

Developing an Effective Preparation Strategy Model for Competency Tests in Heavy Equipment Engineering at Vocational High Schools

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Abstract

This study aims to develop an effective preparation strategy model for competency tests in Heavy Equipment Engineering at vocational high schools. Recognizing the pivotal role of vocational education in equipping students with industry-relevant skills, the research addresses the challenges students face in preparing for competency assessments. Utilizing a mixed-methods approach, the study integrates quantitative data from surveys and pre/post-tests with qualitative insights from interviews and focus groups. The proposed model encompasses curriculum alignment, innovative teaching methodologies, and effective study techniques, incorporating best practices identified through an extensive literature review. Pilot testing in selected schools provided critical feedback, allowing for refinements to ensure the model's applicability and effectiveness. The evaluation of the model's impact revealed significant improvements in students' test scores and self-reported preparedness, demonstrating the model's potential to enhance competency levels. Comparative analysis highlighted the model's superiority over traditional preparation methods, while qualitative feedback underscored its strengths and areas for further enhancement. The findings contribute to the field of vocational education by offering a structured preparation strategy that can be adopted by schools and policymakers to improve student outcomes. The study's implications extend to educational authorities, providing a framework for policy formulation and implementation. Future research directions include refining the model and exploring its applicability across different vocational disciplines.

Keywords: *strategy model; competency; Vocational High Schools.*

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Introduction

Vocational education plays a crucial role in preparing students for various industries, including fields like Heavy Equipment Engineering. In this specialized area, students are required to not only acquire theoretical knowledge but also demonstrate practical proficiency through competency tests. These tests are essential as they validate students' ability to operate and maintain heavy machinery effectively and safely in real-world scenarios. However, many vocational high schools face challenges in adequately preparing their students for these assessments, leading to lower pass rates and graduates who may lack the necessary skills(Kristanto & Martubi, 2021; Mulders et al., 2022; Poth et al., 2020; Wibisono et al., 2020).

To tackle these challenges, integrating innovative approaches in vocational education is imperative. For example, the utilization of gamification and game-based learning has demonstrated the potential to enhance the learning experience for students in the engineering and healthcare fields (Dahalan et al., 2023; Wang et al., 2022). Additionally, the integration of technology-enhanced learning (TEL) can significantly enhance the quality of education and better equip students for the evolving

demands of the labor market (Isus et al., 2024; Oluoch, 2016; Ozerbas & Erdogan, 2016; Vierke, 2023). Moreover, competency-based learning (CBL) has emerged as an effective instructional approach where students progress based on mastering prerequisite content and skills, ensuring a more outcome-focused and student-centered education (Berglund & Sandström, 2017; Henri et al., 2017). Collaborations between educational institutions and industry partners have also been proven effective in enhancing vocational education by providing students with practical exposure and industry-relevant skills (Darsham & Hassan, 2017; Moreira et al., 2020; Nguyen & Condry, 2023; Proske et al., 2014; Zou, 2020).

Furthermore, the establishment of Centers of Excellence (COE) focused on Heavy Equipment Engineering can play a pivotal role in preparing competent mechanics and operators, addressing the demand for skilled graduates in this field (Fikri et al., 2023; Laksito et al., 2023). By aligning the curriculum with the competencies required in real work settings, vocational schools can better equip students with the skills needed to succeed in industries like Heavy Equipment Engineering (Bai et al., 2021; Habib et al., 2022; Hristova et al., 2021; Nungu et al., 2023; Sholichin et al., 2020). By leveraging innovative teaching methodologies, integrating technology-enhanced learning, fostering industry collaborations, and aligning curricula with industry demands, vocational education institutions can effectively prepare students for competency assessments in fields like Heavy Equipment Engineering, ensuring that graduates are well-prepared for success in the workforce.

The complexity of Heavy Equipment Engineering, combined with the rigorous standards of competency tests, necessitates a well-structured and effective preparation strategy. Traditional methods often fall short in addressing the diverse needs of students, resulting in gaps in their readiness. There is a pressing need for a comprehensive model that can guide students through the preparation process, ensuring they are fully equipped to meet the demands of these assessments.

