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Development of a Web-Based Computer-Based Test System Using Exact Matching and Fuzzy Text Matching for Automated Scoring

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Abstract: Conventional paper-based examinations present operational challenges, including time-consuming grading procedures, increased administrative workloads, and potential errors in examination result processing. **Objective:** This study aims to develop a web-based Computer-Based Test (CBT) system integrating Exact Matching and Fuzzy Text Matching to support examination administration and automated scoring at SMP Al Jabr Islamic School. **Methodology:** This study adopts a software development research design using the Waterfall methodology, combining qualitative descriptive analysis of user requirements with quantitative descriptive evaluation of system functionality. Data were collected through observations, interviews, and literature reviews. The system was implemented using Laravel and MySQL and evaluated through Black Box Testing. **Findings:** The developed system accommodates three user roles and five question types, applying Exact Matching to four objective question types and Fuzzy Text Matching to essay responses. The reported functional testing results achieved a 100% success rate, indicating conformity with the evaluated system requirements. **Implications:** The proposed system provides a technological foundation for digital examination management, automated scoring, and structured academic data processing. However, scoring accuracy and operational efficiency require further quantitative validation. **Originality:** This study contributes an integrated assessment approach that combines deterministic and similarity-based scoring mechanisms within a unified web-based CBT platform tailored to the operational requirements of junior secondary education.

Keywords: Automated Scoring; Computer-Based Test; Educational Assessment; Exact Matching; Fuzzy Text Matching.

INTRODUCTION

The digital transformation of education has encouraged a shift from conventional paper-based tests (PBT) to computer-based tests (CBT) as an alternative approach to evaluating students' learning outcomes. This transformation extends beyond the adoption of digital devices to encompass assessment instrument management, automated scoring, data storage, and academic reporting. Conventional paper-based examinations present several operational challenges, including considerable resource consumption, increased administrative workloads for teachers, time-consuming grading procedures, and potential errors in score processing. In Indonesia, the adoption of digital assessment is reflected in

the implementation of the Computer-Based National Assessment (ANBK), which supports the evaluation of educational quality (Kementerian Pendidikan Dasar dan, 2025a). This transformation is further reflected in the introduction of the Academic Competency Test (TKA) as part of the national educational assessment framework (Kementerian Pendidikan Dasar dan, 2025b). Perry, Meissel, and Hill emphasized that transitioning from paper-based to computer-based assessments requires careful consideration of technological readiness, assessment characteristics, and user experience (Perry et al., 2022). Furthermore, through a study involving 2,676 ninth-grade students in Germany, highlighted the importance of considering students' test-taking effort across different assessment modes (Weirich et al., 2024). At SMP Al Jabr Islamic School, examinations are still conducted using paper-based methods, resulting in operational difficulties related to question distribution, answer grading, and examination result reporting. These circumstances highlight the need to develop an integrated CBT system that not only digitalizes examination procedures but also incorporates automated scoring mechanisms appropriate to different question types. From an academic perspective, this development contributes to the application of computational methods in educational assessment, while from a practical perspective, it offers opportunities to support more systematic and efficient examination management.

Previous studies on technology-based educational assessment can be classified into three major research categories. The first category focuses on the transition from paper-based to computer-based assessments. Boevé, Meijer, Albers, Beetsma, and Bosker investigated the implementation of computer-based testing in high-stakes examinations through a field experiment (Boevé et al., 2015). Perry examined the opportunities and challenges associated with transitioning from conventional paper-based assessments to computer-based summative assessments (Perry et al., 2022). Meanwhile, Weirich investigated differences in students' test-taking effort across paper-based and computer-based assessment environments (Weirich et al., 2024). The second category concerns the design and development of digital examination systems. Saptono and Widjasena developed and implemented a CBT application to support computer-based examinations in a vocational secondary school (Saptono & Widjasena, 2019). Nur, Piarsa, and Sukarsa investigated the development of a web-based examination system to facilitate digital examination administration (Nur et al., 2022). More recently, Iman and Farida developed a CBT application using Laravel and Electron JS, demonstrating the application of modern software frameworks in digital assessment systems (Iman & Farida, 2025). The third

category addresses automated textual answer assessment through computational approaches. Burrows, Gurevych, and Stein reviewed the development of automatic short-answer grading methods and identified methodological trends and challenges in textual response assessment (Burrows et al., 2015). Del Gobbo developed GradeAid, a framework for automated short-answer grading in educational environments (del Gobbo et al., 2023). Furthermore, Kurniadi investigated the application of cosine similarity to automated short-answer assessment in computer-based examinations (Kurniadi et al., 2023). Although these research categories have contributed to the development of digital assessment technologies, integrating scoring mechanisms tailored to different question characteristics remains relevant to the specific operational requirements of educational institutions. Accordingly, the research gap addressed in this study concerns the development and functional evaluation of a web-based CBT system integrating Exact Matching for objective questions and Fuzzy Text Matching for essay questions within a unified platform at the junior secondary school level. Rather than introducing a new text-matching algorithm, this study emphasizes the integration of complementary scoring mechanisms within a comprehensive examination management system.

This study aims to design, develop, and functionally evaluate a web-based Computer-Based Test system incorporating Exact Matching and Fuzzy Text Matching to support automated examination scoring at SMP Al Jabr Islamic School. Specifically, the proposed system integrates user management, question bank administration, examination scheduling, online examination delivery, automated answer scoring, and examination result processing within a single platform. Exact Matching is applied to multiple-choice, multiple-response, true-or-false, and matching questions by comparing students' responses against predefined answer keys. Meanwhile, Fuzzy Text Matching is employed to assess essay responses by measuring textual similarity between students' answers and reference answers. The system development follows the Waterfall methodology, which provides a structured software development approach encompassing requirements analysis, system design, implementation, testing, and maintenance (Pressman & Maxim, 2020). System implementation utilizes the Laravel framework and MySQL database, while Unified Modeling Language (UML) is employed to represent system structure, user interactions, and functional processes. Black Box Testing is conducted to evaluate the conformity of system functionality with predefined requirements. The principal contribution of this study lies in the integration of two complementary automated scoring approaches that

accommodate five question types within a single web-based CBT system tailored to the examination management requirements of a junior secondary school.

