JPPIPA 11(1) (2025)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Effective Solutions for Implementing Android-Based Computer-Based Testing (CBT) In Vocational High Schools as A Digital Assessment Innovation

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Received: November 22, 2024
Revised: December 27, 2024
Accepted: January 24, 2025
Published: January 31, 2025

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DOI: 10.29303/jppipa.v11i1.10155

Abstract: The rapid development of information technology currently demands a transformation in the education assessment system, especially in Vocational High Schools (SMK). One of the challenges faced is the limited facilities and infrastructure such as computer laboratories that are not comparable to the number of students, so that the implementation of computer-based test (CBT) is less than optimal. The aim is to develop an Android-based CBT assessment system that is integrated with the Case Method in the Business Economics subject in SMK. This innovation is designed so that students can take exams anytime and anywhere, without being constrained by limited computer devices or internship schedules. The ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development method with the Waterfall Development Model approach to build the system. The developed system was validated by material and media experts, followed by small-scale and large-scale trials on class XI students of SMK Negeri 14 Medan. This Android-based CBT system is effective and feasible to use. In terms of usability, this system received a positive response from students, with high scores on indicators of ease of use, speed of access, and time efficiency. The integration of Case Method- based questions has also been shown to improve students' understanding in solving real problems in the field of Business Economics. The CBT system based on Android integrated with Case Method is able to be an effective solution to overcome the limitations of facilities and infrastructure in vocational schools. The implications provide significant contributions in supporting the digitalization of education and improving the quality of learning evaluation in schools.

Keywords: Android; Computer-based test; Case Method; Learning Evaluation; Vocational High School

Introduction

The rapid advancement of information and communication technology has significantly transformed the education sector, particularly in learning and evaluation methods (Hori and Fujii, 2021). Innovations such as Computer-Based Testing (CBT) have been introduced to enhance the efficiency of assessing student learning outcomes (Sobers et al., 2023). However, the implementation of CBT in vocational high schools (SMK) faces challenges, including limited infrastructure, inadequate computer availability, and insufficient internet access, particularly in remote areas (Pandey, 2023).

Key challenges in implementing CBT include limited internet access, affecting 67% of schools, and the need for flexibility for internship students, impacting 60% (Nguyen et al., 2023. Other issues involve infrastructure limitations (52.7%), unvalidated Case Method questions (48%), resistance to change among schools (40%), and a gap in technological understanding among teachers (35%) (Huh, 2023). These challenges highlight the necessity for solutions focusing on infrastructure improvement, internet connectivity,

How to Cite:
Siregar, T. M., Armanto, D., Frisnoiry, S., & Ruslan, D. (2025). Effective Solutions for Implementing Android-Based Computer-Based Testing (CBT) In Vocational High Schools as A Digital Assessment Innovation. *Jurnal Penelitian Pendidikan IPA*, *11*(1), 623–633. https://doi.org/10.29303/jppipa.v11i1.10155

question validation, and digital literacy training (Zainal et al., 2023).

Despite these challenges, the increasing trend of smartphone usage among students in Indonesia, which reached 83.41% in 2023, presents an opportunity to leverage mobile technology for educational purposes (Daryanto et al., 2023). This widespread access to smartphones provides a practical platform for implementing Android-based CBT systems, allowing exams to be conducted flexibly and efficiently (Touloupis et al., 2023). This approach not only addresses the technological gap but also supports the modernization of educational assessments in the digital era (Karampatakis et al., 2023).

Integrating the Case Method into the CBT system can enhance students' critical thinking and problem-solving skills by providing real-world scenarios for analysis (Nansumba et al., 2023; Taha & Barukab, 2022). Previous studies have demonstrated the effectiveness of CBT systems in accelerating exam evaluations and reducing errors (Furukawa et al., 2023), However, they often fail to consider the specific needs of vocational schools, such as limited facilities and the necessity for flexible assessments for internship students (Lutfi & Alqudah, 2023).

Computer-Based Testing (CBT) is an innovative assessment method that replaces traditional paper-based systems by utilizing technology to enhance efficiency in exam administration, processing, and evaluation (Kamaludin, 2023). CBT offers significant advantages, such as reducing exam time through automatic corrections, minimizing subjectivity in grading, and decreasing the use of physical resources like paper and ink. Features such as question randomization and time limits help reduce cheating and provide flexible exam settings, both locally and remotely (Rajiha, Salatiga and Rini, 2023). However, implementing CBT in educational institutions, particularly in Vocational High Schools (SMK), faces challenges, including inadequate computer labs and unstable internet connectivity in remote areas (Taha and Salim, 2023).

