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Research Article

Implementation of Google Classroom, YouTube, and Quizizz Multimedia to Improve Students' Motivation and Cognitive Learning Outcomes in Islamic Religious Education Learning

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Abstract: This study was motivated by the low levels of student motivation and cognitive learning outcomes in the Islamic Education (PAI) subject at SMK Pasundan 1 and SMK Bunga Persada Cianjur. The phenomenon was identified through preliminary observations showing that 45% of students scored below the Minimum Mastery Criteria (KKM) and demonstrated low engagement during the learning process. The school's efforts to improve student motivation and learning outcomes have not been optimal, as teaching methods and media are still largely limited to conventional approaches. Therefore, innovation in learning through the use of technology-based interactive multimedia such as Google Classroom, YouTube, and Quizizz is needed to create more engaging and effective learning experiences. The objectives of this study were to identify: (1) the implementation of Google Classroom, YouTube, and Quizizz multimedia in PAI learning; (2) students' learning motivation; (3) students' cognitive learning outcomes; (4) the influence of multimedia implementation on students' learning motivation; (5) the influence of multimedia implementation on students' cognitive learning outcomes; and (6-8) the qualitative findings that expand and deepen the quantitative results regarding multimedia implementation, learning motivation, and cognitive learning outcomes at SMK Pasundan 1 and SMK Bunga Persada Cianjur. This research employed a Mixed Methods approach using a sequential explanatory design, combining quantitative and qualitative methods in sequence. Data were collected through questionnaires, interviews, observations, and document analysis. The results revealed that: (1) the implementation of Google Classroom, YouTube, and Quizizz multimedia in PAI learning was rated "good" with an average score of 83%; (2) students' learning motivation was rated "very good" with a score of 86%; (3) students' cognitive learning outcomes were rated "very good" with a score of 86.5%; (4) multimedia implementation had a positive and significant effect on students' learning motivation; (5) multimedia implementation had a positive and significant effect on students' cognitive learning outcomes; and (6-8) qualitative findings reinforced and enriched the quantitative results. Thus, the implementation of multimedia-based learning using Google Classroom, YouTube, and Quizizz has proven effective in enhancing students' motivation and cognitive learning outcomes in Islamic Education at SMK Pasundan 1 and SMK Bunga Persada Cianjur

Keywords: Cognitive Learning; Implementation; Islamic Education; Motivation; Multimedia.

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1. Introduction

The world of education in Indonesia is perceived to be developing very rapidly. This is evidenced by the advancement of technology, which has had a positive impact on education. Through technology, students are able to access information more widely and quickly from various sources. The utilization of technology makes learning activities more innovative and less monotonous, as reflected in the diversity of learning methods and media used (Sadiman, 2012).

Law of the Republic of Indonesia Number 20 of 2003 Article 3 concerning the National Education System states that national education functions to develop learners into citizens who believe in and fear God Almighty, possess noble character, are knowledgeable, competent, creative, independent, and responsible. Based on this provision, educators play a strategic role in improving the quality of national education. This is in line with Law of the Republic of Indonesia Number 14 of 2005 Article 6, which emphasizes that teachers and lecturers, as professional educators, are tasked with implementing the national education system to achieve national education goals.

To achieve the functions and objectives of national education, educators are required to think creatively in developing students' potential. One effort that can be made is the utilization of instructional media in the teaching and learning process. The use of learning media can increase students' learning motivation, clarify learning materials, vary teaching methods, and encourage more optimal student learning activities (Ambiyar, 2016). The variety of instructional media used makes the learning process more dynamic and contributes to improving students' achievement and learning motivation.

Motivation is an important factor in the success of the learning process. Motivation determines whether students will actively engage in learning activities or avoid them. Learning without motivation will be difficult to achieve optimal outcomes because students are not encouraged to learn seriously (Kompri, 2012). Learning itself is a conscious activity to acquire knowledge and understanding, while learning outcomes or academic achievement are the results obtained by students after participating in the learning process, either individually or in groups (Djamarah, 2012).

Based on the researcher's observations at SMK Pasundan 1 Cianjur in collaboration with the principal and Islamic Religious Education teachers, several problems were identified, including low student learning motivation, declining cognitive learning outcomes, and student behavior that does not adequately reflect the values of Islamic Religious Education. Similar problems were also found at SMK Bunga Persada Cianjur, particularly related to students' motivation and cognitive learning outcomes.