This study is based on the argument that incorporating scoring mechanisms tailored to different question characteristics can provide a more flexible assessment framework than applying a single exact-matching mechanism to all response types. Exact Matching is conceptually suitable for objective questions because its deterministic comparison rules enable consistent scoring against predefined answer keys. Conversely, Fuzzy Text Matching allows the system to accommodate textual variations by considering the degree of similarity between students' responses and reference answers. Burrows highlighted the potential and methodological challenges of computational approaches in automated short-answer grading (Burrows et al., 2015). Del Gobbo further demonstrated the applicability of automated grading frameworks in educational assessment contexts (del Gobbo et al., 2023). Similarly, Kurniadi explored the use of textual similarity measurements to support automated scoring in computer-based examinations (Kurniadi et al., 2023). These studies provide a conceptual foundation for integrating different scoring mechanisms according to question characteristics. Accordingly, this study proposes that integrating Exact Matching and Fuzzy Text Matching into a web-based CBT system enables examination management and automated scoring functions across different question types to operate in accordance with predefined system requirements. This proposition is evaluated through Black Box Testing by examining the conformity between actual system outputs and expected functional outcomes. From a practical perspective, the proposed system is expected to support the digitalization of educational assessment, reduce dependence on manual score processing, and facilitate systematic examination result management. Nevertheless, improvements in scoring accuracy, processing efficiency, and operational effectiveness require separate quantitative validation before such benefits can be empirically established.

RESEARCH METHOD

The unit of analysis in this study is a web-based Computer-Based Test (CBT) system developed to support examination administration and automated scoring at SMP Al Jabr Islamic School. The research focuses on the functional characteristics, software development processes, and implementation of automated scoring mechanisms within the proposed system. The system accommodates three primary user roles: administrators, teachers, and students, each with different access privileges and operational

responsibilities. The scope of analysis encompasses user management, question bank administration, examination scheduling, online examination delivery, automated answer scoring, and examination result reporting. Particular attention is given to the implementation of Exact Matching for multiple-choice, multiple-response, true-or-false, and matching questions, as well as Fuzzy Text Matching for essay questions. These components constitute the principal objects of investigation because they represent the core functionalities required to address the operational limitations of conventional paper-based examinations.

This study adopts a software development research design involving qualitative descriptive analysis for identifying user requirements and quantitative descriptive evaluation for assessing system functionality. The qualitative descriptive approach is employed to understand existing examination procedures, identify operational problems, and determine user requirements. Quantitative descriptive evaluation is subsequently applied to summarize the outcomes of functional testing. The Waterfall methodology is selected as the software development framework because it provides a structured and sequential approach suitable for projects with identifiable functional requirements and systematic documentation. Pressman and Maxim explain that structured software development processes facilitate the systematic transformation of user requirements into software products through requirements analysis, design, implementation, and testing (Pressman & Maxim, 2020). Accordingly, the development process encompasses five stages: requirements analysis, system design, implementation, testing, and maintenance, as illustrated in Figure 1. Unified Modeling Language (UML) is employed to represent system interactions, functional processes, and structural relationships. The system is implemented using PHP with the Laravel framework and MySQL as the database management system. Rahmawati and Sumarsono (2024) describe the application of the Model–View–Controller architecture in Laravel-based web development as an approach to organizing application components. The combination of these development approaches supports the systematic implementation of the proposed CBT system.

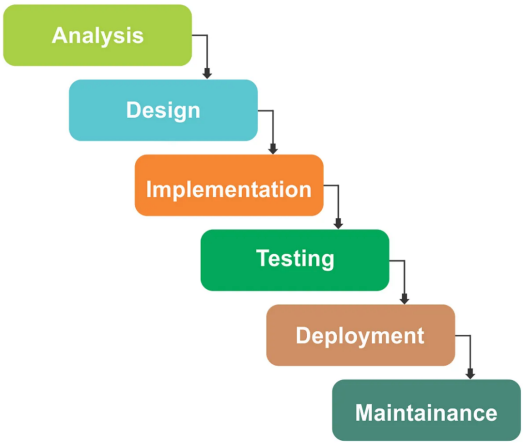

Figure 1. Waterfall Software Development Methodology

The data used in this study consist of primary and secondary data. Primary data are obtained from direct observations of computer-based examination activities and interviews with teachers, students, and the principal of SMP Al Jabr Islamic School. The information obtained concerns existing examination procedures, operational difficulties, user requirements, examination question characteristics, and expectations regarding digital examination management. Secondary data are derived from relevant scientific publications, academic books, technical documentation, and official information concerning the implementation of computer-based educational assessments. Documentation related to the Computer-Based National Assessment (ANBK) and the Academic Competency Test (TKA) is used as contextual information for understanding digital examination procedures and system functionalities. Previous research on the implementation of CBT at the junior secondary school level also provides relevant technical and operational considerations for system development (Hidayat et al., 2024). These data sources serve as the basis for identifying system requirements, determining functional specifications, designing application components, and selecting appropriate automated scoring mechanisms.

