JOURNAL OF TECHNICAL EDUCATION AND TRAINING
ISSN: 2229-8932 e-ISSN: 2600-7932

JTET

Vol. 17 No. 1 (2025) 90-98
https://publisher.uthm.edu.my/ojs/index.php/jtet

The Impact of Competency-based Training Towards Technical Skills Mastery Among Vocational Education Students

Saiful Hadi Masran[1]*, Muhammad Hafizul Iskandar Zulkiffle[1], Azman Hasan[1], Shinobu Yume Yamaguchi[2], Fairuz Marian[1]

[1] *Faculty of Technical and Vocational Education, Universiti Tun Hussein Onn Malaysia, Batu Pahat, Johor, 86400, MALAYSIA*
[2] *United Nations University Institute for the Advanced Study of Sustainability, 5–53–70 Jingumae, Shibuya-ku, Tokyo 150-8925, JAPAN*

*Corresponding Author: saifulm@uthm.edu.my
DOI: https://doi.org/10.30880/jtet.2025.17.01.007

Article Info

Received: 4th December 2024
Accepted: 7th February 2025
Available online: 14th April 2025

Keywords

Competency-based training (CBT), employability, TVET, career readiness

Abstract

Technical skills are essential for success in various professional fields, playing a crucial role in ensuring job readiness and adaptability. This study investigates the impact of Competency-Based Training (CBT) on the technical skills mastery of final-year vocational education students at a public university in Malaysia, focusing on three mechanical programs: General Machining, Welding and Metal Fabrication, and Refrigeration and Air Conditioning. Using a quantitative research design, the study surveyed 115 students to assess their perceptions of proficiency in key technical skills, including technical communication, analytical, computer, and practical skills. The results indicate that students generally exhibit high levels of competence across most technical areas, particularly in Technical Drawing, Workshop Safety, and Technical Communication, suggesting the effectiveness of CBT in aligning educational outcomes with industry needs. However, areas such as Blueprint Reading and Quality Control were identified as needing improvement. The findings underscore the importance of continuous curriculum enhancements to address specific skill gaps and ensure that graduates are well-prepared to meet the evolving demands of the workforce.

1. Introduction

Competency-Based Training (CBT) is an educational approach that emphasizes the achievement of specific skills and competencies, aligning training programs with industry requirements to enhance workforce readiness and learner success (Mulder, 2017). In the contemporary job market, technical skills have become indispensable for career advancement and success. These skills, encompassing the use of specialized tools, technologies, and procedures, are vital across a wide array of industries (Pan, S., & Lee, J., 2011). As technological advancements continue to reshape the professional landscape, the demand for a highly skilled workforce is more pressing than ever. Consequently, vocational education plays a pivotal role in equipping students with the necessary competencies to thrive in their chosen careers.

This paper investigates the perceptions of final-year students enrolled in the Bachelor of Vocational Education (ISMPV) programs at one public university in Malaysia regarding their technical skill proficiency. The study specifically focuses on three mechanical programs: General Machining (BBA), Welding and Metal

Fabrication (BBD), and Refrigeration and Air Conditioning (BBG). By understanding students' perceptions, this research aims to evaluate the effectiveness of these programs in preparing students for the competitive job market.

Vocational education must strike a balance between imparting theoretical knowledge and practical skills to ensure students are job-ready. This study employs a survey methodology to assess students' confidence in their technical abilities, aiming to provide insights into the strengths and areas for improvement within the curriculum. Ultimately, the findings will contribute to the enhancement of educational strategies, ensuring graduates are well-prepared to meet the evolving demands of the workforce.

1.1 Problem Statement

Despite possessing formal qualifications, many vocational education graduates in Malaysia face significant challenges in securing employment. This discrepancy is largely attributed to a mismatch between the technical skills acquired during their studies and the actual demands of employers (Hossain et al., 2019; Abu Rahim, 2021; Talent Corp, 2023). Students enrolled in programs such as General Machining, Refrigeration and Air Conditioning, and Welding and Metal Fabrication experience this misalignment as well. These students often express concerns that their technical skills may not adequately meet industry requirements, potentially hindering their employability.

This study seeks to explore how final-year students in these programs perceive their technical skill competencies, aiming to pinpoint specific areas where they feel insufficiently prepared. Additionally, the research will investigate whether these perceptions differ across the various programs offered. By identifying gaps in skill acquisition, this study aims to inform curriculum enhancements that align educational outcomes with industry needs, ultimately improving graduates' preparedness for the job market and enhancing their employment prospects.