To address these challenges, developing Android-based CBT systems presents a promising solution. The Android platform offers flexibility, high accessibility, and operational capabilities, making it suitable for widespread use among students who commonly own smartphones (Fridayanti et al., 2018). This approach not only mitigates infrastructure limitations but also supports the modernization of educational assessments in the digital era, enhancing accessibility and practicality (Febriana et al., 2022).

Android-based CBT represents an innovative advancement in Computer-Based Testing, designed for mobile device access via the Android operating system. As an open-source platform, Android simplifies the development of educational applications, offering a practical alternative to conventional computer-based CBT (Abas et al., 2023), With the rapid growth of Android technology and its availability across various devices, it is particularly suitable for educational settings, especially in Vocational High Schools (SMK), where computer facilities are limited but students typically own smartphones (Tadayon et al., 2022). Android-based CBT provides advantages such as portability, cost savings, time efficiency, reduced cheating, and flexible implementation. It enhances students' competencies in both theory and practice, integrating Case Method-based questions to encourage problem analysis (Szeto et al., 2023). This system not only addresses facility limitations but also elevates the quality of technology-oriented learning (Nicosia et al., 2023).

Despite the efficiency and effectiveness of Computer-Based Testing (CBT), its implementation in Vocational High Schools (SMK) faces challenges, including technical, economic, and human resource issues. Schools often lack sufficient computers (Flygare et al., 2022) and stable internet is essential for online CBT (Batchelor et al., 2020; Ortega-Sánchez, 2023). Teachers and students require technological literacy (Basilotta-Gómez-Pablos et al., 2022). Android-based CBT offers a solution, integrating Case Method questions to enhance conceptual understanding and critical thinking (Wang et al., 2022), and is crucial for practical competencies in the industrial field (Tey, Chiavaroli and Ryan, 2020).

This study aims to fill these gaps by developing an Android-based CBT assessment system integrated with the Case Method, providing a more contextual and applicable learning experience. The system is designed to accommodate students undergoing internships, allowing them to take exams without disrupting their schedules (Cadamuro et al., 2023). By addressing these challenges, the study contributes to improving the quality of technology-oriented learning and offers a novel approach to educational assessment in vocational schools (Martin, McLeigh and Lamminen, 2023).

Method

The research method used in the process of developing an integrated Android-based CBT assessment system using the Case method to improve student understanding is the development of the ADDIE model (Manazila and Supriyati, 2019).

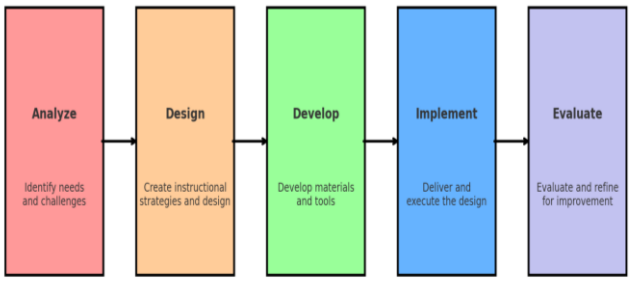

Figure 3. ADDIE Method - Refined Diagram

ADDIE Method diagram consists of five main stages: Analyze, Design, Develop, Implement, and Evaluate. This process begins with identifying needs (Analyze), planning learning strategies (Design), and developing materials (Develop), which are then implemented and tested (Implement). The final stage, Evaluate is used to assess the effectiveness of learning and make improvements so that the instructional development process is more optimal. With SMK 14 Medan partners, grade XI students with a total of 240 respondents. Meanwhile, to develop an android-based CBT assessment system using the Waterfall Development Model (Salihu et al., 2019).