Data collection is conducted through observation, interviews, and literature review. Direct observations of ANBK and TKA activities are performed to obtain information regarding examination workflows, user interactions, interface characteristics, and computer-based assessment procedures. Interviews with teachers, students, and the school principal are conducted to identify problems associated with conventional paper-based examinations and determine the functional requirements of the proposed system. The

information collected through interviews covers examination administration, question management, answer submission, scoring procedures, and examination result processing. A literature review is subsequently conducted to examine relevant concepts concerning CBT systems, software development methodologies, web-based application architecture, automated scoring, and functional software testing. The collected information is organized into functional and non-functional requirements that provide the foundation for system design. These requirements are translated into Use Case Diagrams, Activity Diagrams, Sequence Diagrams, and Class Diagrams using UML. Interface designs are prepared using Figma, while the application interface is implemented using the AdminLTE template. The Use Case Diagram illustrates the interactions between administrators, teachers, and students, whereas the Class Diagram represents system entities, attributes, methods, and relationships, as presented in Figures 2 and 3, respectively.

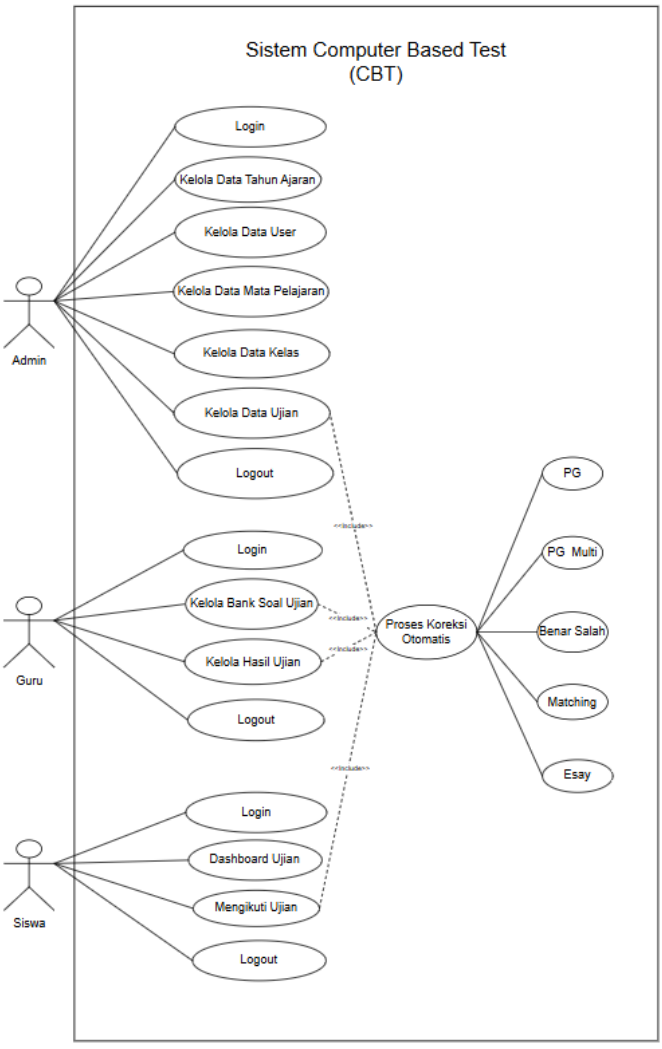

Figure 2. Use Case Diagram of the Proposed CBT System

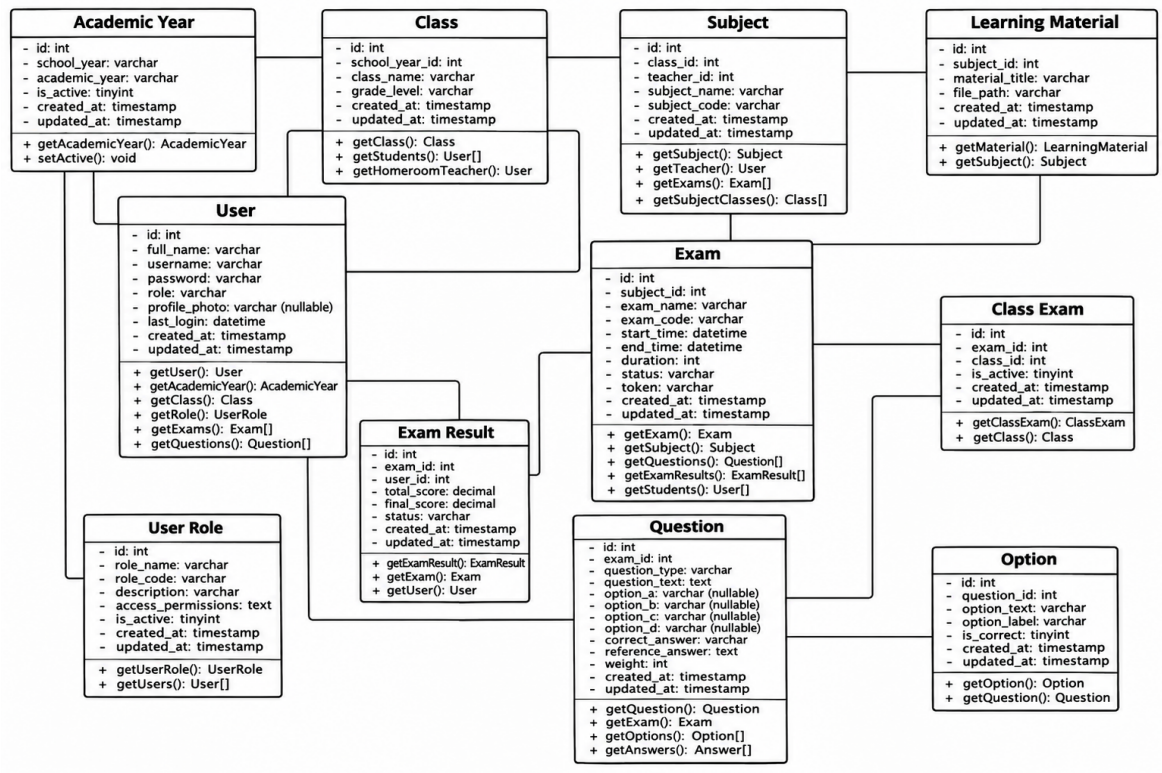

Figure 3. Class Diagram of the Proposed CBT System

Data analysis is conducted through descriptive qualitative analysis and descriptive quantitative evaluation. Qualitative information obtained from observations and interviews is examined to identify operational problems, classify user requirements, and establish system specifications. These specifications are subsequently used as the basis for implementing the automated scoring mechanisms. Exact Matching is applied by comparing students' responses with predefined answer keys for objective question types, whereas Fuzzy Text Matching evaluates essay responses based on textual similarity between students' answers and reference answers. Following system implementation, functional evaluation is conducted using Black Box Testing to determine whether application outputs conform to predefined functional requirements. Amalia, Hamidah, and Kristanto describe Black Box Testing as an approach for evaluating software functionality through input and output behavior without examining the internal program structure (Amalia et al., 2021). The evaluation encompasses authentication, user management, question bank administration, examination scheduling, examination token validation, answer submission, automated scoring, answer storage, examination time management, and result reporting. Each test scenario is evaluated by comparing its expected output with the actual system output and

