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Learning Medium to Improve Science Literacy

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ABSTRACT

Indonesian students continue to demonstrate weak scientific literacy, as indicated by international assessment results, underscoring the need for more effective, contextually relevant learning innovations. This study aims to analyze the implementation of ZEP Quiz in science instruction and to examine its contribution to improving students' scientific literacy in a madrasah context. The research applied a qualitative case study approach involving eighth-grade students and a science teacher at MTsN 23 Jakarta. Data were obtained through classroom observations, semi-structured interviews, questionnaires, and document analysis, and were analyzed using the interactive model of Miles and Huberman. The results indicate a significant improvement in student learning achievement, with the mean score increasing from 44 in the pretest to 80 in the posttest, and 96.6% of students showing positive progress. Qualitative findings reveal that ZEP Quiz use strengthens student engagement, learning motivation, and scientific literacy competencies, particularly in explaining scientific phenomena, interpreting data, and applying concepts to real-world contexts. These findings confirm that ZEP Quiz is an effective digital learning medium for enhancing scientific literacy through active and student-centered science learning in a madrasah environment.

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1. INTRODUCTION

The rapid development of digital technology has significantly transformed educational practices, particularly in teaching and learning processes [1]. The integration of information and communication technology (ICT) has shifted conventional methods toward interactive, collaborative, and technology-enhanced approaches [2]. In this digital era, teachers are no longer merely knowledge transmitters; they serve as facilitators who guide students in constructing understanding through relevant technological media [3]. This shift

is especially critical in science education, where students must develop higher-order thinking skills, including analytical reasoning, critical evaluation, and the application of scientific concepts to real-life situations [4]. Despite these advancements, national assessment results indicate persistent challenges. The Programme for International Student Assessment (PISA) 2018 reported that Indonesian students' scientific literacy remains low, with an average score of 396, far below the OECD average of 489 [5]. This situation highlights a significant problem: conventional instructional strategies are insufficient for engaging digital-native learners in meaningful science learning that fosters scientific literacy. To address this, educational innovations that combine technology, interactivity, and gamification are required [6].

Digital quiz platforms have emerged as promising tools to enhance learning motivation and engagement. By integrating gamification principles, digital quizzes allow students to learn through "learning by playing," providing enjoyable and formative experiences. They offer immediate feedback, assess conceptual mastery, and create a motivating, competitive classroom environment [7]. One such platform, ZEP Quiz, provides multiple question formats, including multiple-choice, true–false, and short-answer items, accessible via students' personal devices. Its intuitive interface, leaderboard system, and real-time feedback encourage active learning, rapid problem-solving, and self-correction [8]. Through gamification, science learning becomes more engaging without compromising academic rigor, supporting student-centered learning while allowing teachers to identify difficulties and adjust instructional [9].

Previous studies have shown that digital quiz platforms effectively increase learning motivation and conceptual understanding. For instance, [10] found that Kahoot improved engagement and retention of scientific concepts in junior high school biology classes, while [11] highlighted ZEP Quiz's role in formative assessment. However, these studies primarily focus on general learning outcomes rather than higher-order scientific literacy skills, and most research has been conducted in elementary and senior high schools. Research specifically examining the use of ZEP Quiz in madrasah contexts, particularly at the MTs level, remains limited. Additionally, few studies analyze the supporting and inhibiting factors that affect the effective implementation of digital quiz tools in real classroom settings [12]. These gaps underscore the need for a comprehensive investigation into how ZEP Quiz influences scientific literacy and the contextual conditions that shape its effectiveness.

Therefore, this study addresses the research problem: how the implementation of ZEP Quiz in science learning affects students' scientific literacy and what factors support or inhibit its effectiveness in madrasah classrooms [13]. The objectives of this research are to examine the implementation process of ZEP Quiz at MTsN 23 Jakarta, to evaluate its impact on students' scientific literacy, and to identify supporting and inhibiting factors in its use. The study is grounded in constructivist learning theory, which emphasizes active knowledge construction through interaction, experimentation, and reflection [14], and the principles of educational gamification, which suggest that incorporating game elements into learning contexts enhances motivation, engagement, and knowledge retention [15].

This research is expected to provide both practical and theoretical benefits. Practically, it offers insights for science educators in madrasah settings on integrating digital

gamification tools effectively. Theoretically, it contributes to the literature on digital learning and scientific literacy by examining not only learning outcomes but also students' cognitive processes and higher-order thinking skills. Moreover, by focusing on an underexplored educational context, this study expands understanding of the relationship between digital technology, gamification, and science learning in Indonesia.

