

Welding Technology Education in Malaysian Vocational Colleges towards Developing Graduate Competence and Employability: Issues and Challenges

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DOI Link: <http://dx.doi.org/10.6007/IJARBSS/v16-i9/29115>

Published Date: 30 September 2026

Abstract

This review examines how the Malaysian Vocational Diploma Program (DVM), particularly Welding Technology, contributes to the development of graduate competence and employability. The review focuses on the relationships among curriculum, practical training, industrial training, instructor capabilities, workshop facilities, pedagogy, assessment, and the transition to employment. The evidence indicates that employability rates are insufficient as the sole measure of program success because they do not explain the quality of competence, job alignment, skills utilization, or variations in learning experiences. Malaysian studies generally report high levels of technical competence but also identify weaknesses in infrastructure, communication skills, thinking and problem-solving abilities, career planning, and program alignment with employer requirements. In welding, the required competencies include proficiency in welding processes, safety, quality control, drawing interpretation, and the ability to work in industrial environments. The main challenges include inconsistencies in facilities across colleges, variations in industrial training experiences, inconsistent industry involvement, and reliance on perception-based measures. Existing studies predominantly employ cross-sectional surveys and localized samples rather than longitudinal designs or inter-college comparisons. These limitations constrain causal explanations of differences in outcomes across colleges and cohorts. A more meaningful program evaluation should integrate welding performance measures, implementation observations, employer feedback, and graduate tracking by college and cohort. Such an approach would enable evaluation to move beyond descriptive reporting towards an explanation of how institutional resources and learning experiences contribute to competence development and employment transitions. It would also provide a stronger evidence base for identifying whether observed differences reflect students' prior experiences, variation in program delivery, or the demands of local labor markets.

Keywords: Vocational Education and Training, Welding Technology, Graduate Competence, Graduate Employability, Program Quality

Introduction

The transformation of vocational schools into vocational colleges in Malaysia aims to establish an educational pathway that integrates knowledge, occupational skills, and employability. Within this framework, the Welding Technology program should be evaluated not only by the number of graduates who secure employment but also by their ability to perform welding tasks safely, accurately, and in accordance with established standards, as well as their capacity to adapt to workplace demands. A study on competence in Malaysian vocational colleges defined technical competence as a combination of knowledge, skills, and attitudes and reported high competence levels among Welding Technology students across a sample from three states. However, the survey design and self-reported measures used in the study do not establish whether graduates achieve comparable workplace performance under different workshop and industrial conditions (Kamin, Latib, et al., 2017).

The central problem addressed by this research is the gap between outcome indicators and program implementation mechanisms. A study of vocational college graduates in Johor found that graduates from several programs, including Welding Technology, experienced difficulties in choosing employment, determining the alignment between their programs and career pathways, and identifying the skills required by employers. The same study identified significant differences across colleges in career choices, program alignment, and employer-required skills (Kiong & Zulkifli, 2024). These findings support the assumption that differences in employability may be associated with program implementation contexts rather than solely with individual graduate characteristics.

Employers emphasize communication, thinking, and problem-solving skills among vocational college graduates, while conceptual studies on TVET additionally highlight skills application, self-efficacy, metacognition, entrepreneurship, and soft skills (Ali et al., 2018; Haron et al., 2019). Therefore, employment rates should be interpreted alongside evidence of technical competence, field-of-study alignment, industrial training quality, transferable skills, and graduates' experiences when entering employment. This review consequently treats graduate employability as the outcome of interacting institutional, instructional, technical, and labor-market conditions. The discussion is organized around competence and employability frameworks, curriculum and industry alignment, practical and work-based learning, instructor and pedagogical factors, assessment practices, and graduate transition outcomes. Across these themes, attention is given not only to reported findings but also to the methodological limits that affect the conclusions that can reasonably be drawn from the available evidence.

Competence and Employability Frameworks in the DVM Programme

Employability in the DVM Welding Technology programme should be understood as a multidimensional outcome that extends beyond employment status to encompass technical competence, safety and quality assurance, transferable skills, and the successful transition into relevant employment. Evidence from graduates of the Kuala Langat Industrial Training Institute demonstrates the importance of distinguishing between employment, further education, and alignment between training and occupation. Among 755 respondents, 60.9% were employed, 24.78% continued their studies, 80.48% of employed graduates worked in their field of training, and 6.09% were still seeking employment that matched their skills (Mamat et. al., 2019). These findings suggest that employment rates alone provide an

incomplete picture of programme effectiveness because they do not establish whether graduates secure relevant jobs, utilize their acquired skills, or meet workplace expectations.