subsequently classifying the result as passed or failed. The functional success rate is calculated by dividing the number of successfully executed test scenarios by the total number of test scenarios and multiplying the result by 100%. The resulting percentage is used as a descriptive indicator of functional conformity rather than as a direct measure of scoring accuracy, assessment validity, or system efficiency.

RESULT

The development process resulted in a web-based Computer-Based Test (CBT) system designed to support digital examination administration and automated scoring at SMP Al Jabr Islamic School. The system was implemented using the Laravel framework, PHP programming language, and MySQL database, with interface designs prepared using Figma and implemented through the AdminLTE template. The developed system integrates user management, question bank administration, examination scheduling, online examination delivery, automated scoring, and examination result processing within a unified platform. Three user roles were implemented, namely administrators, teachers, and students, with different access privileges and functional responsibilities according to their respective operational requirements. The system provides a centralized authentication mechanism that enables users to access the appropriate application functions based on their assigned roles, as presented in Figure 4.

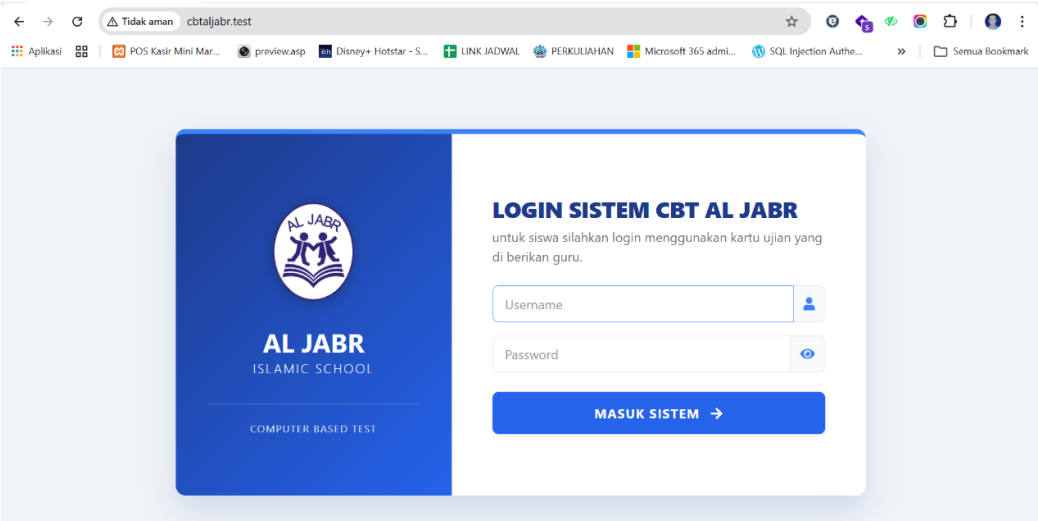

Figure 4. Login Interface for Administrators, Teachers, and Students

Figure 4 illustrates the authentication interface that serves as the primary access point for all registered users. Users are required to provide their authentication credentials before

accessing the examination management system. Following successful authentication, the system directs users to the corresponding dashboard based on their assigned roles. This mechanism distinguishes administrative functions, teaching-related activities, and student examination access within the application.

The administrator dashboard was developed to facilitate centralized monitoring and management of examination-related information. As presented in Figure 5, the dashboard displays statistical summaries of registered students, teachers, examination questions, average examination scores, classes, subjects, total examinations, and active examinations. Administrators can access various management functions, including academic year management, class administration, student assignment, subject management, and examination administration. The integration of these functions provides a centralized interface for organizing examination-related data and monitoring system activities.