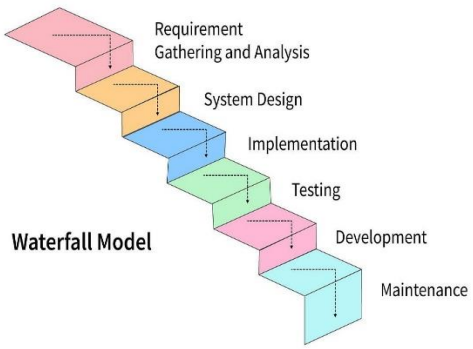

Figure 4. Waterfall Development Model

Waterfall Development A linear and sequential software development model, each stage must be completed before proceeding to the next stage, starting from Requirement Gathering, System Design, Implementation, Testing, to Maintenance. This model has the advantage of a structured and clear process, making it suitable for projects with stable and documented needs (Bjarnason, Wnuk and Regnell, 2012).

The study should employ a mixed-methods approach to data analysis to capture both the quantitative outcomes and qualitative insights. Quantitatively, statistical analysis can be used to evaluate the effectiveness and practicality of the CBT system. This can be achieved by conducting pre- and post-tests to measure improvements in students' critical thinking and problem-solving skills. Descriptive statistics, such as mean scores and standard deviations, can summarize the data, while inferential statistics, such as paired t-tests or ANOVA, can determine the significance of observed changes.

Qualitatively, thematic analysis can be employed to analyze feedback from students and teachers regarding their experiences with the system. This involves coding responses from surveys or interviews to identify recurring themes and insights about the system's usability, accessibility, and impact on learning. This dual approach ensures a comprehensive understanding of the system's effectiveness and areas for improvement, aligning with the study's objectives to enhance educational assessments in vocational schools.

Result and Discussions

Analysis Stage

Problem analysis in the development of an android-based CBT assessment system as an innovation in the assessment technique for the Business Economics subject integrated with the case method in improving student understanding. Assessments designed to assess understanding rather than rote learning can contribute to an in-depth learning approach (Sobers et al., 2023). Based on the needs analysis, it was found that as many as 85% of respondents expressed a clear need for the development of new solutions in the assessment of the Business Economics subject (Voon, Manan and Yahya, 2024). This fairly high figure indicates that there is an awareness of the importance of improving the current assessment methods.

However, the problem analysis revealed that as many as 73% of respondents felt obstacles and barriers in the assessment methods currently being implemented (Kuo, Chen and Kuo, 2022). This indicates that there are challenges that must be overcome, such as the difficulty of measuring students' in-depth understanding or the lack of interaction in the assessment process. Measuring understanding is very difficult and in formulating learning outcomes the word 'understanding' is usually avoided, but in science, developing understanding is one of the main goals of teaching (Gholizadeh and Rahimi, 2023). The results of the technology suitability analysis were very positive with a score of 86%. This shows that most respondents believe that using the Android platform as the basis for a new assessment system is the right step (Gilson et al., 2023). This high score indicates confidence in the potential of this technology in presenting efficient and effective solutions.

The benefit analysis also provides a positive view with a score of 83% (Meier et al., 2023). This shows a strong perception that the development of an Android-

based CBT assessment system with the Case Method approach has the potential to provide significant benefits (Abas et al., 2023). This perception may be based on the belief that this new assessment method will improve student understanding, support active engagement (Furukawa et al., 2023), and have a positive impact on overall learning. Overall, the results of this analysis provide a rich and diverse view of the existing conditions, challenges, and expectations related to the development of this innovative assessment solution (Diwersi et al., 2022). These findings will be an important basis in designing an Android-based CBT assessment system integrated with the Case Method approach, with the ultimate goal of improving student understanding and learning in the Business Economics subject (Vera Cruz et al., 2023) with the following graph:

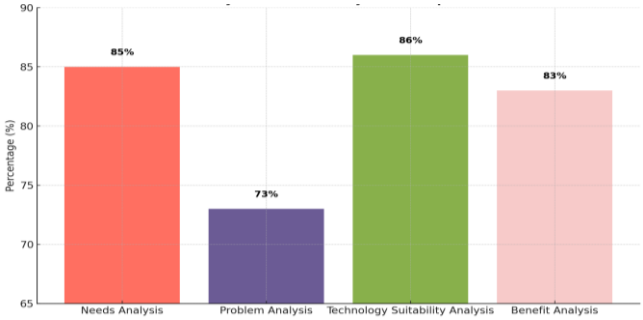

Figure 5. Analysis Results in Project Development

Design Stage

This Android-based CBT assessment system is to implement the Case Method approach (Lion et al., 2023) in assessing the Business Economics subject to improve students' understanding effectively. In other words (Scheel-Sailer et al., 2023), this system is designed to combine Android-based technology with the Case Method approach in order to improve the way students understand and apply concepts. Business Economics concepts in real world situations (Hilbert et al., 2023).