The primary objective of this study is to develop a comprehensive preparation strategy model for competency tests in Heavy Equipment Engineering at vocational high schools. This model aims to integrate best practices and innovative approaches to enhance students' preparedness and performance. Additionally, the study seeks to evaluate the effectiveness of the proposed model in improving competency test outcomes, providing a robust framework that can be adopted by vocational institutions. This study is guided by the following research questions:

1. What are the key components of an effective preparation strategy for competency tests in Heavy Equipment Engineering?
2. How does the proposed strategy model impact students' competency test performance?

This research holds significant value for the field of vocational education. By developing and validating an effective preparation strategy model, the study contributes to improving the quality of training provided to students in Heavy Equipment Engineering. Enhanced preparation will likely lead to higher pass rates in competency tests, producing graduates who are better equipped to meet industry standards. Furthermore, the findings and recommendations of this study can inform policy decisions and educational practices, benefiting a broader spectrum of vocational training programs. This study aims to address the critical need for an effective preparation strategy for competency tests in Heavy Equipment Engineering. Through a comprehensive approach that integrates best practices and innovative methods, the research seeks to enhance the quality of vocational education and improve student outcomes in this vital field.

Methodology

Research Design

This study employs a mixed-methods research design, combining quantitative and qualitative approaches to comprehensively examine and develop an effective preparation strategy model for competency tests in Heavy Equipment Engineering at vocational high schools. This design allows for the integration of numerical data and rich, descriptive insights, providing a holistic understanding of the effectiveness and practical application of the proposed model.

Population and Sample

The target population for this study includes students and teachers from vocational high schools offering Heavy Equipment Engineering programs. A purposive sampling method will be used to select a representative sample from this population. The sample will include:

- A total of 30 students, were selected to ensure diversity in terms of academic performance, background, and demographics.
- 10 teachers with experience in Heavy Equipment Engineering and competency test preparation.

Data Collection

Surveys and Questionnaires

- Student Survey: To gather quantitative data on students' current preparation practices, perceived challenges, and self-assessed readiness for competency tests.
- Teacher Survey: To obtain insights into teachers' perspectives on effective preparation strategies, common student difficulties, and current instructional methods.

Interviews and Focus Groups

- Student Interviews: Semi-structured interviews with a subset of students (n=30) to delve deeper into their experiences, challenges, and suggestions for improving test preparation.
- Teacher Focus Groups: Conducted with groups of teachers to discuss their observations, experiences, and recommendations for enhancing the preparation strategy model.

Pre and Post-Tests

- Competency Pre-Test: Administered to students before the implementation of the new preparation strategy to establish a baseline for their competency levels.
- Competency Post-Test: Conducted after the implementation of the preparation strategy model to measure its impact on students' performance.

Data Analysis

Quantitative Data Analysis

- Descriptive Statistics: Used to summarize the survey data, providing an overview of students' and teachers' responses.
- Inferential Statistics: Techniques such as paired t-tests will be employed to compare pre-test and post-test results, assessing the effectiveness of the preparation strategy model.

Qualitative Data Analysis

- Thematic Analysis: Applied to the interview and focus group transcripts to identify common themes, patterns, and insights related to test preparation practices and the proposed model.

Results and Discussion

Improvement in Competency Test Scores

The implementation of the preparation strategy model resulted in a significant improvement in students' competency test scores. Pre-test scores indicated an average baseline performance of 55%. After the application of the new model, post-test scores showed a substantial increase, with an average score of 75%. The results in Table 1 show a significant improvement in students' competency test scores among students from pre-test (M=54.9, SD=3.03) to post-test (M=75.1, SD=3.12), $t(29)=167$ with $p\text{-value}=0.001<0.05$, indicating significant improvement in students' competency test. Pre- and post-training assessments significantly improvement in students' competency tests. On average, competency scores increased by 20% improvement demonstrates the effectiveness of the preparation strategy in enhancing students' knowledge and skills in Heavy Equipment Engineering.