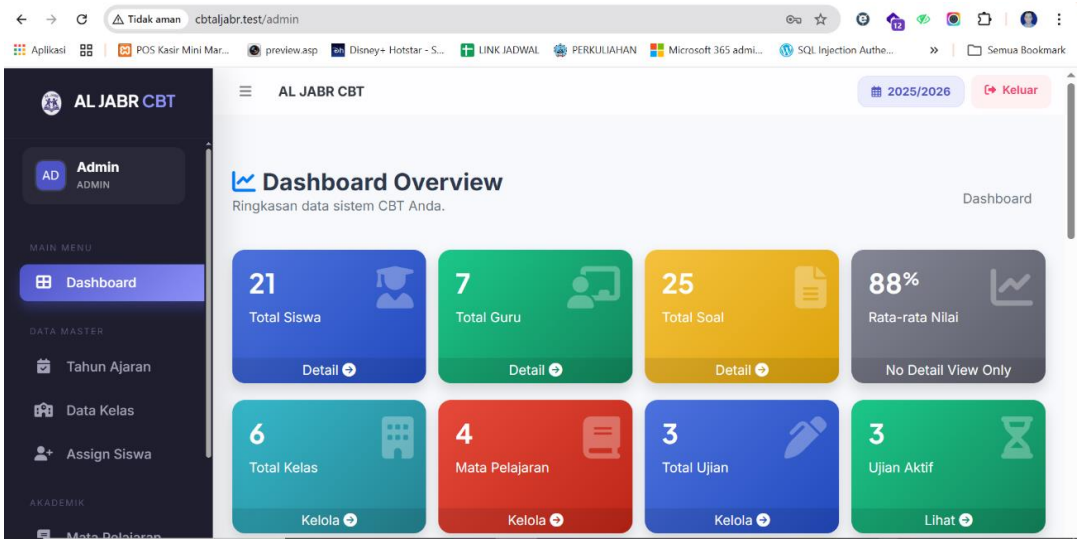

Figure 5. Administrator Dashboard Interface

The student dashboard was implemented to provide access to scheduled examinations and relevant examination information. Figure 6 presents the examination dashboard, which displays available examinations in individual cards containing subject names, examination titles, examination dates, submission deadlines, examination durations, and class information. Students can initiate examinations after completing the examination token validation process. Examinations that have already been completed are automatically identified by the system to prevent repeated access. The implemented examination functions also include automatic answer storage and examination completion when the allocated examination time expires.

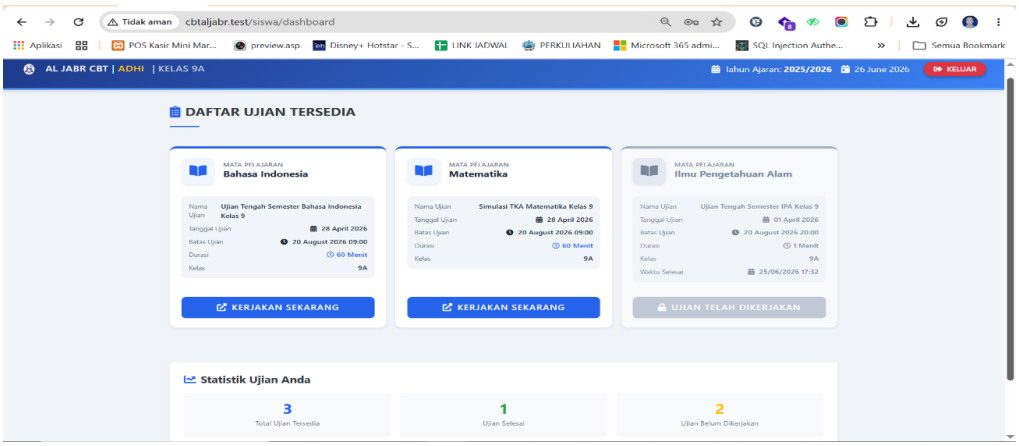

Figure 6. Student Examination Dashboard Interface

The developed CBT system incorporates five question types, namely multiple-choice, multiple-response, true-or-false, matching, and essay questions. Automated scoring was implemented using two complementary approaches according to the characteristics of each question type. Exact Matching was applied to objective questions by comparing students' submitted responses against predefined answer keys stored in the database. Meanwhile, Fuzzy Text Matching was applied to essay responses by evaluating the degree of textual similarity between students' answers and reference answers. The implementation of these scoring mechanisms enables the system to process different response formats within the same examination environment. Table 1 summarizes the relationship between the supported question types and their corresponding scoring mechanisms.

Table 1. Implementation of Automated Scoring Mechanisms

No.	Question Type	Scoring Method	Scoring Principle
1	Multiple-choice	Exact Matching	Comparison with a predefined correct option
2	Multiple-response	Exact Matching	Comparison with predefined correct responses
3	True-or-false	Exact Matching	Comparison with a predefined binary answer
4	Matching	Exact Matching	Comparison with predefined answer pairs
5	Essay	Fuzzy Text Matching	Textual similarity between submitted and reference answers

As shown in Table 1, Exact Matching is utilized for four objective question types, whereas Fuzzy Text Matching is implemented for textual responses. The scoring results generated by both mechanisms are automatically processed and consolidated into examination results. Teachers are provided with access to the resulting scores to support examination result management. This implementation establishes an integrated scoring

workflow connecting question management, answer submission, automated score processing, and examination result reporting.

Functional evaluation was conducted using Black Box Testing to examine the conformity of the implemented system with predefined functional requirements. The evaluation covered the principal functionalities associated with administrator, teacher, and student roles. The tested functions included user authentication, master data management, question bank administration, examination scheduling, examination token validation, online examination delivery, automated scoring, automatic answer storage, automatic examination completion, result reporting, and logout. Table 2 summarizes the functional testing outcomes reported in the original study.

Table 2. Summary of Reported Black Box Testing Results

No.	Functional Component	Expected Outcome	Reported Status
1	User authentication	Users can access the system according to their assigned roles	Passed
2	Master data management	User, class, subject, and academic year data can be managed	Passed
3	Question bank management	Examination questions can be managed	Passed
4	Examination scheduling	Examination schedules can be managed	Passed
5	Examination token validation	Examination access is controlled through token validation	Passed
6	Online examination delivery	Students can access and complete examinations	Passed
7	Exact Matching scoring	Objective responses are processed using predefined answer keys	Passed
8	Fuzzy Text Matching scoring	Essay responses are processed using textual similarity	Passed
9	Automatic answer storage	Submitted answers are stored automatically	Passed
10	Automatic examination completion	Examinations are automatically completed when the allocated time expires	Passed
11	Examination result reporting	Examination results are processed and made available to authorized users	Passed
12	User logout	Active user sessions can be terminated	Passed

According to the reported Black Box Testing outcomes, all evaluated system functionalities operated in accordance with their expected functional specifications. The reported functional success rate reached 100%, with no functional errors identified during the testing process. The authentication mechanism, data management functions, examination administration, automated scoring procedures, answer storage, and

examination result processing were reported to operate successfully. The functional components summarized in Table 2 represent categories of evaluated functions rather than the total number of individual test scenarios.