For welding graduates, employability depends partly on the ability to demonstrate occupational competence through practical performance rather than theoretical knowledge alone. Essential competencies include understanding welding processes, selecting appropriate parameters and machine settings, following safety procedures, producing acceptable welds, and inspecting completed work. A practical welding assessment model developed through expert interviews and observations incorporated welding parameters, machine settings, occupational safety, weld bead formation, grooves, and American Welding Society (AWS) standards (Ahmad & Rofiq, 2020). Although a Malaysian study reported high levels of student technical competence in Welding Technology, its questionnaire-based findings across three states do not establish consistent mastery of individual competencies across all vocational colleges (Kamin, Latib, et al., 2017). Similarly, although curriculum implementation and industrial training were rated highly in a Malaysian vocational college study, infrastructure was assessed at a moderate level, highlighting the importance of institutional capacity in supporting practical skills development (Noor et al., 2023).

Technical competence must also be integrated with transferable skills that enable graduates to function effectively in workplace environments. Malaysian research on employability indicators in technical and vocational education identified communication, creative and critical thinking, information management, self-management, teamwork, leadership, professional ethics, entrepreneurship, and social skills as relevant dimensions (Hanapi et al., 2018). Communication, thinking, and problem-solving skills have likewise been emphasized from employers' perspectives in studies of vocational college graduates (Haron et al., 2019). In welding occupations, these capabilities are required alongside practical skills because workers must interpret technical drawings and specifications, follow instructions, coordinate with colleagues, identify defects, and communicate concerns relating to product quality and safety. Accordingly, learning activities and assessments should integrate technical execution with decision-making, communication, teamwork, and professional responsibility. Authentic welding tasks that require students to interpret specifications, select parameters, complete work safely, inspect weld quality, and explain their decisions could provide more comprehensive evidence of occupational readiness.

Employability outcomes may also vary across colleges and graduate cohorts because programme implementation occurs under different institutional and labor market conditions. Research involving vocational college graduates in Johor identified differences across colleges in career choices, programme suitability, and employer-required skills, although gender differences were not evident across all dimensions of study-career alignment (Kiong & Zulkifli, 2024). However, these findings do not establish whether variations are caused by differences in workshop facilities, instructor experience, industrial placements, or assessment practices. Similarly, changes in graduate employment outcomes across cohorts may reflect curriculum developments, labor market conditions, student characteristics, or differences in tracking periods rather than programme quality alone.

Therefore, evaluating the DVM Welding Technology programme requires an integrated framework that considers demonstrated technical competence, safety and quality

performance, transferable skills, institutional support, and employment alignment. The use of practical demonstrations, workpiece inspections, structured observations, employer feedback, and graduate employment tracking would provide complementary evidence of programme outcomes. Comparisons across colleges and cohorts should also account for differences in training exposure, resources, assessment practices, and external employment conditions. Such an approach would enable programme effectiveness to be assessed more comprehensively while identifying specific areas for improvement in curriculum delivery, practical training, and graduate preparation for relevant employment.

Curriculum, Industry Alignment, and Programme Direction

Curriculum alignment is essential to the effectiveness of the DVM Welding Technology programme, as occupational preparation depends not only on the relevance of curriculum content but also on the capacity to translate intended learning outcomes into authentic learning experiences. Research on demand–supply mismatches in Malaysian technical and vocational education and training (TVET) identified three areas of misalignment: industry demand and programme provision, student demand and programme provision, and institutional readiness and programme provision (Ibrahim & Nashir, 2022). These dimensions highlight the need to evaluate curriculum alignment at both the design and implementation levels. Although curriculum documents may specify appropriate occupational competencies, students’ opportunities to develop these competencies depend on practical training time, access to equipment, the availability of consumable materials, and exposure to realistic workplace tasks. Similarly, a comparative study of vocational college curricula in Malaysia and Nigeria found that the Malaysian curriculum was more up to date but still required improvements in entrepreneurship skills, suggesting that curriculum revision alone does not guarantee comprehensive preparation for employment (Shuaibu et al., 2019). Accordingly, curriculum evaluation should examine the relevance of welding processes, materials, occupational standards, inspection procedures, and professional skills, alongside the extent to which teaching activities and assessments enable students to demonstrate the expected competencies.