2. METHOD

This study employed a qualitative case study design. This design was selected to obtain an in-depth understanding of the implementation of science learning using digital quizzes and its impact on students' scientific literacy regarding the circulatory system. Through this approach, the researcher was able to explore direct descriptions, perceptions, and learning experiences from both teachers and students. Data collection relied on triangulation, analysis was conducted inductively, and the findings emphasized meaning rather than generalization [16]

The study was conducted at MTsN 23 Jakarta and involved 32 Grade VIII.1 students as the main participants. The class was selected based on three criteria: consistent use of ICT tools during learning activities, the teacher's willingness to collaborate throughout the research process, and the heterogeneous academic characteristics of the students that allowed for a comprehensive representation of learning practices. The research was conducted over four weeks during the first semester of the 2025/2026 academic year, with a specific focus on the Human Circulatory System, one of the core competencies in Grade VIII science.

The research instruments consisted of interview guidelines, observation sheets, questionnaires, and supporting documents. The interview guideline was developed to explore teachers' and students' experiences with digital quizzes, their perceptions of the effectiveness of these tools, the challenges encountered during the learning process, and students' conceptual understanding of the circulatory system. In addition, the observation and questionnaire instruments were aligned with three domains of scientific literacy, namely: (1) explaining phenomena scientifically, which reflects students' ability to describe the processes and functions of the circulatory system; (2) evaluating and interpreting data, which refers to students' capacity to read, interpret, and assess response data or scores generated from digital quizzes; and (3) scientific interpretation, which captures the extent to which students can relate circulatory system concepts to real-life contexts.

All instruments were validated by two science education experts who assessed the alignment of indicators, the adequacy of content, the clarity of the construct, and the coherence of the language. The feedback from these experts served as the basis for refining and revising the interview guidelines, observation sheets, and questionnaires before their field application, ensuring that each instrument met the required validity standards.

Additional validation was strengthened through triangulation, which enhanced the credibility of the collected data. Source triangulation was implemented by comparing information obtained from teachers, students, and relevant documents. Method triangulation was achieved by examining consistency across interviews, observations, questionnaires, and documentation. Time triangulation was carried out by verifying and rechecking data at

multiple points in time, allowing the researcher to confirm the stability and reliability of the findings.

Data trustworthiness was ensured through four criteria: credibility, transferability, dependability, and confirmability [17]. Credibility was established through source and method triangulation, complemented by member checking to verify the accuracy of participants' responses. Transferability was supported by providing rich, detailed descriptions of the research context, enabling readers to assess the applicability of the findings to similar educational settings. Dependability was maintained by documenting a comprehensive audit trail of each step in the research process, ensuring that procedures remained transparent and replicable. Confirmability was achieved by grounding all findings in verifiable evidence, thereby minimizing researcher bias and ensuring that interpretations accurately reflected the data collected.

Dependability in this study was ensured by maintaining a complete audit trail documenting all research procedures, including data collection activities, coding decisions, instrument revisions, and analytical steps. Confirmability was strengthened by systematically cross-checking all interpretations against raw data sources, including interview transcripts, observation notes, and documentation, thereby ensuring that findings were grounded in verifiable evidence.

Data collection in this qualitative research was executed using a variety of robust techniques to ensure the validity of findings through triangulation. The primary method employed was the Interview Method, designed to elicit in-depth, firsthand information from the key participants: the Grade VIII Science teacher at MTsN 23 Jakarta and the students of class VIII.1. This approach utilized both in-depth interviews, which were intensive and open-ended to gather rich, detailed narratives, and structured interviews, which followed predetermined questions while still accommodating flexible responses.

Complementing the interviews, the Observation Method was implemented to capture and analyze the dynamics within the learning environment directly. The focus of observation included crucial elements such as teacher–student interactions, student engagement during ZEP Quiz activities, classroom atmosphere, and any technical or non-technical issues that emerged during the implementation phase. This observational data was essential for capturing natural behaviors and events, thereby enriching the analysis of the instructional process.

Furthermore, a Questionnaire Method using closed, open-ended, and mixed-format questions was distributed to collect quantitative and qualitative feedback on students' perceptions, experiences, and responses to the digital quizzes. The questionnaire served as crucial supplementary data, strengthening the information gathered from the interviews and observations. Finally, the Documentation Method was utilized to gather supporting evidence, including key artifacts such as Lesson Plans (RPP/Modul Ajar), ZEP Quiz results, pretest and posttest scores, interview transcripts, and photos of classroom activities. Collectively, these techniques form a comprehensive data set that validates and completes the qualitative inquiry.