Overall, the implementation results indicate that the proposed web-based CBT system integrates the principal components required for digital examination administration and automated scoring. The system accommodates five question types through the implementation of two scoring approaches and provides differentiated functionalities for administrators, teachers, and students. The reported functional testing outcomes provide preliminary evidence of system conformity with the specified operational requirements.

DISCUSSION

The findings of this study demonstrate the functional implementation of a web-based Computer-Based Test (CBT) system integrating Exact Matching and Fuzzy Text Matching for automated examination scoring at SMP Al Jabr Islamic School. The developed system accommodates five question types and provides differentiated functionalities for administrators, teachers, and students within a unified examination management platform. The reported Black Box Testing results indicate a functional success rate of 100%, suggesting that the evaluated system components operated in accordance with predefined functional requirements. These findings address the research objective of integrating examination administration, automated scoring, and result processing within a single digital platform. The implementation is consistent with the perspective of Aidah, Arifudin, Kartika, and Ibrahim, who emphasized the importance of management information systems in supporting systematic information management within educational institutions (Aidah et al., 2024). The principal finding of this study is therefore not merely the digitalization of conventional examinations but the integration of complementary scoring mechanisms tailored to different question characteristics. Nevertheless, the reported functional success rate represents the conformity of software operations with system specifications rather than evidence of scoring accuracy or educational assessment effectiveness.

The functional outcomes can be explained conceptually through the relationship between structured software development, integrated system architecture, and the selection of scoring mechanisms appropriate to different response characteristics. The Waterfall methodology provides a systematic framework for translating identified user requirements into software specifications and functional components. Pressman and Maxim emphasized

the importance of structured development processes in establishing consistency between software requirements, implementation, and evaluation (Pressman & Maxim, 2020). Furthermore, the application of Exact Matching to objective questions allows the system to apply deterministic comparison rules against predefined answer keys, thereby supporting consistent score processing under identical input conditions. In contrast, Fuzzy Text Matching accommodates textual variations by considering the similarity between submitted responses and reference answers. This distinction is important because essay responses may contain differences in spelling, vocabulary, and sentence structure despite addressing the same question. Burrows identified textual variability as one of the methodological challenges in automated short-answer grading (Burrows et al., 2015). Ramesh and Sanampudi further highlighted the importance of computational techniques capable of addressing linguistic complexity in automated essay assessment (Ramesh & Sanampudi, 2022). Accordingly, the integration of Exact Matching and Fuzzy Text Matching provides a conceptual basis for accommodating different response characteristics. However, the extent to which textual similarity accurately represents the correctness and meaning of students' answers remains to be established through independent scoring validation.

The findings share similarities with previous studies concerning the development and implementation of digital examination systems. Saptono and Widjasena developed a computer-based examination application to support school examination activities, demonstrating the practical relevance of digital examination platforms within educational institutions (Saptono & Widjasena, 2019). Similarly, Yudhistira developed an online examination information system using the Extreme Programming methodology, whereas the present study adopts the Waterfall methodology to organize its development stages (Yudhistira, 2024). From the perspective of automated scoring, Kurniadi investigated the application of cosine similarity to automated short-answer assessment in computer-based examinations (Kurniadi et al., 2023). Zhang, Huang, Yang, Yu, and Zhuang developed an automated short-answer grading model incorporating domain-general and domain-specific information to assess semi-open-ended questions (Zhang et al., 2022). Furthermore, del Gobbo proposed GradeAid as a framework for implementing and evaluating automated short-answer grading in educational contexts (del Gobbo et al., 2023). In contrast to the specific research focuses of these studies, the present study emphasizes the integration of two complementary scoring approaches within a comprehensive CBT platform supporting

five question types. The novelty of this study is therefore positioned as an integrative and contextual contribution to examination management at the junior secondary school level rather than the development of a fundamentally new computational algorithm. The available findings do not establish the superiority of the proposed scoring mechanisms over those employed in previous studies.

From a broader educational and technological perspective, the findings indicate that the digital transformation of examination administration involves more than replacing conventional paper-based examinations with computer-based interfaces. The integration of question management, examination scheduling, answer submission, scoring, and academic reporting provides a foundation for establishing a more structured educational information management environment. Automated scoring may also contribute to reducing repetitive administrative tasks, allowing teachers to allocate greater attention to interpreting assessment outcomes and supporting students' learning development. However, the adoption of digital assessment systems must consider the relationship between technological functionality and educational assessment quality. Perry emphasized that transitioning from paper-based to computer-based assessments involves both opportunities and implementation challenges (Perry et al., 2022). Weirich further demonstrated the relevance of considering students' test-taking effort when evaluating different assessment modes (Weirich et al., 2024). These perspectives suggest that the educational significance of the proposed CBT system should not be assessed exclusively through software functionality but should also consider usability, accessibility, assessment fairness, and the suitability of examination instruments. Consequently, the present study contributes to the understanding of how integrated software systems can support digital examination management while recognizing that technological implementation alone does not guarantee improvements in educational quality.

