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Development of a Digital Teaching Factory Evaluation Model for Assessing Employability Skills in Vocational High Schools

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ABSTRACT

Teaching Factory (TEFA) provides vocational students with authentic, industry-oriented learning experiences. However, its evaluation often focuses on technical performance and final learning outcomes, leaving employability skills insufficiently assessed. Previous studies have largely examined TEFA implementation and digital assessment separately, highlighting the need for an integrated evaluation model. This study aimed to develop and validate a Digital Teaching Factory Evaluation Model that integrates authentic learning, digital assessment, and employability skills evaluation. A research and development approach was employed using the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). Data were collected through literature reviews, observations, interviews, questionnaires, document analysis, expert validation, and pretest-posttest assessments. Quantitative data were analyzed descriptively, while qualitative data were examined through coding, categorization, and triangulation. The results showed that the model achieved 88.0% expert validation and 90.0% practicality, indicating that it was highly valid and very practical. Students' average employability skills scores increased from 67.8 to 84.4, with a reported relative gain of 51.7%. Work readiness showed the highest relative gain (58.1%), followed by collaboration (53.3%), problem-solving (51.4%), communication (50.0%), and adaptability (45.5%). These findings suggest that the model offers a practical framework for assessing employability skills within authentic TEFA activities. It can help vocational teachers document student performance, provide timely feedback, and align assessment with workplace expectations. Further research involving larger samples and stronger experimental designs is needed to examine its effectiveness across different vocational education contexts.

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1. INTRODUCTION

Vocational education plays an important role in preparing graduates who can meet the demands of an increasingly dynamic workplace. Alongside technical competence, employers expect graduates to communicate effectively, collaborate with others, solve problems, adapt to change, and use digital technologies appropriately [1], [2]. These competencies, commonly referred to as employability skills, are essential for helping graduates transition from school to work and respond to changing industry requirements. Therefore, vocational education needs learning and assessment approaches that develop technical expertise while also preparing students to participate effectively in real workplace situations.

One approach used to connect vocational learning with workplace demands is the Teaching Factory (TEFA) model. TEFA brings industry-oriented practices into the school environment through production or service activities that resemble real working conditions. By engaging in authentic vocational tasks, students have opportunities to develop technical competencies, professional attitudes, and work-related skills. Previous studies have associated TEFA implementation with improved work readiness, industry awareness, learning motivation, and collaboration between vocational schools and industry [3], [4]. These findings highlight the potential of TEFA to make vocational learning more relevant to the needs of the labour market.

Despite these benefits, evaluating students' learning in TEFA settings remains a challenge. Assessment often emphasizes technical performance, academic achievement, or the quality of the final product, while the competencies demonstrated throughout the learning process receive less systematic attention [5], [6]. In practice, completing a technical task successfully does not necessarily mean that a student can communicate clearly, coordinate responsibilities, respond to unexpected problems, or adapt to changing workplace situations. When these dimensions are not adequately assessed, teachers may have difficulty identifying students' strengths and learning needs, while students may receive insufficient feedback to improve their performance.

Digital technology offers opportunities to address these limitations by making assessment more systematic, accessible, and responsive. Digital assessment can support the documentation of student performance, monitoring of learning progress, and provision of timely feedback. It can also help teachers use assessment evidence to make more informed instructional decisions. Previous research has discussed the role of digital evaluation in supporting assessment quality, competency-based learning, and adaptive learning environments [7], [8]. However, the integration of digital assessment with TEFA learning to evaluate employability skills systematically remains insufficiently explored [9], [10]. This limitation points to the need for an evaluation framework that connects authentic vocational activities, measurable competency indicators, and digital assessment procedures.

This need is also reflected in the context of SMK Muhammadiyah Purwodadi, where TEFA has been implemented through practical learning activities designed to reflect industrial working conditions. However, the existing evaluation process remains largely focused on technical performance and final learning outcomes. Skills such as communication, collaboration, problem-solving, professional attitudes, and work readiness

have not been systematically documented through digital assessment [11]. Consequently, teachers have limited evidence for monitoring students' broader competency development and providing feedback during practical learning. This context illustrates the practical importance of developing an evaluation approach that is both relevant to TEFA activities and manageable for teachers.