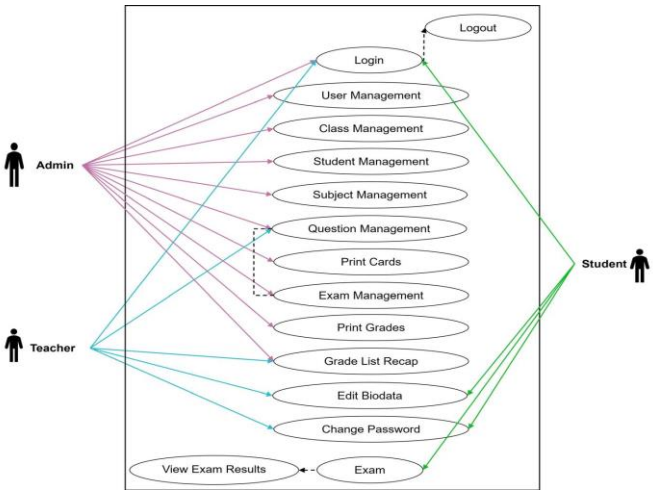

Figure 6. CBT Application Use Case Image

Use Case diagrams help in depicting the sequence of steps required to execute a use case (Baron and Schriml, 2023), thus helping the software development team to deeply understand how the interaction between actors and the system occurs during a particular process (Grambow et al., 2021). These diagrams are also useful in identifying potential problems, segregation of duties, and optimization of workflows in the system being developed, here are some examples of activities.

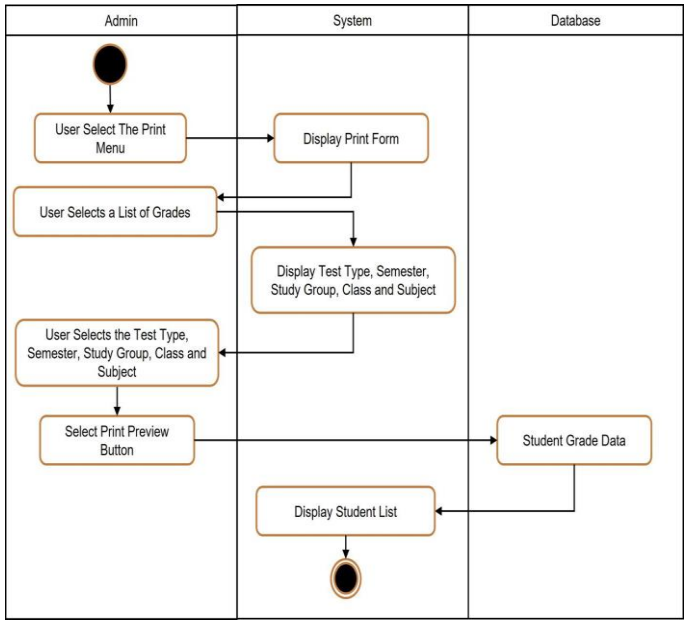

Figure 7. Activity Diagram of Student List

Develop Stages

The creation of the Computer Based Test (CBT) application for SMK Negeri 14 Medan is an important step in outlining the details of the system design in detail based on the analysis of needs and objectives that have been set. This Design stage produces a detailed design that will be a guideline for the development team in implementing the CBT application. This design is also used to ensure that the application will be in accordance with the needs, goals, and expectations of users that have been previously identified. The following are the stages in designing the CBT application for SMK Negeri 14 Medan.