A critical reflection on the findings reveals both potential benefits and limitations associated with the proposed CBT system. Potential benefits include centralized examination management, automated score processing, reduced dependence on paper-based documentation, and improved organization of examination records. Nevertheless, the implementation of automated assessment may introduce technological and pedagogical risks. Exact Matching may be unsuitable for responses requiring partial credit or alternative valid answer combinations unless appropriate scoring rules are established. Fuzzy Text Matching may assign relatively high similarity scores to responses containing comparable

words but different meanings, while semantically correct responses expressed using different vocabulary may receive lower scores. These limitations are particularly relevant when automated scoring is used to assess conceptual understanding rather than simple textual correspondence. In addition, digital examination systems remain vulnerable to infrastructure disruptions, unauthorized access, academic misconduct, and potential exposure of students' personal information. Mushthofa examined academic dishonesty during school examinations, indicating the continuing importance of supervision and assessment integrity (Mushthofa et al., 2021). Although the proposed system incorporates role-based access and examination token validation, these functionalities do not independently establish its security or resistance to academic misconduct. Furthermore, the reported functional success rate of 100% should be interpreted within the scope of the evaluated test conditions. The absence of detailed scoring accuracy measurements, usability evaluations, concurrent-user performance testing, and comprehensive test-case documentation limits the generalizability of the findings beyond the reported implementation context.

Based on these findings, several practical and institutional actions are recommended to support the responsible implementation and sustainable development of the proposed CBT system. School administrators should establish standard operating procedures governing user access, question bank administration, examination scheduling, data backup, technical support, and examination result verification. Teachers should receive appropriate training in digital assessment design, including the preparation of objective answer keys, essay reference answers, and scoring rubrics. Automated essay scores should remain subject to teacher verification, particularly when students provide alternative expressions or responses requiring contextual interpretation. Future system development should prioritize the quantitative validation of automated scoring by comparing system-generated scores with teacher-assigned scores using appropriate statistical measures, such as mean absolute error, root mean square error, and agreement analysis. The similarity threshold should also be evaluated against representative student responses to determine an appropriate scoring configuration. Additional evaluations should include usability testing, security assessment, concurrent-user performance testing, and comparative measurements of examination processing time. At the institutional level, policies concerning student data protection, academic integrity, infrastructure readiness, and human oversight should be established before the system is adopted for high-stakes examinations. Through these

measures, the proposed CBT system can be progressively developed from a functionally evaluated software application into a more reliable, accountable, and empirically validated educational assessment platform.

CONCLUSION

This study successfully developed a web-based Computer-Based Test (CBT) system integrating Exact Matching and Fuzzy Text Matching to support examination administration and automated scoring at SMP Al Jabr Islamic School. The developed system accommodates five question types, comprising multiple-choice, multiple-response, true-or-false, matching, and essay questions, while integrating user management, question bank administration, examination scheduling, online examination delivery, automated scoring, and examination result reporting within a unified platform. The reported Black Box Testing results demonstrated a functional success rate of 100%, indicating that the evaluated system functionalities operated in accordance with predefined requirements. The principal finding of this study highlights the feasibility of integrating complementary scoring mechanisms according to different question characteristics within a digital examination management system.

The scientific contribution of this study lies in the integration of deterministic and similarity-based scoring approaches within a unified web-based educational assessment system. Exact Matching provides a structured mechanism for scoring objective questions based on predefined answer keys, whereas Fuzzy Text Matching enables automated scoring of essay responses by considering textual variations. Rather than introducing a new computational algorithm, this study contributes an integrative approach to automated assessment tailored to the operational requirements of junior secondary education. From a practical perspective, the proposed system provides a technological foundation for digital examination management, reducing dependence on manual scoring procedures and supporting more systematic academic data management. These contributions provide a basis for further development of integrated educational assessment systems that combine automated scoring with appropriate human oversight.

Despite these contributions, this study has several limitations. The evaluation was restricted to functional testing, without comprehensive quantitative validation of automated scoring accuracy, semantic equivalence, processing efficiency, usability, system security, or performance under simultaneous user access. Furthermore, the implementation was

conducted within a single educational institution, limiting the generalizability of the findings to broader educational contexts. Future research should prioritize the validation of automated scoring against teacher-assigned scores, optimization of similarity thresholds, and implementation of semantic similarity approaches to improve the assessment of textual responses. Additional investigations should incorporate comparative efficiency measurements, usability evaluations, security assessments, concurrent-user performance testing, and implementation across multiple educational institutions. These developments are necessary to establish the reliability, scalability, and educational effectiveness of the proposed CBT system.

DECLARATIONS

Artificial Intelligence Use Statement

The authors acknowledge the use of ChatGPT (OpenAI) to assist in manuscript preparation, academic language refinement, structural organization, literature identification, reference organization, and revision of the Introduction, Research Method, Results, Discussion, Conclusion, and Abstract sections. The AI tool was used to improve the clarity, coherence, readability, and academic presentation of the manuscript. AI assistance did not involve generating original research data, developing or implementing the Computer-Based Test (CBT) system, designing the automated scoring algorithms, conducting functional system testing, or independently validating the reported research findings. All AI-assisted content, including suggested references and the presentation of research findings, must be critically reviewed and verified by the authors, who retain full responsibility for the accuracy, scientific validity, originality, ethical compliance, and final content of the manuscript.

Author Contributions Statement

Adi Priyatna: Conceptualization, Methodology, Software, Investigation, Data curation, Formal analysis, Visualization, Writing – original draft.

Juwari: Conceptualization, Methodology, Validation, Supervision, Writing – review & editing.

Abdur Rohman: Validation, Formal analysis, Visualization, Writing – review & editing.

Ahmad Soderi: Methodology, Validation, Investigation, Writing – review & editing.

Karno Diantoro: Conceptualization, Methodology, Validation, Supervision, Project administration, Writing – review & editing.

All authors have read and approved the final version of the manuscript and agree to be accountable for their respective contributions and the accuracy, originality, and integrity of the published work.