1.2 Research Aim

Based on the identified issues and problems, this study addresses four primary objectives related to the perceptions of Bachelor of Vocational Education (ISMPV) students at one public university in Malaysia regarding their technical skills mastery. These objectives are:

1. To identify the technical communication and management skills mastery perceived by vocational education students.
2. To identify the technical analytical and computer skills mastery perceived by vocational education students.
3. To identify the technical practical skills mastery perceived by vocational education students.
4. To identify the differences in technical skills mastery perceived among students of different vocational education programs.

2. Methodology

This study employed a quantitative research design, utilizing a structured survey to investigate students' perceptions of their technical skills. The respondents' population consisted of 164 final-year students from one public university in Malaysia, specifically enrolled in the General Machining (BBA), Welding and Metal Fabrication (BBD), and Refrigeration and Air Conditioning (BBG) programs. By referring to the Table of Sample Size Determination (Krejcie & Morgan, 1970), a total of 115 students were randomly selected from these programs to ensure a representative sample.

Data collection was conducted using a meticulously structured questionnaire divided into two sections. The first section gathered demographic information, including age, gender, and program of study, while the second section assessed students' perceptions of their technical skills through a series of statements rated on a Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree). To enhance the validity and reliability of the questionnaire, it underwent an expert review process and was refined based on feedback from a pilot study involving 30 students. This pilot study aimed to evaluate the clarity and effectiveness of the instrument, ensuring that the questions were comprehensible and appropriately targeted (Masran et al., 2017).

The collected data were analysed using the Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were utilized to summarize the demographic characteristics of the participants and their overall perceptions of their technical skills. Furthermore, an Analysis of Variance (ANOVA) was conducted to explore significant differences in perceptions across the three programs, providing insights into potential program-specific strengths and areas for improvement.

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2.1 Research Design

This study adopts a quantitative research design, utilising a survey method to collect data from participants. Initially, a systematic literature review (SLR) was conducted to identify 13 technical skills relevant to vocational education programs, forming the foundation of the research instrument. A structured questionnaire was developed to assess students' perceptions of these technical skills. Table 1 shows 13 technical skills identified through a comprehensive systematic literature review (SLR) process, together with the item instrument statements.

Table 1 *Technical skills identified from systematic literature review with item instruments*

Domain	Skills	Author	Item Statement
Technical Communication & Management Skills	Technical Writing	Fu et al. (2010); Gero & Mano-israeli (2017); Sukandar, Hasan & Suartini (2020); Wu et al. (2022)	I can build concepts a problem in form of writing.
			I can analyze the content the content that is in technical report.
	Technical Communication	Sageev, Romanowski & Bernard (2003); Ng & Wong (2020)	I'm good at communicate information and accurate information during the presentation a project.
			I'm good at discussion for present the issues that related to the field of work.
	Project Management	Okoye & Nkanu (2018); Kakolwa (2023)	I am good at making planning for something project.
			I'm good at determine the risk in a project management.
Technical Analytical & Computer Skills	Data Analysis	Rybarczyk, Walton & Grillo (2014); Schefer-Wenzl & Miladinovic (2019); Mubichakani & Rotich (2019)	I can identify statistical analysis after analyze the data.
			I am able to interpret diagrams and schedule for analyze the data.
	Numeracy	Cao et al. (2023)	I can apply mathematics at work technical field.
			I can apply math in action daily.
	Computer	Anthony & Sony (2021)	I tried to enter any data into Microsoft software.
			I strive to using software for monitor a system in the computer.
Technical Practical Skills	Blueprint Reading	Graham & Porterfield (2018); Nugraha, Djohar, & Komaro (2019); Dokubo, Ebere & Igharo (2024)	I am good at reading blueprint to build installation for something product.
			I am good at interpreting deep blueprint connect all material units using tools appropriate.
	Technical Drawing	Bakare et al. (2020)	I understand the function equipment for painting technical.
			I understand every type and line drawing functions engineering.
	Tools and Machine Handling	Bakare et al. (2020); Okoye & Nkanu (2020); Mohd Zakaria (2020); Ismail & Kasman (2020); Rizwan et al. (2021);	I have abilities to analyze information from the machine and tools.
			I can apply various usage techniques machines and tools for run something activity.
	Tools and Machine Maintenance	Bakare et al. (2020); Okoye & Nkanu (2020); Ismail & Kasman (2020); Rizwan et al. (2021)	I can implement basic maintenance on engineering machinery and equipment.
			I can do work system troubleshooting work to maintain tools and machines.
	Process Manufacturing	Okoye & Nkanu (2020)	I can handle installation equipment in manufacturing industry.
			I can measure parallelism something components for assembly which is correct in the field manufacturing industry.