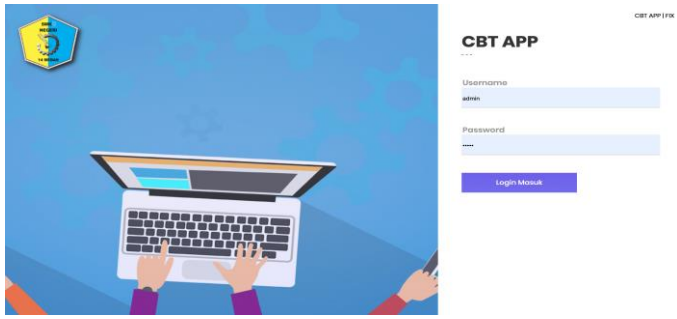

Figure 8. CBT Application Main Page Design

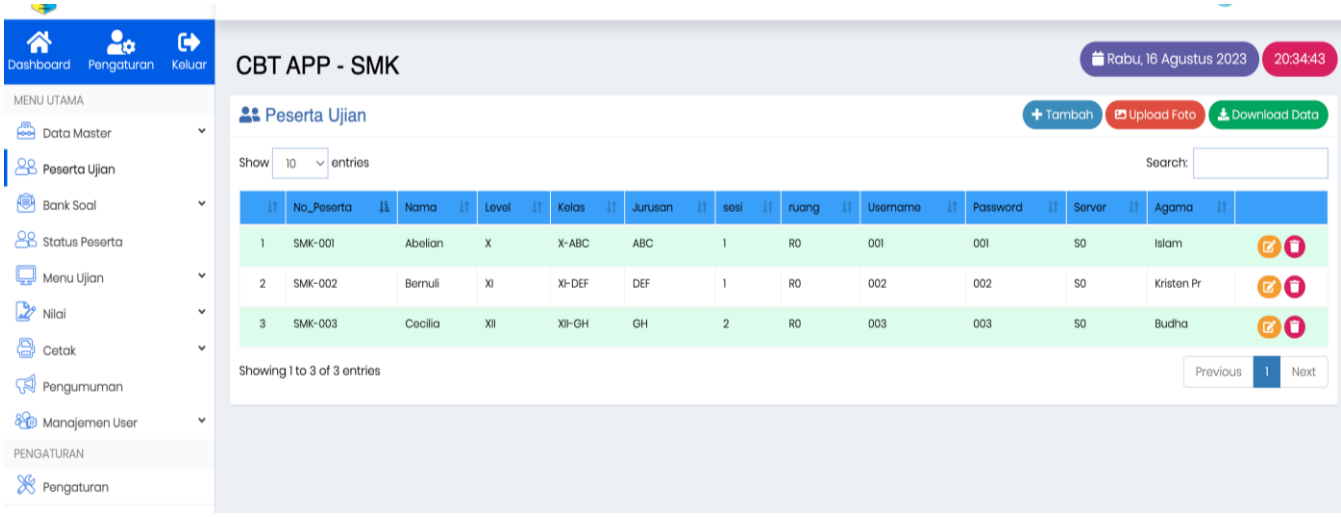

Figure 9. Design of the Examination Participant display

In order to improve the effectiveness and quality of the Computer-Based Test (CBT) Application System that has been developed, the Functionality and Performance Results are Positive and the CBT System successfully carries out the main functions such as presenting questions, taking answers, and calculating scores well. Guaranteed Data Security such as User data and exam results are well protected through strong authentication and authorization mechanisms. The results of this evaluation provide a comprehensive picture of the performance and potential for further development of the Computer-Based Test (CBT) Application System, (Obama et al., 2023) which is worthy of continuing to improve the system in order to provide maximum benefits in supporting the evaluation and assessment process in the learning environment, especially Business Economics.

Implementation Stage

After the product is declared valid by the validator, the next step is to test it. The product was tested by giving it to 40 students of Class XI of SMK Negeri 14 Medan to evaluate the practicality level of the CBT Assessment system. In this trial, the researcher distributed questionnaires to students, who then provided an assessment or response to the developed CBT system. The results of the CBT Assessment System trial on 240 students of class XI studying Business Economics material showed a percentage of 92%, which was categorized as very good after conversion. Responses from teachers teaching Business Economics subjects showed that this system had been assessed as good (Diwersi et al., 2022).

Evaluate Stage

After the implementation stage was carried out, the results of all implementation activities of the CBT Economics Business Assessment System were obtained. These results became the basis for the evaluation stage of the CBT Economics Business Assessment System. Based on the results of interviews and questionnaires given to Economics Business subject teachers and students, a final revision was made to the initial product of the CBT Economics Business Assessment System (Gholizadeh and Rahimi, 2023). The initial product that has been revised according to the results of this evaluation is called the final product of the CBT Economics Business Assessment System which can improve students' understanding in Economics Business lessons.