Although the schools have made various efforts, such as creating a conducive learning environment, organizing learning schedules, preparing lesson plans, improving facilities and infrastructure, and recruiting competent educators, the results have not been optimal. This is evidenced by data showing that approximately 45% of students still achieve scores below the Minimum Mastery Criteria (KKM/KKTP) established by the schools. According to the researcher, this condition is caused by the inappropriate implementation of learning models and instructional media, resulting in less effective and efficient learning.

Therefore, learning innovation is needed through the utilization of technology-based multimedia learning. The multimedia referred to includes the use of Google Classroom as a learning management medium, YouTube as an audio-visual learning medium, and Quizizz as a learning evaluation medium. The use of this multimedia is expected to increase students' motivation and cognitive learning outcomes in the subject of Islamic Religious Education and Character Education, as well as to contribute positively to improving the quality of learning at SMK Pasundan 1 and SMK Bunga Persada Cianjur.

2. Literature Review

This section must contain a state-of-the-art explanation. It can be explained in several ways. First, you can discuss several related papers, both about objects, methods, and their results. From there, you can explain and emphasize gaps or differences between your research and previous research. The second way is to combine theory with related literature and explain each theory in one sub-chapter.

Multimedia Learning Theory, developed by Richard E. Mayer, explains that learning becomes more effective when information is presented through a simultaneous combination of verbal and visual channels (Mayer, 2001; Mayer, 2009). This theory is grounded in a cognitive approach which asserts that humans possess two primary channels for processing information, namely the verbal–auditory channel and the visual–pictorial channel. Mayer proposes three fundamental assumptions—dual-channel assumption, limited capacity assumption, and active processing assumption—which emphasize that effective learning occurs when learners actively attend to, organize, and integrate new information with prior knowledge (Mayer, 2005; Mayer, 2009). Therefore, multimedia instructional design must consider cognitive load management to prevent cognitive overload that may hinder learners' comprehension (Sweller, Ayres, & Kalyuga, 2011).

In Islamic Religious Education (PAI), the use of multimedia is highly relevant because it enables abstract religious concepts to be presented through integrated visual and verbal representations. The use of Google Classroom allows teachers to manage and distribute learning materials systematically in the form of texts, videos, and discussion forums, thereby supporting independent and collaborative learning (Iftakhar, 2016). YouTube, as a video-based learning medium, enhances conceptual understanding through interactive combinations of visuals, audio, and narration, which positively affect students' memory retention and learning effectiveness (Zhang et al., 2006). Meanwhile, Quizizz, through its gamification approach, functions not only as an assessment tool but also as a means of increasing learning motivation by providing immediate feedback and creating an enjoyable learning atmosphere (Bicen & Kocakoyun, 2018). Appropriate use of multimedia can increase students' interest and contribute to improved cognitive learning outcomes (Munir, 2012; Sa'ud, 2011).

Learning motivation and cognitive aspects are essential factors in the success of PAI learning. Learning motivation is understood as a psychological drive within learners that fosters enthusiasm, direction, and persistence in learning (Sardiman, 2011; Uno, 2016). Self-Determination Theory explains that intrinsic motivation develops optimally when the needs for autonomy, competence, and social relatedness are fulfilled. Technology-based learning environments such as Google Classroom, YouTube, and Quizizz provide opportunities for learners to engage in self-directed learning, demonstrate competence, and interact socially, thereby supporting the development of intrinsic learning motivation. From a cognitive perspective, learning occurs through processes of assimilation and accommodation of new information (Piaget) and is strongly influenced by cognitive load management (Sweller et al., 2011). Thus, the application of multimedia in PAI learning functions not only as a means of content delivery but also as an effective pedagogical strategy for enhancing students' motivation and cognitive learning outcomes (Mayer, 2009; Munir, 2012).

3. Materials and Method

The research approach used in this study is Mixed Methods Research, which combines quantitative and qualitative methods within a single study. This approach was chosen because the researcher aimed to obtain more comprehensive data by integrating the strengths of measurable quantitative data with in-depth qualitative data. This study employs a sequential explanatory design, in which the first stage involves quantitative research to test hypotheses through the collection and analysis of numerical data, followed by a qualitative stage intended to deepen, strengthen, and provide meaning to the quantitative findings. The data consist of quantitative data in the form of questionnaire and test scores, as well as qualitative data in the form of narratives derived from observations, interviews, and documentation. All data are primary data obtained directly from the research sources, supported by secondary data in the form of relevant supporting documents.