Quality Control	Bakare et al. (2020)	I'm good at determine the procedure for production (define standards, provide quality guidelines, etc.)
		I'm good at quality control products in the protocol certification.
Workshop Safety	Bakare et al. (2020)	I'm good at checking the workshop security.
		I am good at monitoring or manage properly regulatory compliance safety.

Quantitative research, characterized by its objectivity and results-oriented approach, involves collecting measurable data and applying statistical analysis to derive meaningful insights. According to Ikbal (2021), the quantitative methodology allows researchers to identify key areas for exploration, formulate precise questions, narrow the scope of the subject, gather numerical data from participants, and analyze this data using statistical techniques.

The quantitative approach is particularly suitable for this study as it focuses on evaluating well-established technical skill elements identified in previous research. Since these elements have been extensively studied, employing a mixed-methods approach is unnecessary. The survey-based quantitative design provides a comprehensive understanding of students' perceptions, drawing on the established body of literature without the need for further qualitative exploration.

3. Results and Discussion

The findings of this study are organized to address the four primary objectives related to the perceptions of Bachelor of Vocational Education (ISMPV) students at one public university in Malaysia regarding their technical skills.

Table 2 *Analysis of demographic*

Program	Demographic		N	%
BBA	Gender	Male	28	73.7
		Female	10	26.3
BBD		Male	26	86.7
		Female	4	13.3
BBG		Male	39	83.0
		Female	8	17.0
BBA	Graduates	Vocational College Diploma	14	36.8
		Polytechnic Diploma	11	28.9
		IPTA Diploma	11	28.9
		Matriculation Certificate	2	5.3
		ILKA and others	0	0
BBD		Vocational College Diploma	15	50.0
		Polytechnic Diploma	10	33.3
		IPTA Diploma	2	6.7
		Matriculation Certificate	0	0
		ILKA and others	3	10
BBG		Vocational College Diploma	19	40.4
		Polytechnic Diploma	17	36.2
		IPTA Diploma	5	10.6
		Matriculation Certificate	3	6.4
		ILKA and others	3	6.4
BBA	Skill Certification	SKM 1	0	0
		SKM 2	2	5.3
		SKM 3	15	39.5
		DVM	12	31.6
		None	9	23.7

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BBD	SKM 1	0	0
	SKM 2	1	3.3
	SKM 3	0	0
	DVM	16	53.3
	None	13	43.3
BBG	SKM 1	2	4.3
	SKM 2	0	0
	SKM 3	9	19.1
	DVM	19	40.4
	None	17	36.2

Table 2 shows the demographic analysis of the respondents, which are gender, graduates (before entering UTHM's program), and the skill certification possesses (before entering UTHM's program). These demographic characteristics were categorized based on respondents' respective Bachelor of Vocational Educational programs, namely General Machining (BBA), Welding and Metal Fabrication (BBD), and Refrigeration and Air Conditioning (BBG). For gender, we can see that most respondents are male for all the 3 programs. Next, it is observed that most of the respondents were graduates of the Vocational College before they enrol in UTHM for all the 3 programs. Finally, for the skill certification, the respondents from the BBA program mostly holds level 3 of the Malaysian Skills Certification (SKM). Meanwhile, for the BBD and BBG respondents, most of them holds the Diploma of Vocational Malaysia (DVM) before they enrol into the UTHM program.

3.1 The Technical Communication and Management Skills Mastery Perceived by Vocational Education Students

Table 3 *Analysis of technical communication and management skills mastery perceived by final year vocational education students*

Skills	BBA		BBD		BBG	
	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
Technical Writing	4.03	High	4.10	High	4.06	High
	4.05	High	4.37	High	4.17	High
Technical Communication	4.18	High	4.70	High	4.23	High
	4.39	High	4.60	High	4.00	High
Project Management	4.18	High	4.23	High	4.11	High
	4.32	High	4.20	High	4.11	High

Table 3 shows the results of analysis of technical communication and management skills mastery perceived by the final year vocational education students. The analysis of technical communication and management skills mastery among final-year vocational education students reveals consistently high levels of competency across all assessed skills. Specifically, the mean scores for technical writing range from 4.05 (BBA) to 4.37 (BBD), indicating a strong proficiency in this area. Similarly, Technical communication is highly rated, with mean scores ranging from 4.00 (BBG) to 4.60 (BBD). Project management skills also show high proficiency, with scores varying slightly between 4.11 (BBG) and 4.32 (BBA).