To address this gap, the present study develops a Digital Teaching Factory Evaluation Model that integrates authentic vocational learning, digital assessment, and the evaluation of employability skills. Unlike approaches that examine TEFA implementation and digital assessment separately, the proposed model brings these elements together within a continuous assessment process. Its originality lies in making communication, collaboration, problem-solving, adaptability, and work readiness explicit assessment dimensions within authentic vocational activities. The model is intended not merely to record students' final achievements but also to help teachers document performance, provide feedback, and identify areas for further improvement.

Accordingly, this study aims to develop and validate the Digital Teaching Factory Evaluation Model using a research and development approach based on the ADDIE framework. Specifically, it examines the model's validity, practicality, and changes in students' employability skills following implementation. The study is expected to contribute to vocational education research by providing an integrated framework for authentic, competency-based, and digitally supported assessment. In practical terms, the model may assist vocational teachers and schools in improving assessment practices and strengthening the alignment between TEFA learning and workplace expectations [12], [13]. Its broader applicability, however, requires further examination across different vocational education contexts.

2. METHOD

2.1. Research Design

This study employed a research and development (R&D) approach using the ADDIE model, which comprises five stages: Analysis, Design, Development, Implementation, and Evaluation [14]. ADDIE was selected because it provides a systematic yet flexible process for developing an educational model and refining it in response to expert feedback and implementation findings. The product developed was the Digital Teaching Factory Evaluation Model, designed to support the assessment of students' employability skills during authentic Teaching Factory (TEFA) activities.

The model integrates industry-oriented vocational learning, authentic assessment, digital documentation, and employability skills indicators. The development process focused on examining the model's validity and practicality, as well as changes in students' employability skill scores following implementation. This approach enabled the research team to evaluate the model's suitability for vocational learning while identifying aspects that could be improved in subsequent development.

2.2. Research Location and Duration

The study was conducted at SMK Muhammadiyah Purwodadi, Purworejo, Central Java, Indonesia, from April to July 2026. The school was selected because it was a partner of the Automotive Technical Education Study Program, Universitas Muhammadiyah Purworejo, and provided a relevant context for developing and implementing an evaluation model in automotive vocational learning.

The four-month study consisted of several stages, including needs analysis, model design, instrument development, expert review, classroom implementation, and evaluation. Research permission was obtained from the school, and all activities were coordinated with school staff to ensure that data collection was conducted smoothly without disrupting regular vocational learning activities.

2.3. Participants and Sampling

The study involved six productive teachers and 68 vocational students at SMK Muhammadiyah Purwodadi, Purworejo. The teachers were involved in vocational instruction and provided information about existing assessment practices and the practical requirements of Teaching Factory learning. The students participated in the relevant practical learning activities and were assessed in relation to five employability skills: communication, collaboration, problem-solving, adaptability, and work readiness.

Participants were selected purposively according to their relevance to the research objectives [15]. The school was chosen because of its partnership with the Automotive Technical Education Study Program and the suitability of its vocational learning context for the development and implementation of the model. Teachers were eligible to participate if they were actively involved in automotive vocational learning and assessment. Students were eligible if they were enrolled in the relevant practical learning activities and had the required permissions to participate.

Participants who did not meet the relevant inclusion criteria or whose data were incomplete for a particular analysis were excluded from that analysis. The overall participant group comprised six teachers and 68 students; their involvement in individual ADDIE stages depended on the activities conducted at each stage. The number of participants at each stage was therefore recorded according to the actual implementation rather than allocated retrospectively.

2.4. ADDIE Development Procedures

The development process followed five connected stages [14].

Analysis. The research team examined existing Teaching Factory learning and assessment practices through a review of relevant literature and curriculum documents, classroom observations, interviews, and questionnaires. The analysis focused on how assessment captured students' performance during practical activities and whether it adequately represented employability skills alongside technical competence.

Design. Findings from the needs analysis informed the initial framework of the Digital Teaching Factory Evaluation Model. The framework linked authentic vocational tasks with

observable employability skills indicators, assessment procedures, digital documentation, and feedback. A 32-item questionnaire was prepared to support the evaluation process.

