson correlations reported positive relationships between employability skills and industry-readiness indicators. Overall, the results indicate an association between industry-oriented STEM-TVET learning, industrial training experiences, and students' perceived preparedness for professional engineering roles. The findings provide descriptive and correlational evidence that may be useful to curriculum designers and higher education institutions seeking stronger alignment between engineering education and labour-market expectations.

Keywords: STEM-TVET; employability skills; industry readiness; engineering education; industrial training

INTRODUCTION

The rapid evolution of technology and globalization has transformed the employment landscape, requiring graduates to possess not only strong technical expertise but a comprehensive set of employability skills. Globally, TVET strategies emphasize equipping learners for dynamic economies, emphasizing work-aligned learning in higher education. In Malaysia, the integration of Science, Technology, Engineering, and Mathematics (STEM) with Technical and Vocational Education and Training (TVET) is a national priority. The National TVET Policy 2030 outlines strategic thrusts, which includes unified governance, industry collaboration, and alignment with economic development. The aim is to produce high-skilled, high-income workers in areas such as AI, robotics, advanced manufacturing, and energy systems [1], [2]. The policy further sets frameworks to elevate the

perception and quality of TVET, with substantial funding injected into STEM-related vocational programmes [2]. [11], [12]

Engineering undergraduates form a crucial segment within this national framework, with expectations to serve industry sectors key to Malaysia's growth. Despite strong technical training, employers highlight persistent gaps in soft skills, such as communication, teamwork, and critical thinking. In higher education research, employability is broadly defined as the "achievements skills, understandings and personal attributes, which makes the graduates to be more likely to gain employment and be successful in their chosen occupations" [4].

Industrial training is a common mechanism used to enhance industry readiness. Industry readiness refers to graduates' ability to transition smoothly into professional roles. Industrial training is a key component of TVET programs, providing exposure to workplace culture and real-world problem-solving. Evidence shows that structured internships significantly improve students' confidence and readiness for employment [9]. However, disparities exist in the relevance of tasks assigned during internships, which may affect skill development outcomes [10].

Evidence from Malaysia indicates that well-structured internships significantly develop employability skills, including communication, teamwork, problem-solving, adaptability, and technical proficiency, although they differ in critical thinking development [5]. However, the quality of internship experiences varies widely, which affects how effectively they bridge the divide between theory and practice.

Employability skills encompass technical and soft skills, including communication, teamwork, adaptability, and leadership. Yorke defines employability as "a set of achievements, like skills, understandings and personal attributes that make graduates more likely to gain employment and be successful in their chosen occupations" [6]. Studies in Malaysia indicate that engineering graduates often excel in technical domains but lack interpersonal and managerial skills required by employers [7]. To address these gaps, universities have incorporated project-based learning and industrial training [8]. [11], [14]

While existing literature acknowledges the benefits of STEM-TVET education, empirical evidence on its impact on employability skills and industry readiness in the Malaysian engineering context remains limited. Few studies have examined the combined association between technical and soft skill acquisition during industrial training. This study addresses this gap by analyzing survey data from engineering undergraduates, focusing on perceived skill development and preparedness for industry roles. [11], [14], [17]

Against this backdrop, this study investigates the relationship between STEM-TVET education on employability skills and industry readiness among Malaysian engineering undergraduates, using survey data collected during industrial training placements. By integrating student-reported outcomes within the context of national policy and global TVET trends, the study seeks to provide evidence that may inform curriculum design and policy discussions that better align education with labour market demands.

METHODOLOGY

Data Description

This study employed a quantitative cross-sectional survey design to examine perceived employability skills and industry readiness and their relationship with STEM-TVET education among engineering undergraduates in Malaysia. A quantitative approach was adopted to measure students' perceptions of skill development and industry preparedness through numerical data and statistical analysis.

The study involved engineering undergraduates from a public technical university in Malaysia. The analysis focused on four dimensions of employability skills, namely technical skills, critical thinking and problem-solving, teamwork and collaboration, and communication skills. Industry readiness was assessed through internship preparedness, perceived usefulness of internship, skills relevance to industry, and confidence in entering the industry.

A total of 220 engineering undergraduates participated in the study. Data were collected using a structured survey questionnaire designed to measure students' perceptions of employability skills and industry readiness.

The questionnaire focused on students' perceived development of technical and transferable skills as well as their preparedness for industrial training and future employment. This approach is consistent with the study objective of examining perceived skill development, preparedness for industry roles, and the relationships among the measured constructs.