Quantitative data collection techniques were carried out through closed-ended questionnaires and tests administered to students at SMK Pasundan 1 and SMK Bunga Persada Cianjur. The questionnaire instrument used a five-point Likert scale for both the technology-based multimedia learning variable and students' learning motivation, consisting of favorable and unfavorable items. Meanwhile, qualitative data were collected through observation, interviews, and documentation studies. Observations were conducted to examine the implementation of learning activities, student engagement, and teacher performance during the implementation of multimedia-based learning and conventional learning. Interviews were conducted with school principals, vice principals for curriculum affairs, Islamic Religious Education teachers, and students to obtain more in-depth supporting data. Documentation studies were used to complement the data by collecting curriculum documents, learning devices, as well as photographs and videos of learning activities.

4. Results and Discussion

In this section, the author needs to explain the hardware and software used, dataset sources, initial data analysis, results, and results analysis/discussion. Presenting the results with pictures, graphs and tables is highly recommended. Formulas or evaluation measuring tools also need to be included here. There must be discussion/analysis, and you can't just rewrite the results in sentence form, but you need to provide an explanation of their

relationship to the initial hypothesis. In addition, this section needs to discuss and elaborate on important findings.

Implementation of Multimedia Using Google Classroom, YouTube, and Quizizz in PAI Learning at SMK Pasundan 1 Cianjur and SMK Bunga Persada Cianjur

Based on the results of descriptive statistical analysis, the implementation of multimedia using Google Classroom, YouTube, and Quizizz in Islamic Religious Education (PAI) learning at SMK Pasundan 1 and SMK Bunga Persada Cianjur was categorized as good to very high. At SMK Pasundan 1 Cianjur, the average score reached 82%, while at SMK Bunga Persada Cianjur it reached 84%, with a combined average of 83%. These findings indicate that all stages of the learning implementation were carried out optimally, including student orientation to problems, student organization, guidance of independent and group investigations, development and presentation of results, as well as analysis and evaluation. Students demonstrated high enthusiasm during the learning process, indicating that the use of technology-based multimedia in PAI learning was effective and aligned with learning objectives.

The results of interviews, observations, and documentation studies strengthened the quantitative findings, showing that the implementation of Google Classroom, YouTube, and Quizizz positioned students as the center of learning while encouraging independence, collaboration, and critical thinking skills in solving real-world problems. These findings are consistent with Piaget's and Vygotsky's constructivist theory, Bandura's social cognitive theory, Malcolm Knowles' principles of andragogy, and Deci and Ryan's self-determination theory, which emphasize the importance of autonomy, competence, and relatedness in learning. In addition to improving conceptual understanding and learning motivation, this multimedia implementation also enhanced 21st-century skills, particularly collaborative and communicative skills. The results are supported by previous studies demonstrating that the integrated use of Google Classroom, YouTube, and Quizizz is effective in improving learning outcomes, social skills, and students' self-confidence at the secondary education level.

Students' Learning Motivation in PAI Learning at SMK Pasundan 1 Cianjur and SMK Bunga Persada Cianjur

Based on the results of descriptive statistical analysis of the students' learning motivation variable, it was found that students' learning motivation at SMK Pasundan 1 Cianjur was categorized as very high for 11.4% of students (8 students), high for 21.4% (15 students), moderate for 37.18% (26 students), low for 27.1% (19 students), and very low for 2.9% (2 students). These results indicate that students at SMK Pasundan 1 Cianjur generally demonstrate very good learning motivation. All motivation indicators were achieved at a very good level, as reflected by an average motivation score of 86%.

Similarly, the descriptive statistical analysis of students' learning motivation at SMK Bunga Persada Cianjur showed that 4.3% of students (1 student) were categorized as very high, 26.1% (6 students) as high, 39.1% (9 students) as moderate, 21.7% (5 students) as low, and 8.7% (2 students) as very low. These findings suggest that students at SMK Bunga Persada Cianjur also possess very good learning motivation. Overall, the average motivation score at the two schools reached approximately 86%, indicating that students' learning motivation has been well established and implemented at a very good level in both institutions.