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Conflict of Interest Statement

The authors declare that they have no financial, professional, institutional, or personal conflicts of interest that could have influenced the conceptualization, design, development, implementation, functional testing, analysis, interpretation, or reporting of the Computer-Based Test (CBT) system presented in this study.

REFERENCES

Aidah, A., Arifudin, O., Kartika, I., & Ibrahim, T. (2024). Pengembangan sistem informasi manajemen dalam dunia pendidikan. *Jurnal Tahsinia*, *5*(6), 966-977. https://doi.org/10.57171/jt.v5i6.604

Amalia, A., Hamidah, S. W. P., & Kristanto, T. (2021). Pengujian black box menggunakan teknik equivalence partitions pada aplikasi e-learning berbasis web. *Building of Informatics, Technology and Science (BITS)*, *3*(3), 269-274. https://doi.org/10.47065/bits.v3i3.1062

Boevé, A. J., Meijer, R. R., Albers, C. J., Beetsma, Y., & Bosker, R. J. (2015). Introducing computer-based testing in high-stakes exams in higher education: Results of a field experiment. *PLOS ONE*, *10*(12), e0143616. https://doi.org/10.1371/journal.pone.0143616

Burrows, S., Gurevych, I., & Stein, B. (2015). The eras and trends of automatic short answer grading. *International Journal of Artificial Intelligence in Education*, *25*(1), 60-117. https://doi.org/10.1007/s40593-014-0026-8

del Gobbo, E., Guarino, A., Cafarelli, B., & Grilli, L. (2023). GradeAid: A framework for automatic short answers grading in educational contexts—Design, implementation and evaluation. *Knowledge and Information Systems*, *65*, 4295-4334. https://doi.org/10.1007/s10115-023-01892-9

Hidayat, R., Septian, A., Lattu, A., Permana, M. A., Verianti, G., & Sukmawan, D. (2024). Pengembangan aplikasi ujian online berbasis komputer (CBT) di SMP Terpadu Al-Ghifari Kabupaten Sukabumi. *Jurnal Sistem Informasi dan Teknologi Informasi*, *6*(1), 332-337. https://doi.org/10.52005/jursistekni.v6i1.246

Iman, F. N., & Farida, I. (2025). Pengembangan aplikasi CBT menggunakan framework Laravel dan Electron JS. *JIKA (Jurnal Informatika)*, *9*(4), 446-454. https://doi.org/10.31000/jika.v9i4.14795

Kementerian Pendidikan Dasar dan, M. (2025a). Asesmen Nasional Berbasis Komputer (ANBK). https://anbk.kemendikdasmen.go.id/

Kementerian Pendidikan Dasar dan, M. (2025b). Tanya jawab seputar Tes Kemampuan Akademik (TKA). https://www.kemendikdasmen.go.id/download/file/1201

Kurniadi, D., Gernowo, R., Surarso, B., Wibowo, A., & Warsito, B. (2023). Sistem penilaian jawaban singkat otomatis pada ujian online berbasis komputer menggunakan algoritma cosine similarity. *JEPIN (Jurnal Edukasi dan Penelitian Informatika)*, *9*(2). https://doi.org/10.26418/jp.v9i2.66934

Mushthofa, Z., Rusilowati, A., Sulhadi, S., Marwoto, P., & Mindiyarto, B. N. (2021). Analisis perilaku kecurangan akademik siswa dalam pelaksanaan ujian di sekolah. *Jurnal Kependidikan: Jurnal Hasil Penelitian dan Kajian Kepustakaan di Bidang Pendidikan, Pengajaran dan Pembelajaran*, *7*(2), 446-452. https://doi.org/10.33394/jk.v7i2.3302

Nur, A. M., Piarsa, I. N., & Sukarsa, I. M. (2022). Rancang bangun sistem ujian online berbasis web. *JITTER: Jurnal Ilmiah Teknologi dan Komputer*, *3*(3), 1257-1269. https://doi.org/10.24843/JTRTI.2022.v03.i03.p01

Perry, K., Meissel, K., & Hill, M. F. (2022). Rebooting assessment: Exploring the challenges and benefits of shifting from pen-and-paper to computer in summative assessment. *Educational Research Review*, *36*, 100451. https://doi.org/10.1016/j.edurev.2022.100451

Pressman, R. S., & Maxim, B. R. (2020). *Software engineering: A practitioner's approach* (9 ed.). McGraw-Hill Education.

Ramesh, D., & Sanampudi, S. K. (2022). An automated essay scoring systems: A systematic literature review. *Artificial Intelligence Review*, *55*(3), 2495-2527. https://doi.org/10.1007/s10462-021-10068-2

Saptono, M. P., & Widjasena, H. (2019). Perancangan dan implementasi aplikasi ujian sekolah berbasis komputer atau Computer Based Test (CBT) di SMK Negeri 1 Kabupaten Sorong. *Electro Luceat*, *5*(2), 5-13. https://doi.org/10.32531/jelekn.v5i2.148

Weirich, S., Sachse, K. A., Henschel, S., & Schnitzler, C. (2024). Comparing test-taking effort between paper-based and computer-based tests. *Applied Psychological Measurement*, *48*(1–2), 3-17. https://doi.org/10.1177/01466216241227535

Yudhistira, J. (2024). Perancangan sistem informasi ujian online menggunakan metode Extreme Programming. *Journal of Artificial Intelligence and Technology Information*, *2*(2), 87-95. https://doi.org/10.58602/jaiti.v2i2.122

Zhang, L., Huang, Y., Yang, X., Yu, S., & Zhuang, F. (2022). An automatic short-answer grading model for semi-open-ended questions. *Interactive Learning Environments*, *30*(1), 177-190. https://doi.org/10.1080/10494820.2019.1648300