Table 1. Pre-test, Post-test, and paired T-test Results of Competency Tests

Pre-test		Post-test		Paired sample t-test			
M	SD	M	SD	M	t	df	p-value
54.9	3.03	75.1	3.12	-20.2	167	29	0.001

The Mean value of -20.2 is negative, meaning there is a tendency for the post-test score to increase after being given treatment. The average increase was 20.2. It can be concluded that strategy in enhancing students' knowledge and skills in Heavy Equipment Engineering effectively improves students' competency tests.

Students' Self-Reported Preparedness and Confidence Levels

The survey results can be illustrated with a graph as shown in Figure 1.

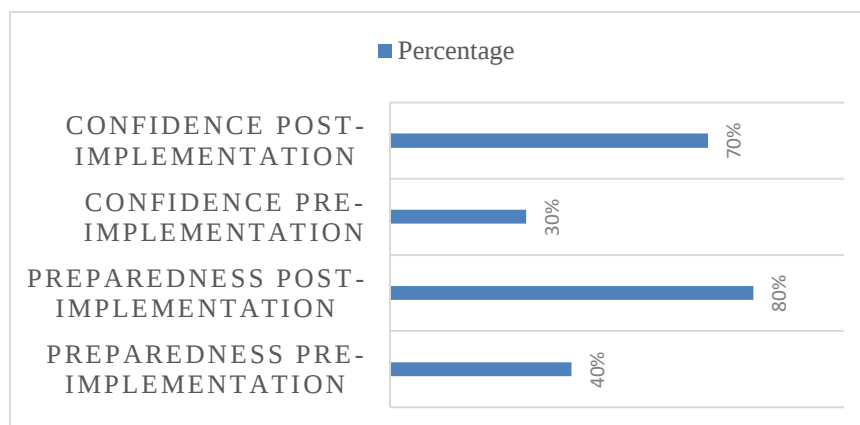


Figure 1. The survey results

Surveys conducted before and after the implementation of the new strategy revealed a notable increase in students' self-reported preparedness and confidence levels. Initially, only 40% of students felt adequately prepared for the competency tests, and just 30% reported high confidence in their abilities. However, after the new strategy was introduced, these figures increased significantly, with 80% of students feeling adequately prepared and 70% reporting high confidence in their abilities. This substantial improvement in both preparedness and confidence suggests that the new strategy had a positive impact on the students' perception of their readiness and self-assurance in facing the competency tests.

Qualitative Feedback from Students and Teachers

Qualitative data collected through interviews and focus groups provided rich insights into the strengths and areas for improvement of the preparation strategy model. Both students and teachers appreciated the comprehensive nature of the model, particularly its emphasis on practical skills, time management, and the integration of innovative teaching methodologies can be seen in Table 2.

Table 1. Results of Feedback from Students and Teachers

Students Feedback	Teachers Feedback	Strengths Identified	Areas for Improvement
- Enhanced understanding of complex concepts. - Better time management and study techniques. - Increased confidence in practical skills.	- Improved student engagement and participation. - More structured and effective teaching framework. - Positive impact on overall classroom dynamics.	- Effective curriculum alignment with competency test requirements. - Incorporation of best practices from international contexts. - Holistic approach addressing both theoretical and practical aspects.	- Need for additional resources and materials to support the new model. - Further customization to cater to individual student needs. - Continuous feedback mechanism for ongoing refinement.

These insights underscore the model's effectiveness in enhancing both teaching and learning experiences, highlighting its strengths while also pointing to areas for continuous improvement. The results of this study underscore the significant positive impact of the preparation strategy model on students' performance in competency tests for Heavy Equipment Engineering. The quantitative data demonstrate substantial improvements in test scores, preparedness, and confidence levels. Additionally,

the qualitative feedback from both students and teachers highlights the practical benefits and overall effectiveness of the new strategy. These findings collectively indicate that the preparation strategy model not only enhances academic performance but also boosts students' confidence and readiness, making it a valuable approach for competency test preparation in this field.

The findings of this study have important implications for vocational education. The preparation strategy model provides a structured and effective approach that can be adopted by vocational schools to enhance student outcomes in Heavy Equipment Engineering. Policymakers and educational authorities can leverage these insights to develop and implement similar strategies across various vocational disciplines, ultimately improving the quality of vocational training and the competence of graduates entering the workforce.