Research Instrument

A structured questionnaire was used as the main data collection instrument. The questionnaire consisted of two main constructs: employability skills and industry readiness.

The employability skills construct comprised four dimensions: (1) technical skills (TS); (2) critical thinking and problem-solving (CT); (3) teamwork and collaboration (TW); and (4) communication skills (CS).

The industry readiness construct consisted of four indicators: (1) internship preparedness; (2) perceived usefulness of internship; (3) skills relevance to industry; and (4) confidence entering industry.

Responses were measured using a five-point Likert scale, where higher scores represented stronger perceptions of employability skills and industry readiness.

Data Analysis

The collected data were analysed using descriptive statistics, reliability analysis, and correlation analysis. The following statistical methods were employed.

Mean

The mean was calculated to determine the average level of perceived employability skills and industry readiness among the respondents. The arithmetic mean was calculated using:

$$\bar{X} = (\sum_{i=1}^n X_i) / n$$

Standard Deviation

Standard deviation (SD) was used to measure the dispersion of respondents' scores around the mean. It was calculated as:

$$SD = \sqrt{[\sum_{i=1}^n (X_i - \bar{X})^2 / (n - 1)]}$$

Cronbach's Alpha

Cronbach's alpha was employed to assess the internal consistency and reliability of the questionnaire items within each construct. Cronbach's alpha can be expressed as :

$$\alpha = [k / (k - 1)] [1 - (\sum_{i=1}^k \sigma_i^2 / \sigma_t^2)]$$

Pearson Correlation Coefficient

Pearson product-moment correlation analysis was conducted to determine the strength and direction of the relationship between employability skills and industry readiness. The Pearson correlation coefficient is calculated as:

$$r = \sum_{i=1}^n (X_i - \bar{X})(Y_i - \bar{Y}) / \sqrt{\{\sum_{i=1}^n (X_i - \bar{X})^2 \times \sum_{i=1}^n (Y_i - \bar{Y})^2\}}$$

Summary of Statistical Analysis

Because the study used a cross-sectional survey and self-reported measures collected at a single point in time, the analysis is intended to describe perceived levels and associations among the measured constructs. The design does not permit causal conclusions about changes attributable to STEM-TVET education or industrial training.

The statistical analysis consisted of descriptive statistics (mean and standard deviation), reliability analysis using Cronbach's alpha, and relationship analysis using Pearson correlation. These methods were used to assess the level of employability skills and industry readiness, establish the reliability of the measurement constructs, and examine the relationships between employability skills and industry preparedness.

RESULTS AND DISCUSSION

Descriptive Statistics

Descriptive statistics were used to examine the level of employability skills and industry readiness among engineering undergraduates enrolled in STEM-TVET programmes. Table 1 presents the mean and standard deviation values for employability skill dimensions.

Table 1. Descriptive Statistics for employability skill dimensions.

Item	Mean	SD	Interpretation
Technical skills	4.21	0.58	High
Critical thinking and problem solving	4.15	0.61	High
Teamwork and collaboration	4.02	0.65	High
Communication skills	3.89	0.69	High