Students' Cognitive Learning Outcomes in PAI Learning at SMK Pasundan 1 Cianjur and SMK Bunga Persada Cianjur

Based on the results of descriptive statistical analysis of the students' cognitive learning outcomes, it was found that at SMK Pasundan 1 Cianjur, 11.4% of students (8 students) were categorized as very high, 25.7% (18 students) as high, 25.7% (18 students) as moderate, 31.24% (24 students) as low, and 2.9% (2 students) as very low. These results indicate that students at SMK Pasundan 1 generally demonstrate good cognitive learning outcomes. All indicators were achieved at a very good level, as reflected by an average cognitive learning outcome score of 86%.

Similarly, the descriptive statistical analysis of cognitive learning outcomes at SMK Bunga Persada Cianjur showed that no students (0%) were categorized as very high, while 39.1% (9 students) were categorized as high, 34.8% (8 students) as moderate, 17.4% (4 students) as low, and 8.7% (2 students) as very low. These findings indicate that students at SMK Bunga Persada Cianjur also demonstrate good cognitive learning outcomes. All

indicators were achieved very well, as evidenced by an average cognitive learning outcome score of 87%.

Overall, the descriptive statistical analysis of cognitive learning outcomes at both schools indicates that students' cognitive learning outcomes have been well established and implemented at a very good level, with a combined average score of 86.5%.

The Effect of Google Classroom, YouTube, and Quizizz Multimedia on Students' Learning Motivation at SMK Pasundan 1 and SMK Bunga Persada Cianjur

The results of simple regression analysis indicate that the implementation of multimedia using Google Classroom, YouTube, and Quizizz in Islamic Religious Education (PAI) learning has a positive and significant effect on students' learning motivation at SMK Pasundan 1 Cianjur and SMK Bunga Persada Cianjur. At SMK Pasundan 1 Cianjur, the calculated *t* value of 4.552 was greater than the *t* table value of 1.997, with a significance level of 0.001 < 0.05; therefore, H_0 was rejected and H_a was accepted. The coefficient of determination (R^2) of 0.234 indicates that 23.40% of the variance in students' learning motivation was influenced by multimedia implementation, while the remaining 76.60% was affected by other variables outside this study.

Similarly, at SMK Bunga Persada Cianjur, the calculated *t* value of 4.600 was greater than the *t* table value of 2.080, with a significance level of 0.001 < 0.05; thus, H_0 was rejected and H_a was accepted. The coefficient of determination (R^2) of 0.502 indicates that 50.20% of students' learning motivation was influenced by the implementation of Google Classroom, YouTube, and Quizizz, while the remaining 49.80% was influenced by other factors.

The difference in the coefficients of determination (R^2) between the two schools indicates distinct learning characteristics and conditions at each research site. These differences are influenced by the academic background and educational level of the PAI teachers. At SMK Pasundan 1, the PAI teacher has an undergraduate (S1) background in Islamic Education, whereas at SMK Bunga Persada, the PAI teacher has a master's degree (S2) in Ushuluddin. In addition, differences were observed in content delivery and instructional approaches: the PAI teacher at SMK Pasundan 1 presented learning problems contextually through community life narratives using an inclusive approach, while the PAI teacher at SMK Bunga Persada employed viral social media content with a holistic approach, resulting in a stronger impact on students' learning motivation.

The Effect of the Implementation of Google Classroom, YouTube, and Quizizz Multimedia on Students' Cognitive Learning Outcomes at SMK Pasundan 1 and SMK Bunga Persada Cianjur

The results of simple regression analysis indicate that the implementation of multimedia using Google Classroom, YouTube, and Quizizz in Islamic Religious Education (PAI) learning has a positive and significant effect on students' cognitive learning outcomes at both schools. At SMK Pasundan 1 Cianjur, the calculated *t* value of 4.932 was greater than the *t* table value of 1.997, with a significance level of 0.001 < 0.05; therefore, H_0 was rejected and H_a was accepted. The coefficient of determination (R^2) of 0.263 indicates that multimedia implementation contributed 26.30% to students' cognitive learning outcomes, while the remaining 72.70% was influenced by other variables outside the scope of this study. These findings demonstrate that the effective use of Google Classroom, YouTube, and Quizizz can enhance students' cognitive learning outcomes.