Industry engagement is equally important in ensuring that curriculum content reflects occupational requirements and employer expectations. A study involving 269 industry employers participating in on-the-job training for vocational college students identified communication, thinking, and problem-solving skills as important workplace competencies (Haron et al., 2019). Similarly, research comparing academic and practitioner perspectives highlighted the importance of graduate competencies and the inclusion of practical or industrial training in educational programmes (Salleh et al., 2015). However, employer participation may be constrained by unclear programme objectives, negative graduate attitudes, and limited employer involvement in workforce education and training (Puad & Hazwan, 2018). For DVM Welding Technology, effective collaboration should therefore extend beyond student placements to include curriculum consultation, the review of performance assessment criteria, industrial supervisor feedback, and the identification of emerging occupational requirements. The effectiveness of these partnerships should be evaluated through evidence of employer contributions to curriculum decisions, the implementation of agreed improvements, and the extent to which industrial feedback informs students’ learning experiences.

The relevance of welding curricula must also be considered alongside technological developments, occupational safety, and quality control requirements. A practical welding assessment model identified welding parameters, machine settings, safety procedures, joint formation, grooves, and professional standards as important dimensions of performance assessment (Ahmad & Rofiq, 2020). Research on mechanical programme students in Malaysian vocational colleges also highlighted the importance of monitoring industry requirements, providing facilities that reflect current technologies, and maintaining equipment continuously (Mohd. F. A. Y. Kamin et al., 2018). These findings indicate that curriculum relevance cannot be assessed independently of institutional capacity. Even when appropriate competencies are specified, insufficient equipment, limited consumable materials, or poorly maintained machinery may restrict students' exposure to welding processes and reduce opportunities for repeated practice. Curriculum audits should therefore be accompanied by assessments of equipment availability, maintenance, practical training hours, individual access to machinery, and opportunities to inspect completed welds and identify defects. Such an integrated review would help determine whether the intended curriculum is supported by adequate resources and whether students can develop the technical judgement required to understand the relationship between welding procedures, safety, and finished-product quality.

In addition to technical preparation, career guidance is necessary to help students translate their acquired competencies into employment opportunities. A study of engineering students in Selangor vocational colleges reported moderately high levels of career decision-making and employability skills and recommended integrating career information and guidance into the learning process (Bakry et al., 2020). In contrast, a study involving 330 graduates from 15 Malaysian vocational colleges reported low career readiness and found no significant effect of the measured competency-based learning approach on career readiness (Musa & Rashid, 2020). These findings should be interpreted in relation to differences in study populations, measurement instruments, and definitions of career readiness. Nevertheless, they highlight the importance of distinguishing technical competence from the capacity to navigate the transition into employment. DVM Welding Technology students should receive guidance on occupational pathways, additional certifications, work portfolios, job interviews, salary expectations, geographical mobility, and the communication of their skills to prospective employers. Career preparation should be integrated into programme delivery rather than postponed until graduation, enabling students to make informed decisions about employment and further training.

Overall, curriculum and industry alignment in DVM Welding Technology should be evaluated through the interaction of four dimensions: curriculum relevance, meaningful employer engagement, institutional capacity to support practical learning, and career preparation. The presence of appropriate curriculum documents, industry partnerships, workshop facilities, or career guidance activities does not independently demonstrate programme effectiveness. Instead, evaluation should establish whether these components provide students with sufficient opportunities to develop, demonstrate, and communicate occupational competencies. Attention should be given to the quality and distribution of practical training, access to equipment, supervision, exposure to varied welding tasks, and the use of employer feedback to improve teaching and assessment. By examining both intended provision and actual learning experiences, programme evaluation can identify implementation gaps and

provide a clearer understanding of how curriculum design, institutional resources, and industry collaboration contribute to graduate competence and employability.

Practical Training, Workshops, and Work-Based Learning

Practical training and work-based learning are essential components of the DVM Welding Technology programme because occupational competence develops through repeated practice, appropriate supervision, feedback, and exposure to authentic workplace tasks. However, the effectiveness of these learning experiences depends on the availability of workshop infrastructure, the quality of industrial placements, the relevance of assigned tasks, and the provision of safe and equitable training opportunities. A study involving 116 instructors from Malaysian vocational colleges, including Welding Technology, found that curriculum implementation and industrial training were rated highly, whereas infrastructure was rated at a moderate level (Noor et al., 2023). Similarly, a conceptual model of mechanical programme readiness involving 566 students and 75 lecturers highlighted the importance of technical competence, teaching methods, infrastructure, and workshop tools and equipment, recommending continuous monitoring of industry requirements, technological updates, and equipment maintenance (Mohd. F. A. Y. Kamin et al., 2018). These findings suggest that the presence of workshop facilities alone does not establish their adequacy. Evaluation should also consider equipment functionality, student-to-machine ratios, the availability of consumable materials and personal protective equipment, ventilation, maintenance arrangements, and actual practical training hours. Such indicators would help determine whether institutional resources provide sufficient opportunities for students to practice repeatedly, correct errors, and develop consistent welding techniques.