The analysis of qualitative data in this study adhered to the interactive model proposed by Miles and Huberman (1994), a structured approach encompassing three

sequential and interactive stages. The process began with Data Reduction, a crucial step that involved selecting, focusing, simplifying, and abstracting the voluminous raw data collected from interviews, observations, and documentation. In practice, this stage included categorizing statements from both teachers and students, summarizing detailed classroom observation notes, and systematically grouping similar responses from the questionnaires. This focused effort ensured that the analytical process focused solely on the most relevant information related to the research objectives.

Following the reduction stage, the data proceeded to Data Display. The condensed data were systematically organized and presented primarily through narrative descriptions. This structured display was instrumental in helping the researchers identify significant patterns, connections, and emerging themes related to the implementation of the ZEP Quiz, its impact on student engagement and improvement in scientific literacy, and the identification of both supporting and inhibiting factors. Presenting the data narratively provided a coherent framework, facilitating the interpretation of how the utilization of digital quizzes influenced the overall science learning process.

The final stage involved Conclusion Drawing and Verification, where researchers derived core meanings and insights from the analyzed data to address the study's research questions directly. To ensure the trustworthiness and rigor of the findings, the conclusions were thoroughly verified. This verification process involved several critical steps, including rechecking original interview and observation records, triangulating data across diverse sources (teachers, students, and documentation), and reviewing the consistency of findings across multiple instruments. Through this systematic, verified process, the researchers produced reliable, well-supported conclusions about the effectiveness of digital quizzes in enhancing scientific literacy.

3. RESULTS AND DISCUSSION

The results of this study demonstrate a clear and substantial improvement in students' conceptual understanding and scientific literacy following the implementation of the ZEP Quiz in the Circulatory System lesson. The quantitative data reveal a notable increase in students' performance, as indicated by the average score rising from 44 on the pretest to 80 on the posttest. This improvement reflects meaningful learning gains, with 29 out of 30 students (96.6%) showing progress after engaging with the digital quiz. To present these findings more clearly, Table 1. Comparison of Pretest and Posttest Scores and Figure 1 presents a bar chart illustrating this improvement.

Table 1. Comparison of Pretest and Posttest Scores

Assessment	Mean Score	n	Description
Pretest	44	30	Initial understanding before using ZEP Quiz
Posttest	80	30	Final understanding after using ZEP Quiz

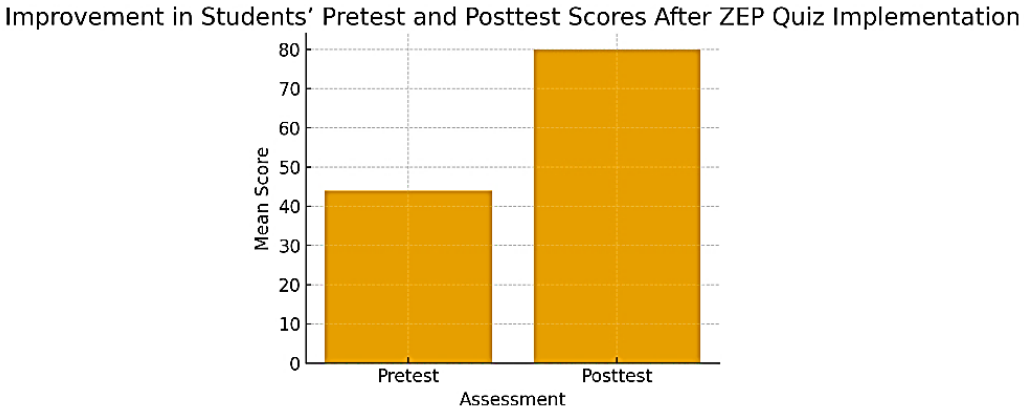

Figure 1. Improvement in Students' Pretest and Posttest Scores After ZEP Quiz Implementation

Table 2. Visualization of Questionnaire Results: Effectiveness of ZEP Quiz

Dimensions of Analysis	Percentage Score (%)	Bar Visualization
Motivation and Interest	89,0%	
Evaluation & Cognitive	85,2%	
Scientific Literacy	83,6%	
Challenges/Barriers	67,0%	

The improvement is also visualized in a simple bar chart that clearly shows the magnitude of the change. The bar representing the pretest score appears substantially lower than the posttest bar, visually reinforcing the substantial positive impact of the ZEP Quiz on students' conceptual mastery. Beyond numerical improvements, qualitative data provide important contextual insights. Classroom observations revealed a highly interactive learning environment in which students actively engaged with the quiz tasks, collaborated with peers, and demonstrated increased focus. Students appeared motivated and responsive, showing positive competition as they attempted to achieve higher scores.