Meanwhile, at SMK Bunga Persada Cianjur, the calculated *t* value of 2.236 was greater than the *t* table value of 2.080, with a significance level of 0.036 < 0.05, indicating a positive and significant effect of multimedia implementation on students' cognitive learning outcomes. The R^2 value of 0.192 suggests that the implementation of Google Classroom, YouTube, and Quizizz contributed 19.20% to students' cognitive learning outcomes, while 80.80% was influenced by other factors. Based on these findings, it can be concluded that the more appropriate and effective the implementation of multimedia learning, the higher the students' cognitive learning outcomes; conversely, less optimal implementation may lead to lower cognitive learning outcomes.

Multimedia Expanding and Deepening Quantitative Data at SMK Pasundan 1 and SMK Bunga Persada Cianjur

The qualitative data analysis in the second phase indicates that the implementation of multimedia using Google Classroom, YouTube, and Quizizz expanded and deepened the quantitative findings in PAI learning at SMK Pasundan 1 and SMK Bunga Persada Cianjur. In both schools, the indicators of multimedia use were categorized as high, showing that teachers effectively utilized Google Classroom for delivering materials, assignments, and online discussions; YouTube as a visual medium to clarify religious concepts and phenomena; and Quizizz as an interactive formative assessment tool. The qualitative findings also reveal that teachers were able to create dynamic learning interactions by incorporating current issues and content closely related to students' daily lives, making the learning process more contextual and meaningful. Teacher–student interactions occurred actively, both in face-to-face classes and through online platforms, with teachers responding promptly to students' questions and opinions.

Furthermore, the effective implementation of multimedia in both schools had a positive impact on students' engagement, independence, and understanding in PAI learning. Teachers guided students in designing, completing, and presenting assignments in various formats, such as videos, presentations, and written reports, thereby encouraging independent and collaborative learning. This multimedia implementation not only enhanced the flexibility and accessibility of learning but also created an interactive learning environment aligned with the characteristics of Generation Z learners. Therefore, the use of Google Classroom, YouTube, and Quizizz in PAI learning at SMK Pasundan 1 and SMK Bunga Persada Cianjur is strongly recommended for sustainable implementation, with teachers acting as facilitators who leverage technology to encourage students to become more active, creative, and critical in the learning process.

Qualitative Analysis of Students' Learning Motivation Expanding and Deepening Quantitative Data at SMK Pasundan 1 and SMK Bunga Persada Cianjur

The qualitative data analysis conducted in the second phase indicates that the qualitative findings expanded and deepened the quantitative data on students' learning motivation in PAI learning at SMK Pasundan 1 and SMK Bunga Persada Cianjur. Regarding the indicators of interest and motivation, high levels were identified, showing that the use of Google Classroom, YouTube, and Quizizz significantly increased students' learning interest. Students perceived the learning process as more flexible, visual, and interactive, which enhanced their enthusiasm for participating in PAI learning. Google Classroom facilitated easy access to learning materials and online interaction, YouTube helped clarify abstract concepts through contextual visualizations, and Quizizz created an enjoyable and challenging assessment atmosphere. The integration of these three media formed a dynamic learning environment that motivated students to actively engage in PAI learning.

In addition to increasing interest, multimedia implementation also had a positive impact on students' learning independence, persistence, active participation, and readiness to face learning challenges. Students became accustomed to managing their study time independently, accessing learning materials proactively, and seeking additional references through YouTube. Meanwhile, the use of Google Classroom and Quizizz encouraged consistency in completing assignments, active involvement in discussions, and positive attitudes toward learning evaluation. Students demonstrated resilience and optimism in facing academic challenges, including a willingness to retry when encountering difficulties. Thus, the integration of Google Classroom, YouTube, and Quizizz in PAI learning not only strengthened learning motivation quantitatively but also fostered positive learning attitudes qualitatively, making it effective in improving the quality of PAI learning at the vocational high school level.

Qualitative Analysis of Students' Cognitive Learning Outcomes Expanding and Deepening Quantitative Data at SMK Pasundan 1 and SMK Bunga Persada Cianjur

Based on the qualitative research data analysis conducted in the second phase, the qualitative findings were able to expand and deepen the quantitative data on students' cognitive learning outcomes. As an illustration, the indicator of remembering achieved an average score of 88.21%. These quantitative results were further elaborated and enriched by qualitative data, showing that students at SMK Pasundan 1 Cianjur made strong efforts to understand and retain PAI learning materials effectively.

