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Digital Learning Ecosystem as a Foundation for Metaverse-Supported Islamic Religious Education: A Case Study at Muhammadiyah Junior High School PK Kottabarat

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ABSTRACT

The rapid development of digital technology has transformed educational practices and encouraged schools to develop more interactive, connected, and technology-supported learning environments. In Islamic Religious Education (IRE), digital technologies can improve material presentation, accessibility, student engagement, and contextual understanding while providing an important foundation for future metaverse-supported learning. This study aims to analyze the digital learning ecosystem at Muhammadiyah Junior High School PK Kottabarat and its relevance as a foundation for metaverse-supported Islamic Religious Education, focusing on technology implementation, perceived effectiveness, supporting factors, inhibiting factors, and contributions to the learning process. This study employed a qualitative approach with a case study design. The participants consisted of one teacher and two students selected through purposive sampling based on their direct involvement in technology-supported learning. Data were collected through semi-structured interviews conducted over approximately two hours and analyzed through data condensation, data display, and conclusion drawing. Data credibility was strengthened through source triangulation by comparing and cross-checking teacher and student responses. The findings show that digital technology has been effectively integrated into Islamic Religious Education through Smart TVs, laptops, PowerPoint presentations, YouTube videos, internet access, visual learning materials, and other digital resources. Teachers and students perceive these technologies positively because they make learning more engaging, understandable, efficient, accessible, and less monotonous. Parental support, adequate technological facilities, students' familiarity with digital media, and institutional commitment

constitute the main supporting factors, while electricity disruptions, network instability, and device connectivity remain technical constraints. The study concludes that Muhammadiyah Junior High School PK Kottabarat has established a well-developed digital learning ecosystem that provides a strong foundation for the future implementation of metaverse-supported Islamic Religious Education. Further development toward fully immersive metaverse learning requires stronger infrastructure, enhanced teacher competence, reliable technical support, appropriate pedagogical design, and dedicated immersive platforms.

Introduction

The rapid development of digital technology has changed the learning environment from conventional classroom instruction toward more interactive, flexible, and technology-supported learning(Ng, 2022; Rahman et al., 2023). Digital transformation in education is no longer limited to the use of computers and internet access but has expanded to various multimedia and immersive technologies that allow students to interact with learning content in new ways(Li et al., 2024; Shamsudin et al., 2024). Among these developments, metaverse technology has attracted increasing attention because it offers virtual, interactive, and immersive environments that can extend learning beyond the physical classroom(Flores-Castañeda et al., 2024). A systematic review identified the growing application of the metaverse in education while emphasizing that its educational implementation remains closely related to technological infrastructure, pedagogical design, and challenges of adoption(Battal & Taşdelen, 2023). The metaverse provides a digital environment in which users can interact with virtual objects, environments, and other users through technologies associated with virtual reality, augmented reality, and three-dimensional digital spaces. In education, these characteristics create opportunities to transform students from passive recipients of information into active participants in learning experiences (Razzaq et al., 2024). Previous studies indicate that immersive technologies can support learning through visualization, interaction, simulation, and experience-based activities. However, the educational value of immersive technology depends on how the technology is integrated with learning objectives and instructional strategies rather than on technological sophistication alone(Marques et al., 2024; Prabakaran et al., 2025).

This issue is particularly relevant to Islamic Religious Education (IRE), which has distinctive educational objectives(Tural & Koçak, 2023). Islamic Religious Education does not merely transmit religious knowledge but also supports students in understanding, experiencing, and applying Islamic teachings in everyday life (Onu et al., 2024). Consequently, digital transformation in Islamic Religious Education requires an approach that connects technological innovation with pedagogical and religious values(Fadhel et al., 2024; Sharifi et al., 2025). Technology should function as a medium that helps students understand religious concepts without reducing learning to technological entertainment(Asiksoy, 2023). The metaverse offers several possibilities in this context(Lee, 2022). Islamic history, places of worship, religious practices, and other learning materials that require spatial or contextual visualization can potentially be presented through interactive virtual environments. Students may explore learning objects and environments that are difficult to access directly in conventional classroom settings. Research concerning Islamic Religious Education in Indonesia has begun to

discuss these possibilities, for example argues that metaverse integration has the potential to support interactive and meaningful Islamic Religious Education when implemented through a holistic, adaptive, and integrative approach that maintains fundamental religious, social, and cultural values(Dwivedi et al., 2022; Hussain, 2023).

Studies concerning augmented reality and virtual reality in Islamic Religious Education also indicate emerging applications in areas such as Hajj and Umrah simulation, tajwid, daily prayers, hijaiyyah letters, religious tourism, and ablution procedures. Nevertheless, their application in Indonesian Islamic Religious Education remains relatively limited. More recent studies have also explored metaverse platforms such as Roblox as potential environments for learning Islamic concepts, including aqidah, worship, muamalah, and Islamic history(Choi et al., 2025; Díaz, 2020). These developments indicate that metaverse-based Islamic education is becoming an emerging research area, but its practical integration into school-level learning still requires empirical investigation. The challenge becomes more significant because successful metaverse adoption does not depend solely on the availability of the technology(Wang, 2025). A systematic review of metaverse adoption in education shows that implementation involves interconnected individual, technological, and environmental factors. Another systematic review found that users' willingness to adopt educational metaverse environments is associated with factors such as effort expectancy, self-efficacy, enjoyment, immersion, behavioral intention, and contextual conditions. Therefore, examining metaverse technology in an actual school context requires attention not only to its pedagogical potential but also to infrastructure, teacher readiness, student responses, institutional support, and technical constraints(Bizel, 2023; Lam & Kiu, 2024).