The student questionnaire results further support these observations. With an average rating of 4.5 out of 5, students consistently indicated that ZEP Quiz enhanced their learning experience by providing immediate feedback, increasing motivation, and making lessons more enjoyable. These perceptions were echoed in student interviews, where learners reported that the instant feedback helped them identify misconceptions and correct them independently. The Science teacher's interview reinforced this view, highlighting that the ZEP Quiz not only streamlined the evaluation process but also encouraged deeper engagement during and after the activity. Although several minor challenges emerged, most notably unstable internet connectivity and limited device availability, the teacher effectively mitigated these issues by adjusting the session duration or providing alternative arrangements. Overall, the results confirm that ZEP Quiz effectively enhances student learning and supports the development of scientific literacy in a digital learning environment [18].

The findings of this study align with established theoretical frameworks explaining how digital learning tools influence student motivation, engagement, and scientific understanding. The marked improvement in students' engagement and performance closely

aligns with Self-Determination Theory [19], which posits that intrinsic motivation grows when students experience autonomy, competence, and relatedness. ZEP Quiz supports autonomy by enabling independent learning, enhances competence through immediate feedback, and promotes relatedness through collaborative reflection. These elements contribute to a motivational environment that encourages active and sustained learning [9].

The gamified elements of ZEP Quiz, such as time limits, scoring, and rankings, are also consistent with Gamification Theory [20], which asserts that game-like features increase engagement by creating a sense of challenge, enjoyment, and accomplishment. Observations from classroom implementation reflect these theoretical principles: students demonstrated heightened excitement, focus, and cognitive engagement throughout the activities [21].

The improvement in scientific literacy aligns with the OECD Scientific Literacy Framework, which emphasizes skills such as explaining phenomena scientifically, interpreting data, and using scientific evidence for reasoning. The reflective review session conducted after the quiz, during which teachers analyzed common errors, displayed score graphs, and reinforced related concepts, played a crucial role in strengthening these competencies. This process turned the quiz into a deeper learning experience rather than merely a test of recall [22].

Comparisons with prior studies show both alignment and important distinctions. Similar to the findings of Shofawati et al. [23], this study found that digital assessment tools enhance student concentration and achievement. Aprilia et al. [24] also reported the effectiveness of instant feedback in correcting misconceptions, a pattern evident in this study. However, this research differs from previous work by focusing explicitly on scientific literacy rather than general learning outcomes, and by being conducted in a madrasah context, which remains underrepresented in digital learning research. Additionally, this study offers richer qualitative perspectives through observations, interviews, and questionnaire triangulation, in contrast to earlier studies that were primarily quantitative.

Several obstacles were encountered, particularly unstable internet connections and varying levels of digital proficiency among students. Despite these challenges, the overall implementation remained effective due to strong student enthusiasm, teacher readiness, and adequate school facilities. This supports the view of Paling and Suparyono (2024), who argued that successful digital learning integration requires collaborative readiness from teachers, students, and institutions [25].

In conclusion, the findings highlight that ZEP Quiz is not merely a digital assessment tool but an effective instructional medium that enhances engagement, strengthens motivation, and improves scientific literacy. Its integration of gamification strategies, motivational principles, and reflective learning processes positions it as a highly relevant and powerful resource for contemporary science education, especially within madrasah settings.

4. CONCLUSION

The study highlights that integrating ZEP Quiz as a digital learning medium can meaningfully transform science learning by fostering interactive, student-centered engagement and enhancing key aspects of scientific literacy. These findings suggest that

incorporating gamified digital tools can serve as an effective strategy for stimulating motivation, promoting self-regulated learning, and facilitating deeper conceptual understanding. From a practical perspective, the study underscores the need for schools and educators to invest in adequate technological infrastructure and ongoing professional development to optimize the implementation of digital learning innovations. The research boundaries include its focus on a single grade level within a single madrasah context, which may limit the generalizability of the findings to other educational settings or age groups. For future research, investigations could examine the longitudinal effects of digital gamification on scientific literacy across multiple grade levels, compare different gamified platforms, or examine its integration with hybrid learning models. Overall, this study contributes to the broader educational field by providing evidence that gamified digital media, such as ZEP Quiz, can strengthen both engagement and scientific reasoning skills, offering practical insights for educators and policymakers seeking to advance digital learning practices in schools.

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