The research findings indicate that, on the remembering indicator, students demonstrated very good achievement with an average score of 88.21%. This figure represents students' ability to recall information delivered during the learning process, particularly in Islamic Religious Education (PAI) materials. Remembering is the initial stage in the cognitive taxonomy and plays a crucial role as a foundation for higher-order thinking processes, such as understanding, applying, and evaluating. The high score on this indicator suggests that most students were able to accurately retrieve previously learned knowledge.

This positive learning attitude and behavior significantly supported the high achievement in the remembering aspect. Students did not rely solely on rote memorization but also demonstrated consistent learning persistence. They understood that PAI materials are not merely subjects to be memorized for examinations but are integral to character formation and the reinforcement of moral values in daily life. This awareness encouraged students to engage earnestly in the learning process, thereby strengthening their cognitive learning outcomes qualitatively as well as quantitatively.

5. Conclusion & Suggestions

Conclusion

Based on the results of the research and discussion presented in the previous chapters, it can be concluded that the implementation of Google Classroom, YouTube, and Quizizz multimedia in Islamic Religious Education (PAI) learning at the vocational high school level was effective in improving students' learning motivation and cognitive learning outcomes at SMK Pasundan 1 and SMK Bunga Persada Cianjur. The implementation of multimedia in PAI learning achieved a good qualification with an average score of 83%, indicating that multimedia-based instruction was carried out effectively and in accordance with learning objectives.

Students' learning motivation at both schools was classified as very good, with an average score of 86%. This result reflects high levels of enthusiasm, persistence, and active engagement among students during PAI learning activities supported by multimedia. In addition, students' cognitive learning outcomes also reached a very good qualification, with an average score of 86.5%, demonstrating that the use of multimedia contributed positively to students' understanding and mastery of PAI concepts.

The findings further indicate that the implementation of Google Classroom, YouTube, and Quizizz multimedia had a positive and significant effect on students' learning motivation at both schools. Multimedia-based learning environments encouraged students to participate more actively, increased their interest in learning, and supported the development of positive learning attitudes. Similarly, multimedia implementation also had a positive and significant effect on students' cognitive learning outcomes, confirming that effective integration of digital learning media can enhance academic achievement in Islamic Religious Education.

Qualitative findings expanded and deepened the quantitative results by providing contextual explanations of how multimedia was implemented in the learning process. The qualitative data revealed that the use of Google Classroom, YouTube, and Quizizz facilitated interactive learning, independent and collaborative study, and meaningful engagement with learning materials. Furthermore, qualitative evidence strengthened the quantitative data on students' learning motivation and cognitive learning outcomes, showing that students developed positive learning behaviors, strong engagement, and deeper understanding of PAI values.

Overall, the integration of Google Classroom, YouTube, and Quizizz multimedia in PAI learning was proven effective in improving students' learning motivation and cognitive learning outcomes, both quantitatively and qualitatively. Therefore, this approach is appropriate to be considered as an alternative instructional strategy for Islamic Religious Education at the vocational high school level.

Suggestions

Based on the findings of this study, several recommendations are proposed for relevant stakeholders. The Ministry of Education, Culture, Research, and Technology is encouraged to continue supporting and facilitating the use of digital-based multimedia in learning, particularly in PAI subjects, through systematic training programs and technical assistance for teachers. The development of inclusive policies that integrate digital platforms such as Google Classroom, YouTube Edu, and Quizizz into the national curriculum is also recommended,

along with equitable infrastructure development, especially in underdeveloped, frontier, and outermost regions.

Educational institutions, including schools, madrasahs, and education offices, are advised to provide strong institutional support for teachers in implementing multimedia-based learning by ensuring adequate internet access and supporting learning devices. Regular professional development activities should be conducted to enhance teachers' digital literacy and optimize the use of Google Classroom, YouTube, and Quizizz as innovative learning tools.

Future researchers are encouraged to explore the long-term effects of multimedia-based learning on students' character development and religiosity in Islamic Religious Education. Further studies may also examine similar multimedia implementations at different educational levels or in other subject areas and focus on developing contextual technology-based learning models tailored to diverse student characteristics.

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