Industrial training provides an opportunity to connect classroom learning with occupational practices, but its contribution to competence depends on the relevance of assigned tasks and the quality of workplace supervision. Research on work-based learning in Malaysia identified logistical, accommodation, and safety challenges in an automotive training programme, although the findings were drawn from a sector other than welding (Kamin, 2010). A study of industrial training at the University of Malaya also found that some trainee tasks were not aligned with students' fields of study and highlighted the importance of continuous industry feedback, English proficiency, and soft skills (Pillai et al., 2011). These findings indicate that completing an industrial placement does not necessarily demonstrate that students have acquired relevant occupational competencies. For DVM Welding Technology, evaluation should establish the types of welding tasks performed, the processes and equipment encountered, the level of responsibility assigned, the extent of direct technical practice, and the feedback received from workplace supervisors. Clear learning outcomes should be established before placements begin, with regular monitoring to ensure that assigned activities correspond to programme requirements and provide meaningful opportunities to apply previously acquired knowledge.

The quality of industrial placements must also be distinguished from the existence of formal partnerships between colleges and employers. Research on workplace training has highlighted the importance of evaluating workplace learning environments and using mentor feedback to improve programme implementation and understand students' skills development (Theerasak & Khampirat, 2019). Although instructors in Malaysian vocational colleges rated industrial training highly, these perceptions do not necessarily reflect students'

actual performance or the assessments of workplace supervisors (Noor et al., 2023). Differences in placement quality may arise when students receive varying levels of supervision, encounter different ranges of occupational tasks, or have unequal opportunities to practice technical procedures. Consequently, programme evaluation should combine college records, student reports, industrial supervisor assessments, and evidence of completed work. Relevant indicators include task alignment, exposure to welding processes, the frequency and quality of feedback, student participation, adherence to occupational standards, and the completeness of assessment records. Triangulating these sources would provide a more comprehensive understanding of whether industrial training contributes to the competencies expected of welding graduates.

Safety and equitable access further influence the effectiveness of practical training. Logistical and safety concerns identified in Malaysian work-based learning research highlight the need to consider the conditions under which students participate in workplace learning (Kamin, 2010). In welding education, safety is an integral component of occupational competence, as reflected in a practical assessment model that includes machine settings and occupational safety alongside technical performance (Ahmad & Rofiq, 2020). Students therefore need to demonstrate their ability to identify hazards, use appropriate protective equipment, follow workshop procedures, and recognize situations requiring corrective action. Equitable training also requires sufficient access to machinery, materials, supervision, and relevant industrial tasks. Students following the same curriculum may nevertheless experience different learning opportunities if equipment is unavailable, practical sessions are limited, or placements provide unequal exposure to welding activities. Accordingly, evaluation should examine not only whether training and safety provisions exist but also whether they are consistently implemented and accessible to all students.

Overall, effective practical training and work-based learning depend on the interaction between adequate infrastructure, repeated hands-on practice, relevant industrial tasks, effective supervision, and safe learning environments. Programme evaluation should move beyond recording the availability of facilities or the completion of industrial placements to examining the actual learning opportunities provided and the competencies demonstrated by students. Comparisons across vocational colleges should incorporate consistent indicators of equipment access, practical training exposure, placement quality, supervisory feedback, and safety performance. This evidence would help identify gaps between intended training provision and students' actual experiences, enabling targeted improvements in workshop management, industrial collaboration, and the preparation of graduates for welding occupations.

Instructors, Pedagogy, and Learning Experiences

Instructors play a central role in translating curriculum requirements into meaningful learning experiences and measurable student competencies in the DVM Welding Technology programme. Effective implementation requires both pedagogical competence and up-to-date technical knowledge of industry practices. A study of technical and vocational education and training graduates employed in Malaysian secondary schools and vocational colleges reported high levels of professional knowledge, skills, and practice, although some elements remained at moderate levels and required continuous improvement (Ridzwan et al., 2017). Similarly, research on teaching in mechanical engineering programmes at Malaysian vocational colleges

recommended stronger collaboration with industry and instructor training in effective teaching methods and current occupational requirements (Kamin, Saud, et al., 2017). These findings highlight the need for continuous professional development that integrates technical updating, pedagogical improvement, assessment moderation, occupational safety, and exposure to emerging technologies. Professional development should be evaluated not only through participation records but also through evidence of improved teaching practices, assessment quality, and students' practical performance. Collaborative lesson planning, peer observation, shared assessment rubrics, and industry engagement could further support consistency in instructional practices across colleges.