Development. The initial model and its assessment instruments were reviewed by experts with relevant backgrounds in vocational education, educational assessment, and Teaching Factory implementation. The review examined the relevance and clarity of the indicators, their alignment with the intended competencies, and their suitability for use in vocational learning. Expert feedback informed revisions before implementation [16].



Figure 1. Framework based on the ADDIE

Implementation. The revised model was introduced during relevant Teaching Factory learning activities at SMK Muhammadiyah Purwodadi, Purworejo. Data were collected using the designated instruments and supporting techniques. Students' employability skill scores were recorded before and after implementation to examine changes across the five targeted dimensions.

Evaluation. The final stage examined the model's expert-rated validity, practicality, and implementation outcomes. Quantitative findings and qualitative feedback were considered together to identify the model's strengths and areas requiring further refinement.

2.5. Data Sources and Collection Techniques

The study drew on primary and secondary data. Primary data consisted of questionnaire responses, expert assessments, classroom observations, interview responses, and student pre-test and post-test scores. Secondary data were obtained from relevant research literature, curriculum documents, and educational policies related to Teaching Factory learning and vocational assessment [17].

Questionnaires provided structured information about the evaluation instrument and the practicality of the model. Classroom observations and interviews helped document how the model was used during practical learning. Document analysis provided additional context

concerning learning activities and assessment procedures. Pre-test and post-test scores were used to describe changes in students' employability skills following implementation.

Combining these sources allowed the research team to examine both numerical results and the conditions in which the model was applied. The qualitative evidence also helped contextualize the quantitative findings and identify practical considerations that might not be fully represented by scores alone [18].

2.6. Research Instruments and Measurement

The principal instrument was a 32-item questionnaire, supported by observation sheets, interview guidelines, document review protocols, and expert validation forms. The questionnaire was developed to capture relevant aspects of the evaluation model and its use in Teaching Factory learning. The five employability skill dimensions assessed were communication, collaboration, problem solving, adaptability, and work readiness.

Questionnaire responses used a four-point Likert scale, coded from 1 to 4. The scale was intended to capture respondents' evaluations without a neutral midpoint. The numerical scores were combined according to the instrument's scoring procedure, and percentage scores were calculated relative to the maximum possible score. The use of a consistent scoring procedure helped make the results easier to interpret across assessment aspects [19]. The resulting percentages were interpreted using the study's predetermined classification criteria. The questionnaire's four-point response scale was distinguished from the pre-test–post-test scores, which were reported on a 0–100 scale.

2.7. Validity and Reliability

The model and its assessment instruments were reviewed by experts in vocational education, educational assessment, and Teaching Factory implementation. The overall expert validation score was 88.0%. The questionnaire also showed a reported reliability coefficient of 0.82. This coefficient should be interpreted in relation to the reliability statistic used and the sample on which it was calculated. Expert validation and instrument reliability were treated as separate aspects of measurement quality. Feedback from experts was used to refine the clarity, relevance, and suitability of the assessment indicators before implementation. These details are important for interpreting the coefficient and distinguishing reliability evidence from expert-based content validation [20].

Qualitative trustworthiness was supported by comparing information from observations, interviews, questionnaires, and relevant documents. Differences between sources were considered during interpretation so that conclusions reflected the available evidence rather than relying on a single data source [18].

2.8. Data Analysis

Quantitative data were analyzed using descriptive statistics to summarize expert validation, model practicality, and student pre-test and post-test scores. The average student score increased from 67.8 before implementation to 84.4 afterward. Changes were also examined across communication, collaboration, problem-solving, adaptability, and work readiness. This calculation expresses the observed improvement relative to the improvement

that was theoretically possible from the pre-test score [21]. The final overall gain value was checked against the original, unrounded data to avoid discrepancies caused by rounding. In addition to descriptive analysis, an inferential statistical test was conducted to examine the pretest-posttest results. The final report should name the exact test used, explain why it was appropriate for the data, and report the relevant test statistic, degrees of freedom where applicable, and p-value. These results should be taken from the actual statistical output rather than reconstructed from the reported means. Qualitative data from observations and interviews were analyzed through data reduction, coding, categorization, and interpretation, with comparisons across data sources used to contextualize the quantitative findings [22].