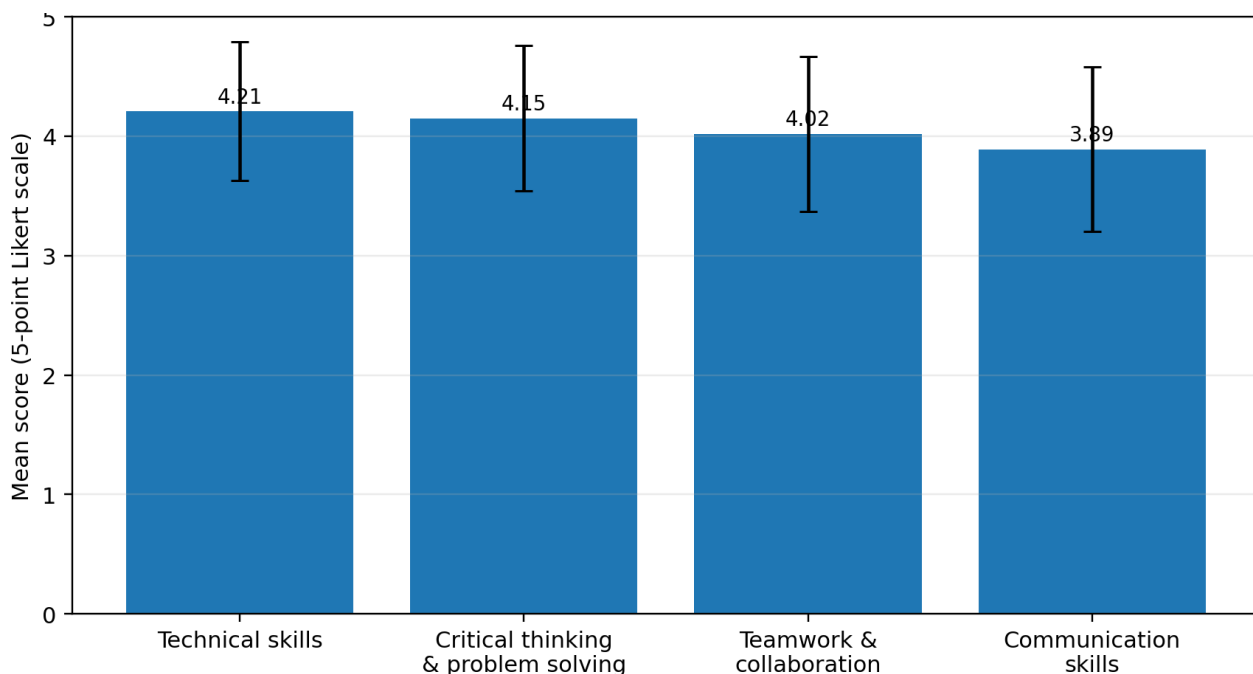


Figure 1. Perceived employability skills among engineering undergraduates.

Overall, students reported high levels of employability skills, with mean values ranging from 3.89 to 4.21. Technical skills recorded the highest mean score ($M = 4.21$, $SD = 0.58$), followed by critical thinking and problem-solving skills ($M = 4.15$, $SD = 0.61$). Teamwork and collaboration skills ($M = 4.02$, $SD = 0.65$) and communication skills ($M = 3.89$, $SD = 0.69$) also demonstrated strong perceived development.

Table 2. Descriptive Statistics for industry readiness indicators.

Item	Mean	SD	Interpretation
Internship preparedness	4.18	0.57	High
Perceived usefulness of internship	4.24	0.54	High
Skills relevance to industry	4.22	0.6	High
Confidence entering industry	4.05	0.63	High