These results suggest that vocational education programs are effectively equipping students with the necessary technical communication and management skills, as evidenced by the uniformly high mean scores across different student groups. Such findings align with existing literature that emphasizes the importance of these skills in vocational education and their critical role in ensuring graduates are well-prepared for the workforce (Rahmat, 2020). However, based on these findings, it can be suggested that technical writing skills can be improved to make sure students have higher skills mastery.

3.2 The Technical Analytical and Computer Skills Mastery Perceived by Vocational Education Students

Table 4 *Analysis of technical analytical and computer skills mastery perceived by final year vocational education students*

Skills	BBA		BBD		BBG	
	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
Data Analysis	4.21	High	3.90	Moderate High	4.09	High
	4.24	High	4.23	High	4.21	High
Numeracy	4.18	High	4.37	High	4.38	High
	4.18	High	4.60	High	4.43	High
Computer	4.37	High	4.80	High	4.45	High
	4.29	High	4.13	High	4.04	High

Table 4 shows the results of analysis of technical analytical and computer skills mastery perceived by the final year vocational education students. The analysis of technical analytical and computer skills mastery among final-year vocational education students highlights a generally high level of proficiency across the assessed skills, with some variation between different student groups. The mean scores for data analysis skills indicate a high level of mastery, with scores ranging from 3.90 (BBD, interpreted as Moderate High) to 4.24 (BBG, interpreted as High). Similarly, Numeracy skills show a strong performance across all groups, with mean scores consistently interpreted as High, ranging from 4.18 (BBA) to 4.60 (BBD). The assessment of Computer skills also reveals high proficiency, with mean scores ranging from 4.04 (BBG) to 4.80 (BBD).

These results suggest that the vocational education programs are effectively developing technical analytical and computer skills, which are critical for students' success in their respective fields. This aligns with the findings of previous studies that emphasize the importance of integrating technical and analytical skill development in vocational education to enhance employability (Ismail & Hassan, 2013). Durrani et al. (2012) found that weak numeracy skills can limit job opportunities, especially in engineering. This shows that industries prioritize numeracy skills to assess graduates' ability to handle calculations. Numeracy should be emphasized in the curriculum before entering the workforce. Dalim et al. (2023) highlighted that numeracy and digital skills are crucial for all graduates, regardless of their field of study.

3.3 The Technical Practical Skills Mastery Perceived by Vocational Education Students

Table 5 *Analysis of technical practical skills mastery perceived by final year vocational education students*

Skills	BBA		BBD		BBG	
	Mean	Interpretation	Mean	Interpretation	Mean	Interpretation
Blueprint Reading	4.05	High	3.97	Moderate High	3.94	Moderate High
	4.00	High	4.00	High	3.98	Moderate High
Technical Drawing	4.50	High	4.67	High	4.38	High
	4.34	High	4.73	High	4.36	High
Tools and Machine Handling	4.29	High	4.40	High	4.11	High
	4.32	High	4.57	High	4.23	High
Tools and Machine Maintenance	4.08	High	4.30	High	4.32	High
	3.97	Moderate High	4.27	High	4.13	High
Process Manufacturing	4.18	High	4.33	High	3.96	Moderate High
	4.26	High	4.37	High	3.98	Moderate High
Quality Control	4.05	High	3.87	Moderate High	3.96	Moderate High
	4.08	High	4.00	High	3.98	Moderate High
Workshop Safety	4.32	High	4.57	High	4.38	High
	4.45	High	4.57	High	4.32	High

Table 5 shows the results of analysis of technical practical skills mastery perceived by the final year vocational education students. The analysis of technical practical skills mastery among final-year vocational education

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students reveals a nuanced picture of their competencies, with some skills showing high levels of proficiency while others indicate areas for improvement. Notably, Technical Drawing and Workshop Safety stand out with high mean scores across all groups, particularly among BBD students, who scored 4.73 and 4.57, respectively, in these areas. This suggests that students are well-prepared in these critical skills, which are essential for their success in technical fields. However, the analysis also identifies areas where students' mastery is less robust. For instance, Blueprint Reading shows a Moderate High mean score among BBG (Mean = 3.94) and BBD (Mean = 3.97) students, indicating that these students may need additional training to enhance their proficiency in this area. Similarly, Quality Control is another skill with relatively lower mean scores, particularly among BBG (Mean = 3.87) and BBD (Mean = 3.96) students, which may reflect a need for more focused instruction on maintaining quality standards.