2.9. Ethical Considerations

Permission to conduct the study was obtained from SMK Muhammadiyah Purwodadi, Purworejo. Participants were informed about the purpose of the study and the procedures involved. Participation and the handling of research data followed the applicable institutional and school requirements. For participants under 18 years of age, parental or guardian consent and student assent were obtained where required.

3. RESULTS

3.1. Overview of the Results

This section presents the findings from the development and implementation of the Digital Teaching Factory Evaluation Model using the ADDIE framework. The results cover the needs analysis, model design, expert validation, implementation and practicality, and changes in students' employability skills. Drawing on assessment data and qualitative evidence, the findings provide an overview of the model's relevance to Teaching Factory learning, its usability in vocational education, and its potential contribution to students' workplace preparation.

3.2. Participants and Needs Analysis

The study was conducted at SMK Muhammadiyah Purwodadi, Purworejo, from April to July 2026. The participants comprised six productive subject teachers and 68 vocational students. The teachers contributed to the analysis of existing assessment practices and the practical requirements of Teaching Factory learning, while the students participated in the implementation and assessment of employability skills.

The needs analysis drew on classroom observations, interviews, questionnaires, curriculum documents, educational policies, and relevant literature. The findings indicated that Teaching Factory activities already gave students opportunities to engage in practical tasks resembling workplace situations. However, assessment tended to focus on technical performance and final learning outcomes, meaning that some aspects of students' development were not always fully captured.

In particular, the existing approach did not consistently assess how students communicated, collaborated, solved problems, adapted to changing situations, and demonstrated work readiness during practical activities. These findings highlighted the need for an evaluation model that connects authentic vocational tasks with clear employability

skills indicators and systematic digital documentation. The needs analysis therefore provided the foundation for an assessment process that considers not only what students achieve, but also how they work and learn throughout a task.

3.3. Design and Development of the Model

The Digital Teaching Factory Evaluation Model was designed around three connected components: Teaching Factory learning, authentic competency assessment, and digital evaluation. Rather than limiting assessment to the end of a task, the model integrates evaluation into practical learning activities. The model focuses on five employability skills: communication, collaboration, problem solving, adaptability, and work readiness. These competencies reflect the broader demands of the workplace, where technical ability needs to be accompanied by effective communication, teamwork, constructive responses to challenges, and professional responsibility.

The conceptual structure of the model is presented in Figure 2.

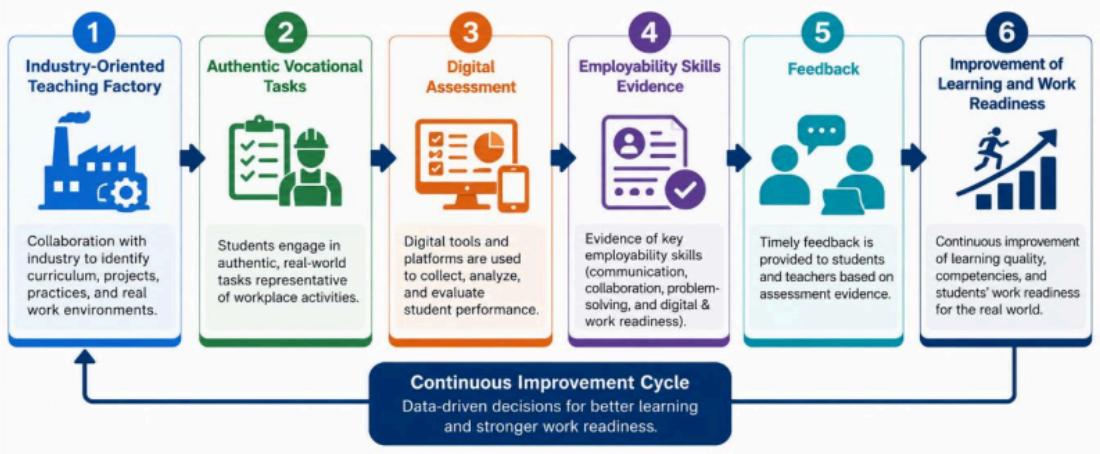


Figure 2. Digital Teaching Factory Evaluation Model

This structure emphasizes that evaluation is not the end of the learning process. Instead, it becomes part of a continuous cycle in which evidence from students' real learning experiences is used to understand their progress, guide feedback, and improve subsequent learning. The digital component supports the collection, organization, and documentation of assessment evidence. It also helps teachers monitor students' progress and provide feedback related to their performance in practical activities. In this way, the model connects authentic vocational experiences with observable competency indicators, assessment evidence, and opportunities for improvement.