The effectiveness of pedagogy also depends on how successfully theoretical knowledge is transferred into practical performance. Welding instruction should integrate demonstrations, guided practice, repeated attempts, constructive feedback, and opportunities for students to explain technical decisions and diagnose defects. A practical welding assessment model identified multiple performance dimensions, including welding parameters, machine settings, occupational safety, weld formation, grooves, and professional standards, indicating that competence involves more than a single general measure (Ahmad & Rofiq, 2020). Accordingly, teaching approaches should enable students to understand the relationships between welding procedures, equipment settings, safety requirements, and the quality of completed joints. Practical activities could require students to select appropriate parameters, perform welding tasks, inspect their work, identify defects, and recommend corrective actions. However, the effectiveness of teaching methods should be established through evidence rather than assumed from their use. Classroom observations, practical performance records, student work samples, and structured assessments would help determine whether teaching activities provide sufficient opportunities for students to develop technical reasoning and occupational competence.

Student motivation, discipline, and engagement also contribute to competence development, although positive attitudes and self-reported readiness should not be treated as direct evidence of occupational performance. A study of engineering students in Selangor vocational colleges reported moderately high employability skills and emphasized the importance of career exposure in supporting career decisions (Bakry et al., 2020). Similarly, a study of technical students from six vocational colleges in Johor reported high self-assessments of knowledge, skills, and attitudes (Heong et al., n.d.). Nevertheless, students' perceptions of their readiness may differ from their demonstrated ability to meet workplace requirements relating to weld quality, accuracy, safety, and task completion. Evaluation should therefore combine questionnaire responses with practical demonstrations, observations, and work samples. It should also consider attendance, persistence, responsiveness to feedback, previous experience, and adherence to workshop procedures when examining differences in student outcomes. Importantly, student engagement must be considered alongside institutional conditions because motivation alone cannot compensate for inadequate facilities, limited practice opportunities, or insufficient instructional support.

Communication and self-directed learning are additional components of effective preparation for welding occupations. Industry employers have identified communication, thinking, and problem-solving as important competencies among vocational college graduates (Haron et al., 2019), while research on Malaysian industrial training has highlighted the need to

strengthen English proficiency and soft skills (Pillai et al., 2011). In welding workplaces, these capabilities support the interpretation of technical instructions, understanding of occupational documents, completion of inspection records, reporting of defects, participation in safety briefings, and communication with supervisors. Consequently, technical language should be integrated into workshop activities rather than treated exclusively as a component of general education. Students could be assessed through tasks requiring them to interpret technical drawings, explain parameter selections, document inspection findings, and communicate safety risks. Self-directed learning should also be encouraged so that students can consult technical documents, seek clarification, evaluate their work, and identify areas for improvement. Practical demonstrations, technical reports, observed communication tasks, and reflective records would provide evidence of these capabilities beyond general self-assessments.

Overall, instructor capabilities, pedagogical practices, student engagement, and communication support are interconnected factors in the development of occupational competence. Effective teaching requires instructors to combine current technical knowledge with systematic instructional strategies, while students need opportunities to practice, receive feedback, solve problems, and communicate their decisions in authentic technical contexts. Programme evaluation should therefore examine the relationship between instructional practices and demonstrated learning outcomes rather than relying solely on perceptions of teaching quality or student readiness. Integrating evidence from classroom observations, practical assessments, work samples, and communication tasks would provide a more comprehensive understanding of how learning experiences contribute to graduate competence and employability. Such an approach would also help identify whether differences in student performance are associated with instructional practices, student characteristics, or the resources available to support learning.