The analysis results show an urgent need to replace traditional computer-based assessment methods with a more flexible and accessible Android-based platform. Infrastructure limitations, such as inadequate computers and internet connectivity challenges, hinder the implementation of exams evenly, especially in Vocational High Schools (SMK) (Obama et al., 2023). By utilizing Android devices owned by the majority of students, the assessment system can be designed to run offline, thus overcoming technical constraints and allowing students, including those on internships, to take exams anytime and anywhere. In addition, the integration of Case Method-based questions in this system can improve students' critical thinking skills and support real-world context-based learning. This solution is a strategic step to create digital assessments that are inclusive, responsive, and relevant to the needs of modern education (Basilotta-Gómez-Pablos et al., 2022).

Results show that the Android-Based CBT Assessment System is designed by integrating Android technology and the Case Method approach to ensure that user needs, both students and teachers, are optimally met. The design begins with the creation of a Use Case Diagram, which maps the interaction flow

between students, teachers, and the system, including login, access to exam questions, question navigation, to assessment result reports. The user interface is designed to be simple, responsive, and easy to use, with key features such as login, question navigation, and automatic display of exam result reports (Batchelor et al., 2020). In addition, this system is designed to accommodate Case Method-based questions, which display real cases to encourage students' critical and analytical thinking skills, especially in the Business Economics subject. The integration of these elements ensures that the system not only functions technically but also provides added value in improving the quality of student learning and evaluation through a contextual and applicable approach (Tadayon et al., 2022).

The development results show that the Android-Based CBT Assessment System application was developed using a structured and systematic Waterfall Development Model approach. This process includes the development of modules for teachers and students. The teacher module is designed to facilitate question management, exam schedule settings, and automatic exam result reports, while the student module includes login features, question work, and exam result delivery (Melisse et al., 2023). To overcome network constraints, this system is equipped with offline capabilities, so students can access and complete exams without requiring an internet connection. In addition, data security is a top priority, with the implementation of a user authentication system to protect exam results and ensure that only authorized users can access data. This development stage ensures that the application meets technical and operational needs in supporting technology-based assessments effectively and safely (Lo and Tsai, 2022).

The implementation results show that the Android-Based CBT Assessment System was tested through two trial stages to ensure the functionality and practicality of the system. A small-scale test was conducted involving 40 students, which aimed to evaluate the interface and main features of the system. The results showed a positive response, where students felt the system was easy to use and met their needs (Hwang et al., 2022). Furthermore, a large-scale test involved 240 students of grade XI SMK Negeri 14 Medan to test the practicality of the system in real scenarios. The results showed a practicality level of 92%, which was categorized as very good. Teachers also gave positive assessments, highlighting that this system simplifies the assessment process, increases time efficiency, and reduces administrative burdens. This implementation stage confirmed that the system is feasible for widespread use in supporting technology-based assessment in school environments (Fordham et al., 2021; Guiney et al., 2024).

The evaluation results show that a comprehensive assessment was carried out to ensure that the Android-Based CBT Assessment System meets user needs optimally. Evaluation activities include revisions based on teacher and student input (Guiney et al., 2024), which focus on improving interface features to make them easier to use and improving exam result reports to provide more complete and accurate information. Furthermore, a final assessment was carried out, where teachers and students agreed that this system is an effective solution that not only makes it easier to carry out assessments but also improves student understanding through Case Method-based questions (García Zare et al., 2023). This evaluation ensures that the developed system not only functions technically but also has a positive impact on the learning and assessment process (Flores, Cappiello and Salinas, 2023).

Conclusion

The Android-based CBT system is able to overcome the limitations of the number of computers and internet connections, with offline features that allow students to take the exam anytime and anywhere. Case Method-based questions effectively improves students' critical and analytical thinking skills, especially in Business Economics subjects. The system is designed with a simple, responsive interface and key features such as login, question navigation, and automatic assessment result reports. Using the Waterfall Development Model, the development includes modules for teachers (question and report management) and students (login, working on questions, sending results). The trial showed a practicality rate of 92%, with positive responses from teachers and students, who felt the system simplified the assessment process and increased time efficiency. Revisions based on teacher and student feedback ensure the system meets user needs and has a positive impact on student understanding. This system supports the transformation of digital assessment in vocational schools, providing innovative, flexible and relevant solutions to modern learning needs.

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