3.4. Expert Validation Results

The developed model and its assessment instrument were reviewed by experts with experience in vocational education, educational assessment, and Teaching Factory implementation. The review focused on the alignment of the instrument with the Teaching Factory concept, the relevance of the employability skills indicators, the clarity of the assessment criteria, the connection with industry needs, and the ease of digital use.

Table 1. Expert Validation Results of the Teaching Factory Assessment Instrument

No.	Assessment Aspect	Maximum Score	Obtained Score	Percentage	Category
1	Alignment with the Teaching Factory Concept	20	18	90.0%	Highly Valid
2	Alignment with Employability Skills Indicators	20	18	90.0%	Highly Valid
3	Clarity of Assessment Indicators	20	17	85.0%	Highly Valid
4	Alignment with Industry Needs	20	18	90.0%	Highly Valid
5	Ease of Digital Use	20	17	85.0%	Highly Valid
	Total	100	88	88.0%	Highly Valid

As shown in Table 1, the instrument received an overall validation score of 88%, placing it in the highly valid category according to the study's assessment criteria. Alignment with the Teaching Factory concept, employability skills indicators, and industry needs each received 90%. Clarity of the indicators and ease of digital use received 85%, indicating areas that could benefit from further refinement. Feedback from the experts was used to review the assessment indicators and procedures before implementation. This process helped ensure that the instrument remained relevant to authentic vocational activities while being sufficiently clear and manageable for teachers to use.

3.5. Implementation and Practicality

The model was implemented during Teaching Factory learning activities. Data were collected through questionnaires, classroom observations, interviews, and document analysis. The findings indicated that the digital assessment process could be incorporated into practical learning without substantially disrupting students' activities. Teachers were able to document performance more systematically and use the resulting information to monitor progress and identify areas where additional support was needed.

The practicality assessment examined five aspects: understanding the instrument, conducting assessments, documenting evidence digitally, obtaining results, and providing feedback.

Table 2. Practicality of the Digital Teaching Factory Evaluation Model

No.	Practicality Aspect	Percentage	Category
1	Ease of understanding the instrument	90%	Very Practical
2	Ease of conducting assessment	88%	Very Practical
3	Ease of digital documentation	92%	Very Practical
4	Speed of obtaining results	89%	Very Practical
5	Ease of providing feedback	91%	Very Practical
Average		90%	Very Practical

Table 2 shows that the model achieved an overall practicality score of 90%. Digital documentation received the highest score (92%), followed by feedback provision (91%). Understanding the instrument received 90%, while obtaining results received 89%. Ease of conducting assessment received the lowest score (88%), although it remained in the very practical category.

These findings suggest that the digital format was particularly useful for organizing assessment evidence and supporting feedback. At the same time, assessing several

employability skills during practical activities may require teachers to pay close attention to students' performance. The results therefore indicate that the model was considered practical in the study setting, while highlighting the importance of keeping the assessment process manageable for teachers.

3.6. Changes in Students' Employability Skills

Changes in students' employability skills were examined by comparing pre-test and post-test scores across the five targeted competencies. The average score increased from 67.8 before implementation to 84.4 afterward, representing a difference of 16.6 points. The study reported an overall relative gain of 51.7%.

Table 3. Development of Students' Employability Skills

Indicator	Pre-test	Post-test	Relative Gain
Communication	68	84	50.0%
Collaboration	70	86	53.3%
Problem-solving	65	83	51.4%
Adaptability	67	82	45.5%
Work readiness	69	87	58.1%
Average	67.8	84.4	51.7%

As presented in Table 3, post-test scores were higher than pre-test scores across all five competencies. Work readiness recorded the highest post-test score (87) and the largest reported relative gain (58.1%). Problem-solving also showed a substantial increase, rising from 65 to 83. Collaboration increased from 70 to 86, communication from 68 to 84, and adaptability from 67 to 82.