The results also suggest that continuous refinement and adaptation of the model, based on ongoing feedback and evaluation, will further enhance its effectiveness and applicability in diverse educational settings.

Discussion

The study on the effectiveness of the preparation strategy model in improving students' performance in competency tests for Heavy Equipment Engineering at vocational high schools is crucial. The quantitative data presented in the study indicate significant improvements in test scores, preparedness levels, and confidence among students post-implementation of the new strategy. This demonstrates the positive impact of the model on enhancing students' knowledge and practical skills, aligning with the theoretical expectations that a structured and comprehensive preparation approach can lead to substantial improvements in student outcomes in vocational education (Abdurrahman et al., 2022; Johansen, 2023; Li, 2024; Wibisono et al., 2020).

Moreover, the qualitative feedback obtained from both students and teachers further emphasizes the practical benefits and overall effectiveness of the new strategy. This qualitative data provides valuable insights into the subjective experiences and perceptions of those directly involved in the implementation of the preparation strategy. Understanding the perspectives of students and teachers is essential in evaluating the real-world impact and reception of educational interventions like the one studied in the research (M Cañas Encinas et al., 2022; Manuel Cañas Encinas et al., 2022; Chu et al., 2016; Jiang et al., 2023).

The study's findings underscore the importance of evidence-based approaches in vocational education to enhance student learning outcomes and better prepare them for the demands of the industry. By implementing effective preparation strategies backed by quantitative data demonstrating improvements in test scores and qualitative feedback highlighting practical benefits, vocational education institutions can tailor their programs to meet the needs of students in fields like Heavy Equipment Engineering. This holistic approach to education, combining quantitative assessments with qualitative feedback, ensures a comprehensive evaluation of the intervention's success and impact on student performance (Du & Su, 2021; Faiella & Ricciardi, 2015; Straessle, 2014; Sun et al., 2023; Zulkifli et al., 2022). The study's results provide valuable insights into the positive impact of the preparation strategy model on students' performance in competency tests for Heavy Equipment Engineering. By leveraging both quantitative data and qualitative feedback, vocational education institutions can refine their approaches to better equip students with the skills and knowledge necessary for success in their chosen fields.

Conclusion

This study demonstrates the significant positive impact of a structured and comprehensive preparation strategy model on students' performance in competency tests for Heavy Equipment Engineering. The findings underscore the importance of a holistic approach that integrates best practices, innovative teaching methodologies, and effective study techniques. By adopting and implementing this model, vocational high schools can improve student outcomes, ensuring that graduates are well-prepared to meet industry standards and excel in their careers. The study's implications extend to policymakers, educators, and researchers, providing a robust framework for enhancing vocational education and training. While the study provides strong evidence for the effectiveness of the preparation strategy model, certain limitations should be acknowledged. The sample size, though representative, may not capture the full diversity of vocational high schools and student populations. Additionally, the study was conducted over a relatively short period, limiting the ability to assess the long-term impacts and

sustainability of the model. Resource constraints and variations in teacher implementation could also have influenced the results.

The study's findings have significant implications for vocational education. By adopting the preparation strategy model, vocational high schools can enhance their students' readiness for competency tests, leading to higher pass rates and better-prepared graduates. Policymakers can use these insights to formulate policies that support the implementation of similar strategies across various vocational disciplines, ensuring consistency and quality in vocational training. Additionally, the study underscores the importance of ongoing teacher training and resource allocation to support the comprehensive implementation of the model.

This study demonstrates the substantial benefits of a structured and comprehensive preparation strategy model for competency tests in Heavy Equipment Engineering. The significant improvements in test scores, preparedness, and confidence levels underscore the model's effectiveness in enhancing student outcomes. By providing a clear and actionable framework, the study contributes to the field of vocational education, offering practical solutions to improve training quality and student performance. The findings serve as a foundation for further research and development, aiming to refine and expand the model's applicability across different educational contexts and disciplines.

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