This perspective is relevant to Muhammadiyah Junior High School PK Kottabarat as a digital-based school. Preliminary interview data indicate that technology has become an integral component of classroom learning at the school. Teachers utilize digital facilities to make learning more efficient, accessible, and engaging. Smart TVs are available in classrooms and are used to present PowerPoint materials, educational videos, visual content, and other digital learning resources. Students also perceive visual and video-based materials, particularly YouTube videos, as helpful because the materials become easier to understand and remember(Cassandra et al., 2025; Elnemr et al., 2026). These findings indicate that digital technology is not positioned merely as an additional facility but has become part of the school's learning environment. The preliminary data also reveal several conditions that influence technology integration. Teacher interviews indicate that parental support constitutes an important external factor, particularly when the school provides clear information concerning the use of technology. At the same time, technical problems remain present. Electricity disruptions, network-related consequences, and difficulties connecting teachers' laptops to classroom Smart TVs can interrupt technology-supported learning. Students expressed similar experiences. Despite these limitations, they expected more complete and reliable technological facilities that could support more engaging learning activities in the future(Jaaffar & Adnan, 2025).

Recent studies have shown growing interest in the use of metaverse technology in education because it enables interactive, immersive, and visually enriched learning environments (Di Natale et al., 2024). However, existing research has largely focused on higher education, conceptual frameworks, technology acceptance, and the general

potential of virtual and immersive environments. Empirical evidence regarding the implementation of metaverse-oriented technology in specific school subjects, particularly Islamic Religious Education (IRE) at the secondary school level, remains limited(Mizher et al., 2026). This gap is important because the successful integration of metaverse technology depends not only on technological availability but also on infrastructure, teacher readiness, pedagogical design, student engagement, and institutional support. Therefore, empirical investigation within an established digital school environment is needed to understand how existing digital practices can support the implementation and further development of metaverse-oriented learning(Egliston et al., 2025).

Metaverse technology is particularly relevant to Islamic Religious Education because several IRE materials involve visual, contextual, procedural, and experiential dimensions. Islamic history, worship practices, Hajj and Umrah, religious sites, and other religious practices can potentially be presented through interactive and immersive digital environments, allowing students to engage with learning content beyond conventional verbal and textual explanations. In this context, Muhammadiyah Junior High School PK Kottabarat provides a relevant empirical setting because digital technologies, including Smart TVs, laptops, multimedia presentations, YouTube videos, and internet-based resources, have already been integrated into classroom learning(Kucinski et al., 2026). Accordingly, the novelty of this study lies in its empirical examination of metaverse-oriented technology within an established digital ecosystem for Islamic Religious Education at the junior secondary school level, focusing on its implementation, perceived effectiveness, supporting and inhibiting factors, and contribution to the learning process(Hutson, 2022).

Method

This study employed a qualitative approach with a case study design to examine the utilization of digital technology and its relevance to metaverse-based Islamic Religious Education learning at Muhammadiyah Junior High School PK Kottabarat (Sugiyono, 2016). The research participants consisted of one teacher and two students who were selected through purposive sampling based on their direct involvement in technology-supported learning activities. Data were collected through semi-structured interviews. The interview questions focused on the implementation of technology in the classroom, perceived learning effectiveness, supporting and inhibiting factors, student engagement, preferred digital media, technical difficulties, and expectations regarding future technology use in learning(Sugiyono, 2017).

The collected data were analyzed through data condensation, data display, and conclusion drawing. The researchers identified important statements from the interview results and grouped them into several themes, including technology implementation, learning benefits, student motivation, supporting factors, technical barriers, and future expectations. To ensure data credibility, the researchers compared information obtained from the teacher with responses from the students)(Chye et al., 2024). This comparison was used to identify similarities and differences in their experiences. The findings were interpreted according to the actual conditions of digital learning at the school. The use of Smart TVs, PowerPoint presentations, YouTube videos, and internet-based resources was positioned as part of the existing digital

learning ecosystem and as a foundation for understanding the potential development of metaverse-supported Islamic Religious Education(Jans et al., 2024).

Participants were selected through purposive sampling based on their direct involvement in technology-supported Islamic Religious Education. One teacher represented the instructional perspective, while two students provided complementary classroom experiences. The limited number of participants was appropriate for this bounded qualitative case study, which emphasized information richness and contextual depth rather than statistical generalization. Data were collected through semi-structured interviews during two hours and analyzed through data condensation, data display, and conclusion drawing. Data credibility was strengthened through source triangulation by comparing and cross-checking teacher and student responses.