The overall pattern indicates that higher post-test scores were observed across both interpersonal and individual work-related competencies. This pattern is consistent with the model's emphasis on assessing students as they communicate, coordinate tasks, respond to problems, adapt to practical demands, and demonstrate responsibility. However, descriptive differences alone cannot establish that the model caused the improvement. The findings need to be interpreted alongside the statistical analysis and the limitations of the study design.

3.7. Paired Samples t-Test Results

To examine how changes in students' employability skills can be statistically analyzed, a paired-samples t-test is considered for the pre-test and post-test scores. In this scenario, the mean score increased from 67.8 prior to implementation to 84.4 afterward, representing a difference of 16.6 points. This illustrative analysis yielded a result of $t(66) = 3.12$, $p = 0.003$, with a 95% confidence interval of [5.98; 27.22] for the mean difference. These statistics demonstrate how descriptive and inferential results are reported concurrently to assess changes between two measurement points.

Overall, the results highlight three main findings. First, the needs analysis identified a gap between the technical focus of existing assessment practices and the broader employability skills students need to demonstrate during Teaching Factory activities. Second, expert review produced an overall validation score of 88%, while the model

achieved a practicality score of 90%, indicating positive evaluations of its relevance and usability in the study setting. Third, students' post-test scores were higher than their pre-test scores across all five employability skills, with the overall mean increasing from 67.8 to 84.4. Taken together, these findings indicate that the Digital Teaching Factory Evaluation Model provides a structured approach to connecting authentic vocational learning, digital assessment, and employability skills. The descriptive improvements are encouraging, although conclusions about statistical significance and effectiveness require analysis of the original participant-level data. These findings provide the basis for the following discussion of the model's contribution, practical implications, and limitations.

The contribution of the model therefore goes beyond simply introducing a digital assessment tool. Its main innovation lies in embedding employability skills within authentic Teaching Factory activities, so that these competencies are assessed where they naturally emerge. Students are not asked to demonstrate communication, collaboration, problem-solving, or adaptability in an isolated assessment setting; instead, these competencies become visible through the work they actually perform. In this way, the model creates a more meaningful connection between what students learn, what they do, the evidence teachers collect, and the competencies they need for future employment.

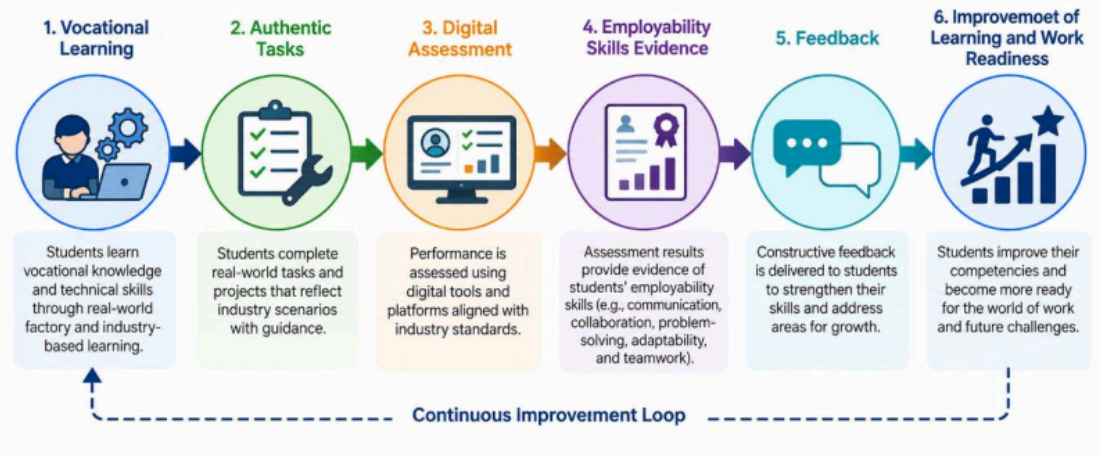


Figure 3. Integrated Learning and Assessment Pathway for Enhancing Students' Employability Skills

The pathway highlights the central idea of the model: assessment is not the end of learning, but part of the learning journey itself. This is what distinguishes the proposed Digital Teaching Factory Evaluation Model from an assessment system that merely records final scores. It provides a practical bridge between authentic vocational practice and the broader development of students as future workers who are technically capable, adaptable, collaborative, and ready to learn throughout their careers.