Assessment, Performance Standards, and Evidence of Competence

Competency-based assessment is essential for determining whether students in the DVM Welding Technology programme can demonstrate the technical and professional capabilities required for employment. A practical welding assessment model developed through a research and development process incorporated performance levels, aspects, indicators, descriptions, and scores across five domains: welding parameters, machine settings and safety, weld beads, grooves, and American Welding Society (AWS) standards (Ahmad & Rofiq, 2020). This multidimensional structure provides more informative evidence than a single overall grade because it identifies specific strengths and weaknesses requiring improvement. Assessment should therefore examine both the welding process and the quality of the finished product, including the procedures followed, decisions made, compliance with safety requirements, and ability to identify and address defects. Detailed assessment rubrics can help instructors provide specific feedback, monitor individual progress, and distinguish weaknesses associated with technical knowledge, practical technique, machine settings, materials, or training conditions. Systematic records of practical performance, identified defects, feedback, and subsequent improvements would further support the evaluation of competence development.

The validity and consistency of assessment decisions are equally important when comparing student performance across vocational colleges. A study of Welding Technology students in

three Malaysian states reported high levels of technical competence, although the findings did not establish whether practical assessment standards had been standardized or moderated across institutions (Kamin, Latib, et al., 2017). Meanwhile, research involving Malaysian vocational college instructors found that infrastructure was rated at a moderate level, raising questions about whether students have equivalent opportunities and conditions for demonstrating their competencies (Noor et al., 2023). These findings highlight the need for aligned assessment rubrics, assessor training, shared performance exemplars, moderation procedures, and appropriate assessment resources. External assessment and reliability checks could provide additional evidence of consistency between internal grading decisions and established occupational standards. Nevertheless, differences in assessment results should be interpreted alongside the conditions under which students are assessed, because variations in equipment, materials, and practical training opportunities may influence performance. Recording these conditions would help distinguish differences in demonstrated competence from limitations associated with the learning environment.

Assessment should also incorporate occupational safety, quality control, and diagnostic ability as interconnected dimensions of welding competence. The practical welding assessment model developed by Ahmad and Rofiq (2020) treats safety and technical standards as integral components of performance, while research on employer requirements emphasizes communication and problem-solving skills among vocational college graduates (Haron et al., 2019). Consequently, producing an acceptable weld under controlled conditions may not provide sufficient evidence of readiness for occupational tasks. Students should also demonstrate their ability to select appropriate parameters, follow safety procedures, inspect completed joints, identify defects, explain possible causes, recommend corrective actions, and document inspection results. Safety should be evaluated throughout the work process because an acceptable finished product does not, by itself, establish that the task was performed safely. Integrating these dimensions into practical assessments would provide a more comprehensive representation of students' ability to apply technical knowledge, exercise professional judgement, and respond appropriately to problems encountered during welding activities.

Although competence development is conceptually associated with employability, the available evidence does not establish a direct relationship between practical welding assessment results and graduates' subsequent employment outcomes. A study involving students in business programmes at Malaysian vocational colleges reported a significant positive relationship between competence development and employability skills, while academic achievement did not moderate this relationship (Omar et al., 2024). However, this evidence comes from business programmes and cannot be assumed to apply directly to Welding Technology. Existing studies have examined technical competence through questionnaire-based measures and graduate outcomes through indicators such as career choices, programme suitability, and alignment between training and employment (Kamin, Latib, et al., 2017; Kiong & Zulkifli, 2024). Without linked student-level or cohort-level data, it remains unclear whether higher practical assessment scores are associated with employment in relevant occupations, shorter job-search periods, or greater utilization of acquired skills. Future evaluation should therefore connect students' practical assessment records, industrial training performance, and graduate employment information to investigate these relationships more directly.

Overall, effective assessment of the DVM Welding Technology programme requires a combination of valid performance criteria, consistent assessment practices, diagnostic feedback, and evidence of graduate outcomes. Evaluation should move beyond overall grades or self-reported competence to examine observable technical performance, safety compliance, product quality, problem-solving ability, and consistency with occupational standards. These measures should be linked, where possible, to industrial training experiences and subsequent employment outcomes. Graduate tracking should distinguish programme completion, readiness for job seeking, entry into employment, employment in a relevant occupation, utilization of acquired skills, and employment retention, as these represent different stages of the transition from education to work. Such an integrated approach would provide a stronger evidence base for identifying assessment gaps, improving practical training, and determining how effectively the programme prepares graduates for welding-related employment.