These findings suggest that while students are excelling in certain technical skills, there is a clear need to address gaps in Blueprint Reading and Quality Control to ensure a well-rounded technical education. Blueprint skills are widely used in engineering and relate to mathematics learning. Rumanová et al. (2021) showed that combining creative methods and blueprint techniques in math makes learning more engaging and improves geometric abilities. This can help technical students become more interested in mastering blueprint reading and better prepare for their careers. Addressing these gaps is critical, as previous research has underscored the importance of aligning vocational education curricula with industry demands to enhance employability and job readiness (Ismail & Hassan, 2013).

3.4 The Differences of Technical Skills Perceived Among Final-year Bachelor of Vocational Education Students in General Machining (BBA), Welding and Metal Fabrication (BBD), and Refrigeration and Air Conditioning (BBG)

Table 6 *Analysis of differences among BBA, BBD and BBG programs using ANOVA*

	Sum of Squares	*df*	Mean Square	F	Sig.
Between Groups	0.568	2	0.284	4.590	0.012
Within Groups	6.931	112	0.062		
Total	7.499	114			

Table 6 shows the analysis of differences among BBA, BBD and BBG students using ANOVA. The research shows significant differences in the perceptions of final-year BBA, BBD, and BBG students about their technical skills. This means students from these programs view their technical skills differently. Oproiu et al. (2019) highlighted that engineering graduates need high-quality professional training and employability skills to meet changing industry demands. Each technical field has different views on the necessary skill levels, and industry demands for technical skills are constantly changing. Scaffidi (2018) noted that employers now value both technical and soft skills in graduates. Universities often survey employers to understand industry needs and expectations.

The most significant perception difference is between BBD and BBG students, with a P-value of 0.010 ($P<0.05$). Both programs have similar student backgrounds, mainly from KV and polytechnic diplomas. This indicates that their technical skills are not entirely aligned with those required after studying at the studied university. Most were mechanical engineering students before learning welding and air conditioning skills, making it hard for them to assess their technical skills accurately. However, students must keep updating their technical skills to meet industry standards. Lyu et al. (2021) found that in the energy sector, general computer and digital skills are more important than soft skills, which boost productivity. Students need to stay aware of evolving technical skills to remain competitive and reduce unemployment rates among graduates.

4. Conclusion

The findings from this study demonstrate that Competency-Based Training (CBT) has had a significant positive impact on the technical skills mastery of vocational education students. Across the different programs examined, students consistently reported high levels of proficiency in key technical areas such as Technical Drawing, Workshop Safety, and Technical Communication. These results suggest that the CBT approach effectively aligns educational outcomes with industry requirements, thereby enhancing students' preparedness for the workforce (Mulder, 2017). The high mean scores in these areas reflect the successful implementation of CBT in fostering the technical competencies that are critical for students' future careers.

However, the study also identified areas where improvements could be made. Skills such as Blueprint Reading and Quality Control, which received relatively lower mean scores, highlight the need for targeted curriculum enhancements (Rahmat, 2020). Addressing these gaps is crucial, as proficiency in these areas is essential for

ensuring that students are fully equipped to meet the demands of their respective industries. By refining these aspects of the curriculum, vocational education programs can further strengthen their ability to produce graduates who are not only competent but also highly competitive in the job market (Ismail & Hassan, 2013).

Overall, the study underscores the importance of continuous assessment and improvement in vocational education curricula to ensure that they remain responsive to the evolving needs of the industry. The evidence suggests that while CBT is effective in developing technical skills, ongoing adjustments are necessary to address specific areas of weakness and to keep pace with technological advancements. This will ensure that vocational education students are not only prepared for their immediate career goals but are also equipped with the adaptability and skills required for long-term success in their professions (Mulder, 2017; Ismail & Hassan, 2013).

Acknowledgement

Publication of this research is made possible through monetary assistance by Universiti Tun Hussein Onn Malaysia via TIER 1 Grant Q420.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Saiful Hadi Masran, Muhammad Hafizul Iskandar Zulkifflie, Shinobu Yume Yamaguchi, Azman Hasan;* ***data collection:*** *Saiful Hadi Masran, Muhammad Hafizul Iskandar Zulkifflie;* ***analysis and interpretation of results:*** *Saiful Hadi Masran, Muhammad Hafizul Iskandar Zulkifflie, Azman Hasan;* ***draft manuscript preparation:*** *Saiful Hadi Masran, Muhammad Hafizul Iskandar Zulkifflie. All authors reviewed the results and approved the final version of the manuscript.*

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