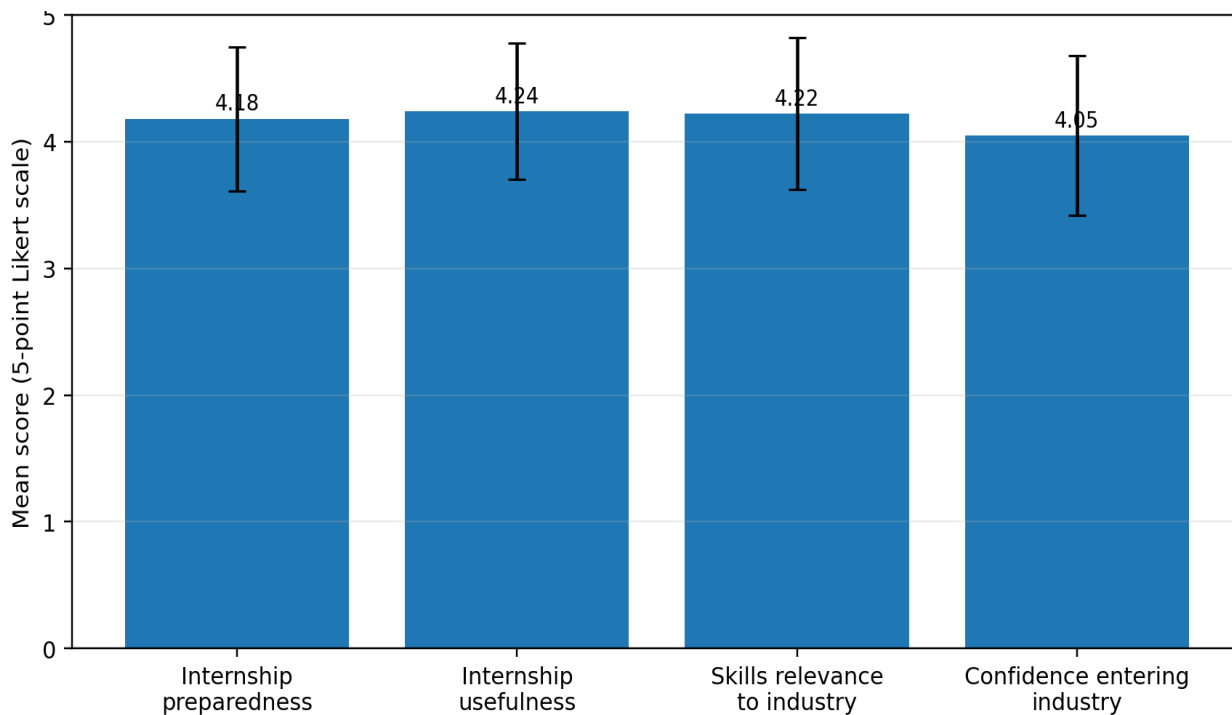


Figure 2. Perceived industry readiness indicators.

Industry readiness indicators likewise showed positive results. Internship preparedness achieved a mean score of 4.18 (SD = 0.57), while perceived usefulness of internship was rated highly (M = 4.24, SD = 0.54). Skills relevance to industry (M = 4.12, SD = 0.60) and confidence entering industry (M = 4.05, SD = 0.63) further confirm that respondents felt well prepared for industrial engagement.

These findings indicate high perceived levels of technical and transferable skills among the engineering students surveyed.

Reliability Analysis

Reliability analysis was conducted to assess the internal consistency of the employability skills and industry readiness constructs. The employability skills scale achieved a Cronbach's alpha value of 0.89, indicating excellent reliability. Similarly, the industry readiness construct recorded a Cronbach's alpha of 0.87, exceeding the recommended threshold of 0.70.

These results indicate that the measurement items used in this study demonstrate satisfactory internal consistency for the subsequent correlational analysis.

Correlation Analysis

Pearson correlation analysis was performed to examine the relationship between employability skills and industry readiness. The results revealed moderate to strong positive correlations, as shown in Table 3.

Table 3. Pearson Correlation Matrix.

Variables	TS	CT	TW	CS
Technical Skills (TS)	1	0.842**	0.774**	0.694**
Critical Thinking (CT)	0.842**	1	0.754**	0.750**
Teamwork (TW)	0.774**	0.754**	1	0.758**
Communication Skills (CS)	0.694**	0.750**	0.758**	1

Technical skills were strongly correlated with internship preparedness ($r = 0.68$, $p < 0.01$) and confidence entering industry ($r = 0.65$, $p < 0.01$). Critical thinking and problem-solving skills also demonstrated a significant positive relationship with industry readiness ($r = 0.63$, $p < 0.01$).

Additionally, communication skills ($r = 0.54$, $p < 0.01$) and teamwork skills ($r = 0.57$, $p < 0.01$) were positively associated with perceived internship usefulness and skills relevance to industry. These findings suggest that higher reported levels of employability skills are associated with greater reported readiness for industrial training and workplace integration.

DISCUSSION

The findings show high perceived levels of employability skills and industry readiness among the engineering undergraduates surveyed. Given the cross-sectional design, these results describe associations and perceptions rather than causal effects of STEM-TVET education. The high mean scores across all skill dimensions reflect the effectiveness of hands-on, industry-oriented curricula embedded within STEM-TVET programmes. [11], [12], [18]

The positive correlations between employability skills and industry readiness indicate that higher reported levels of employability skills are associated with higher reported levels of industry readiness. In particular, technical and problem-solving skills play a crucial role in enhancing confidence and readiness for real-world engineering tasks.

These results are consistent with prior research highlighting the importance of experiential learning, industry collaboration, and outcome-based education in reducing graduate skill mismatches. From a policy perspective, the findings support continued emphasis on STEM-TVET pathways as a strategic mechanism for producing competent, industry-ready engineering graduates aligned with national workforce development goals.

CONCLUSION

This study concludes that engineering undergraduates reported high levels of employability skills and industry readiness within the STEM-TVET context examined. The findings indicate high levels of perceived technical skills, critical thinking and problem-solving, teamwork and collaboration, and communication skills. Industry readiness was also rated highly in terms of internship preparedness, perceived internship usefulness, skills relevance to industry, and confidence in entering the workplace. The reliability results further demonstrate that the measurement constructs were consistent, with Cronbach's alpha values of 0.89 for employability skills and 0.87 for industry readiness. The observed positive relationships between employability skills and industry-readiness indicators suggest an association between technical and transferable skills and students' perceived readiness for industry. These findings suggest that continued collaboration between universities and industry, particularly through practical learning and industrial training, may support alignment between engineering education and workplace requirements.

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