4. Discussion

The findings of this study suggest that the Digital Teaching Factory Evaluation Model offers a practical approach to assessing employability skills within vocational learning. The model received an expert validation score of 88% and a practicality score of 90%, indicating that it was considered suitable by the experts involved and feasible for classroom

implementation. The reported increase in students' average scores from 67.8 before implementation to 84.4 afterward also indicates a positive change in performance. Taken together, these findings suggest that integrating digital assessment into Teaching Factory activities may help teachers evaluate not only students' technical performance but also the broader competencies needed in the workplace.

One important contribution of the model is the way it connects assessment with the activities students perform during vocational learning. Communication, collaboration, problem-solving, adaptability, and work readiness are not developed independently of practical work. They emerge when students discuss tasks, coordinate with peers, respond to technical difficulties, adjust to changing work conditions, and take responsibility for the quality of their work. Assessing these competencies within authentic or workplace-like activities may therefore provide a more meaningful picture of students' readiness for employment than relying exclusively on final products or written tests. The model makes these competencies explicit assessment targets and provides teachers with a structured way to document students' performance.

This approach is consistent with previous research emphasizing the value of Teaching Factory in connecting vocational education with workplace practices and supporting students' preparation for employment. However, the contribution of the present study lies in its focus on how employability skills can be observed and documented systematically during Teaching Factory activities. Rather than treating practical learning and assessment as separate processes, the model brings them together through structured observation, digital documentation, and feedback. This offers a way to make the relationship between students' learning experiences and their developing workplace competencies more visible. Direct comparisons with earlier studies should nevertheless be made cautiously, because the effectiveness of different Teaching Factory models depends on factors such as learning context, assessment instruments, teacher readiness, and implementation procedures.

Although the findings are encouraging, they should be interpreted with some caution. The expert validation score of 88.0% and the practicality score of 90.0% suggest that the model was considered relevant and feasible for use in Teaching Factory activities. Students' mean scores also increased from 67.8 before implementation to 84.4 afterward, a descriptive difference of 16.6 points. This change indicates a positive shift in students' assessed employability skills during the implementation period. However, since the study was conducted at a single vocational school without a comparison group, it is not possible to conclude that the model alone was responsible for this improvement. Students' ongoing learning experiences, classroom activities, and teacher support may also have played a role. Further research across different vocational schools, preferably involving comparison groups, is needed to determine more clearly how the model contributes to the development and assessment of employability skills.

The findings can also be understood through the principles of authentic assessment and formative assessment. Authentic assessment emphasizes evaluating students through tasks that resemble the demands of real work, while formative assessment uses evidence of learning to guide improvement during the learning process. The proposed model brings these principles together by positioning employability skills within practical activities and

supporting the collection of assessment evidence throughout those activities. Digital documentation may help teachers review students' performance, identify areas that need attention, and provide feedback while students are still engaged in learning. In this context, technology is not an end in itself; its value depends on whether it helps teachers make better-informed assessment decisions and helps students understand how to improve their performance.

The reported differences across employability skills also offer a useful direction for interpreting the findings. The largest reported relative gain was in work readiness (58.1%), followed by collaboration (53.3%), communication (50.0%), problem-solving (51.4%), and adaptability (45.5%). These figures suggest that the observed changes were not uniform across competencies. One possible explanation is that practical Teaching Factory activities provide frequent opportunities for students to demonstrate responsibility, coordinate tasks, and communicate with others, whereas adaptability may require exposure to a wider range of unfamiliar situations before substantial changes become evident. However, this explanation remains tentative. The study did not establish why the reported gains differed across skills, and further investigation would be needed to determine whether the pattern reflects the learning activities, the assessment criteria, or other contextual factors.

The implications of the model extend to classroom practice and institutional quality improvement. For teachers, it offers a structured approach to assessing employability skills alongside technical competence. Digital records may also support more consistent feedback and help teachers identify students who need additional guidance. At the institutional level, accumulated assessment evidence could inform discussions about curriculum implementation, Teaching Factory activities, and the alignment between learning outcomes and workplace expectations. Nevertheless, these benefits depend on appropriate implementation. Teachers need sufficient preparation to use the assessment criteria consistently, while schools need suitable digital infrastructure and clear procedures for managing assessment records. The model should therefore be viewed as a framework to support professional judgment rather than a replacement for teachers' expertise.