Graduate Transition, Job Alignment, and Variations in Outcomes

Graduate transition provides an important indication of how effectively the DVM Welding Technology programme prepares students for employment. However, readiness for employment should be distinguished from demonstrated competence and actual labor market outcomes. A study involving 300 final-year technical students from six vocational colleges in Johor reported high self-assessment scores for knowledge, skills, and attitudes, suggesting that students perceived themselves as ready to enter the workforce (Heong et al., n.d.). In contrast, a study involving 330 graduates from 15 Malaysian vocational colleges reported low levels of career readiness (Musa & Rashid, 2020). These findings may reflect differences in the timing of measurement, study populations, and assessment instruments rather than a direct contradiction. Students' confidence before graduation may differ from their experiences when seeking employment and responding to workplace expectations. Therefore, evaluating DVM Welding Technology requires a distinction between perceived readiness, verified technical competence, and actual employment outcomes. Relevant indicators include time taken to secure employment, employment in welding-related occupations, utilization of acquired skills, additional training requirements, job retention, and employer evaluations. Career preparation should also address recruitment requirements, technical portfolios, practical demonstrations, and the ability to communicate competencies to prospective employers.

Employment outcomes must also be examined in relation to occupational alignment and the actual utilization of acquired skills. Research involving vocational college graduates in Johor identified difficulties concerning programme–career alignment and the competencies required by employers (Kiong & Zulkifli, 2024). Similarly, a study of graduates from the Kuala Langat Industrial Training Institute distinguished between employment status, further education, employment in the field of training, and continued searches for suitable jobs (Mamat et. al., 2019). These findings demonstrate the importance of examining employment relevance rather than relying exclusively on aggregate employment rates. For welding graduates, employment in manufacturing or another industrial sector does not necessarily indicate that welding competencies are being applied in daily work. Graduates may undertake welding, fabrication, inspection, maintenance, or production-related tasks, with different levels of relevance to their training. Graduate tracking should therefore examine actual job responsibilities, welding processes performed, opportunities to apply acquired competencies,

and employers' assessments of graduate preparedness. Comparing these findings with the competencies assessed during training would help establish whether the programme prepares students for the tasks they encounter after graduation.

Variations across colleges and graduate cohorts further complicate the interpretation of employability outcomes. A Malaysian study involving 234 graduates from Electrical, Electronics, Welding, Construction, and Automotive programmes across the 2020–2022 cohorts identified differences across colleges in career choices, programme suitability, and employer-required skills (Kiong & Zulkifli, 2024). However, because the study covered several programmes and used a survey design, the findings do not establish whether these differences resulted from institutional practices, programme characteristics, geographical location, local industrial opportunities, or cohort composition. Similarly, the Kuala Langat Industrial Training Institute study provided information on employment, field alignment, and salaries within one institution but did not establish equivalent comparisons across colleges and cohorts (Mamat et al., 2019). Longitudinal research using consistent measures would therefore be necessary to investigate variations over time. Such research should account for institutional resources, training experiences, student characteristics, local labor market conditions, and the time elapsed since graduation. Employment outcomes measured shortly after graduation should also be distinguished from those measured after longer periods, as graduates may enter employment at different stages of their transition from education to work.

Employability rates remain useful for monitoring graduate destinations, but they cannot independently establish programme effectiveness or causal relationships between training and employment. Graduate outcomes may be influenced by economic conditions, geographical location, industrial opportunities, social networks, further education decisions, and individual circumstances. The Kuala Langat Industrial Training Institute study illustrates this complexity by distinguishing employment, further education, permanent employment, employment in the field of training, and continued job searching as separate outcomes (Mamat et al., 2019). Consequently, differences in employment rates across vocational colleges should not be interpreted as direct evidence of differences in programme quality without considering relevant contextual factors. A more comprehensive evaluation of DVM Welding Technology should connect institutional inputs, teaching and training processes, demonstrated competence, transferable skills, and subsequent employment outcomes. For example, graduates may possess adequate technical competence but encounter difficulties securing relevant employment because of limited local opportunities or insufficient career guidance. Alternatively, graduates may obtain jobs but require additional training because their practical experience does not fully correspond with workplace expectations. These situations represent different challenges and require separate investigation.

Overall, graduate transition should be evaluated as a sequence of interconnected outcomes, encompassing programme completion, perceived readiness, demonstrated competence, entry into employment, occupational alignment, skills utilization, and employment retention. Integrating graduate tracking with practical assessment results, industrial training records, and employer feedback would provide a stronger evidence base for understanding the relationship between training experiences and employability. Comparisons across colleges and cohorts should incorporate institutional and labor market conditions to distinguish

programme-related factors from external influences. This integrated approach would enable the identification of specific gaps in technical preparation, practical training, career guidance, and employment alignment, providing a more informative basis for improving the DVM Welding Technology programme than reliance on a single employability percentage.