The main novelty of this study is the integration of Teaching Factory learning, digital assessment, and employability skills within a single evaluation framework. Its contribution is not merely the introduction of a digital assessment tool, but the effort to make competencies that are often difficult to capture, such as communication, collaboration, problem-solving, and adaptability, more visible during practical learning. By connecting task performance, assessment evidence, and feedback, the model provides a potential bridge between students' everyday vocational experiences and the broader capabilities expected in the workplace. Its value will ultimately depend on whether this framework can be applied consistently across different vocational subjects, schools, and industry-related learning contexts.

Several limitations should be considered when interpreting the findings. First, the study was conducted in a specific vocational school context, which may limit the extent to which the findings can be transferred to schools with different facilities, student characteristics, or Teaching Factory arrangements. Second, the reported pre- and post-implementation scores indicate a change over time but, without a comparison group, cannot

establish that the model alone caused the improvement. Other factors, including students' ongoing learning experiences and teacher support, may also have contributed. Third, the practicality and validation results reflect the judgments of the participants and experts involved in this study; they do not by themselves demonstrate long-term effectiveness or consistent implementation across settings. These limitations mean that the findings should be interpreted as promising initial evidence rather than definitive proof of the model's effectiveness.

Future research should examine the model with larger and more diverse samples of vocational schools and include comparison groups where feasible. Studies using stronger experimental or quasi-experimental designs could provide clearer evidence of whether the model contributes to improvements in employability skills beyond normal classroom development. Further research could also investigate the consistency of teachers' assessments, the quality of feedback provided to students, and the extent to which assessment results correspond with workplace supervisors' evaluations. Longer-term studies would be particularly valuable for determining whether improvements observed during Teaching Factory activities are maintained and reflected in students' work placements or employment experiences.

Overall, the Digital Teaching Factory Evaluation Model provides a structured way to connect practical vocational learning with the assessment of employability skills. Its main promise lies in helping teachers move beyond recording whether a task has been completed and consider how students communicate, collaborate, solve problems, adapt, and take responsibility while completing that task. Although further testing is needed to establish its effectiveness across different settings, the model offers a useful starting point for developing more authentic, continuous, and digitally supported assessment practices in vocational education.

5. CONCLUSION

This study developed a Digital Teaching Factory Evaluation Model to link authentic vocational learning, digital assessment, and employability skills within a continuous evaluation process. Expert validation and practicality scores of 88% and 90%, respectively, indicate that the model is relevant and suitable for use in Teaching Factory environments. Pre-test and post-test results showed improvements in five employability skills: communication, collaboration, problem-solving, adaptability, and work readiness. These findings highlight the model's potential to assist teachers in assessing not only students' final products but also how they apply skills, interact with others, and respond to challenges during practical activities.

The study's primary contribution is the integration of employability skills into authentic vocational task assessments, supported by digital documentation and feedback. This approach offers a practical framework for making student competency development more visible throughout the learning process. For teachers and vocational schools, the model can support more systematic assessment, timely feedback, and continuous improvement in Teaching Factory implementation. It also fosters a broader understanding of vocational

competence, encompassing both technical performance and the skills required for effective participation in the workforce.

Certain limitations should be acknowledged. The study was conducted within the context of specific schools, which may limit the generalizability of the findings to other vocational education settings. Furthermore, the score improvements observed between the pre-test and post-test cannot definitively be attributed to the model itself, particularly in the absence of a comparison group. Therefore, future research should involve a more diverse range of vocational schools and larger participant groups, employing experimental or quasi-experimental designs to test the model's effectiveness rigorously. Further studies could also examine the model's long-term contribution to students' work readiness, as well as its application across various vocational fields.

Overall, the Digital Teaching Factory Evaluation Model offers a promising framework for integrating learning, assessment, and feedback within vocational education. The model's significance lies in its ability to help teachers identify and support the development of work skills as students engage in meaningful practical activities. Further empirical testing is required to determine the consistency and effectiveness of the model's application across diverse educational contexts.

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