Synthesis of Issues and Challenges in Welding Technology Program

Although previous studies have examined TVET graduate employability, technical competency development and the implementation of vocational training, several gaps remain. In particular, the extent to which findings from general TVET and engineering contexts apply specifically to DVM Welding Technology requires further examination. Limited evidence also remains regarding the relationship between demonstrated welding competence, the quality of industrial training, programme delivery conditions and graduates' actual employment outcomes. These gaps are synthesized in Table 1.

Table 1

Synthesis of Major Research Gaps

Research gap	Evidence from the reviewed literature	Recommended research direction
1. Limited welding-specific evidence	Several studies combine Welding Technology with other technical programmes (Kiong & Zulkifli, 2024; Noor et al., 2023).	Investigate DVM Welding Technology separately, including welding processes, occupational standards, safety, and employment outcomes.
2. Gap between perceived and demonstrated competence	High competence levels were reported using questionnaire measures, while welding assessment models specify observable performance criteria (Ahmad & Rofiq, 2020; Kamin, Latib, et al., 2017).	Combine self-assessments with practical tests, standardised rubrics, workpiece inspections, and supervisor evaluations.
3. Limited longitudinal evidence	Existing studies provide graduate outcomes or cohort comparisons but offer limited evidence of individual changes over time (Kiong & Zulkifli, 2024; Mamat et. al., 2019).	Track students from enrolment through graduation and into employment, using consistent measures across stages.
4. Unclear relationships between institutional inputs and outcomes	Infrastructure, curriculum implementation, and industrial training have been examined, but their relationships with welding performance and employment remain unclear (Noor et al., 2023; Mohd. F. A. Y. Kamin et al., 2018).	Examine how facilities, instructor capabilities, and training quality relate to competence and employment, while accounting for contextual factors.
5. Industrial training quality is insufficiently differentiated from participation	Research identifies logistical and safety challenges and possible mismatches between placement tasks and students' fields of study (Kamin, 2010; Pillai et al., 2011).	Develop and validate indicators of placement quality, including task relevance, supervision, feedback, safety, and welding-process exposure.
6. Limited linkage between competence and actual employment	Competence and employability have been studied in different programme contexts, while graduate studies report employment and job-alignment outcomes separately (Omar et al., 2024; Kiong & Zulkifli, 2024).	Link individual practical assessment records and industrial training experiences with employer evaluations, job alignment, skills utilization, and employment retention.

Taken together, these research gaps indicate the need for a more integrated examination of welding programme quality, institutional and training conditions, demonstrated technical

competence and graduate employability. Attention should be given to distinguishing self-reported readiness from objectively assessed competence and to examining whether graduates obtain employment aligned with their training. This synthesis establishes the rationale for the present review.

Conclusion

The review indicates that the challenges facing the DVM Welding Technology program in Malaysia extend beyond the employment rates of graduates. The central challenges concern how programs translate curriculum requirements into sufficient practical training, quality industrial training, valid assessment, and competencies valued by employers. Employability rates should be interpreted alongside job alignment, competence utilization, safety, quality control, communication, and problem-solving skills. The available evidence supports three conclusions. First, a foundation of technical competence exists within the vocational college system, but the predominant measurement approaches are insufficient to demonstrate practical performance and consistency across colleges. Second, infrastructure, industrial experience, employer involvement, pedagogy, and career guidance may help explain differences in graduate outcomes. Third, existing studies have not yet established longitudinal relationships between program implementation factors and graduate outcomes specifically in Welding Technology.

Accordingly, the most important research priority is to conduct comparative studies across colleges and cohorts that integrate facility audits, teaching observations, industrial training records, rubric-based competence tests, employer feedback, and graduate tracking. This approach would establish not only whether the program produces employed graduates but also how program experiences develop competence and under what conditions that competence can be applied in the workplace. In practical terms, program improvement would benefit from a shared monitoring framework across participating colleges. Core indicators could include equipment availability and functionality, student access to practical sessions, instructor professional development, the relevance and supervision of industrial placements, moderated welding performance, transferable skills, and graduate job alignment. Common indicators should be supplemented by contextual information so that differences between colleges are interpreted carefully rather than treated automatically as evidence of performance differences.

The contribution of this review is therefore to frame DVM Welding Technology employability as a connected system of inputs, learning processes, assessed competencies, and post-graduation outcomes. The next step is not simply to collect more perception data, but to link multiple sources of evidence at student, program, college, and cohort levels. Such a design would offer a more strong basis for identifying improvement priorities while recognizing the influence of wider employment conditions.

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