Results and Discussion

The results of this study indicate that the integration of technology at Muhammadiyah Junior High School PK Kottabarat has become an important part of the learning process. Based on interviews with teachers and students, technology is not merely used as supplementary equipment but has been incorporated into classroom activities to facilitate the delivery of learning materials, increase student engagement, and provide wider access to learning resources. The findings are discussed through five main aspects corresponding to the research questions: the implementation of technology, its effectiveness, supporting factors, inhibiting factors, and its contribution to the learning process.

1. Implementation of Technology in the Learning Process

The first finding concerns how technology is implemented in learning at Muhammadiyah Junior High School PK Kottabarat. The teacher explained that technological development at the school has progressed significantly and continues to follow current developments. The teacher stated:

"Technology at this school is now very advanced. As technology continues to develop, the school will continue to try to keep up with and follow the latest technological developments." (G1)

This statement indicates that the school has a strong institutional commitment to adapting learning practices to technological development. Technology is not viewed as a temporary innovation but as an important component of educational development. The implementation of technology can also be seen directly in classroom activities. Students explained that Smart TVs

are available in classrooms and are used to support teachers in presenting learning materials. One student stated:

"The school has provided Smart TVs, and we use them to explain materials through PowerPoint presentations, show learning videos from YouTube, and support other learning activities." (S1)

This finding demonstrates that technology has been integrated into daily teaching practices. Teachers use laptops, Smart TVs, presentation software, YouTube videos, and internet-based materials to complement verbal explanations and printed learning resources(Rina et al., 2025). Thus, technology functions as a medium for presenting materials in more varied forms(Faisal Fadli, 2023; Intana Syifa Nabila, 2026). The presence of Smart TVs also shows a transition from conventional teaching toward digital-supported learning. However, the current use of Smart TVs, PowerPoint, YouTube, and internet resources should not automatically be categorized as metaverse learning. Instead, these technologies represent an existing digital learning ecosystem that can become a foundation for the future adoption of more immersive technologies(Buragohain et al., 2025; Jafari, 2023; Triono Ali Mustofa, Fadhilla Nangroe Anggraini & Jasmine Aulia Kyria Hakim, 2025).

In Islamic Religious Education, this digital foundation is important because several learning materials require contextual or visual explanation. Topics related to Islamic history, worship procedures, and religious practices can be presented more concretely through digital media. Therefore, the current technology integration can be understood as an initial stage toward more advanced digital learning models(H. Huang et al., 2024; Inayati et al., 2026).

2. Effectiveness of Technology in Supporting Learning

The second research question examines whether technology is effective in supporting the learning process. The teacher perceived technology as effective because it improves both efficiency and learning quality. The teacher stated:

"Yes, with the current technology, the learning process has become more effective and efficient for students." (G1)

This statement indicates that the teacher experiences practical benefits from the use of technology during teaching. Digital media allow teachers to present information more quickly and combine text, images, videos, and other materials within a single learning session. Student responses reinforce this finding. The students stated that technology, especially Smart TVs and visual learning materials, increases their motivation to participate in learning. One student explained:

"With technology such as Smart TVs, students become more enthusiastic about learning. The learning process becomes more effective through more creative

methods, with images and visuals that make it easier for students to understand and connect with the material." (S1)

Another important finding concerns students' preference for video-based learning. One student stated:

"The technology that students like most in learning is YouTube videos. Through these videos, the material becomes easier to understand and remember because there are real visual illustrations." (S2)

These responses indicate that students perceive audiovisual materials as helpful for comprehension and retention. Technology does not only change the way teachers deliver material but also influences how students experience and understand the lesson(Zunic et al., 2025). However, the effectiveness found in this study should be interpreted as perceived effectiveness. This research does not measure learning achievement through pre-tests, post-tests, or experimental comparison. Therefore, the findings demonstrate positive perceptions of efficiency, engagement, and understanding rather than statistically measured improvement in academic performance(Ariningsih et al., 2026; Suiçmez & Ozansoy, 2024). In the context of Islamic Religious Education, this perceived effectiveness is relevant because visual and audiovisual materials can help explain religious concepts that are difficult to understand through verbal explanation alone. Technology can support the presentation of practical and contextual examples so that students receive a more concrete learning experience(Farhan & Ali, 2026; Hutson, 2022).

3. Supporting Factors for Successful Technology Implementation

The third research question focuses on factors that support the successful implementation of technology. The teacher identified parents or guardians as a major supporting factor. The teacher stated:

"The main supporting factor is the parents or guardians. If we always provide clear information to them, this becomes a very significant source of support for us." (G1)

This finding indicates that technology-based learning is not determined solely by school facilities. Parental understanding and support also play an important role. Clear communication helps parents understand why technology is used and how it contributes to students' learning(Prosen & Ličen, 2025). Parental support is particularly relevant at the junior secondary level because students remain under close family supervision. The use of digital media can raise concerns related to internet exposure, screen time, and the type of digital content accessed by students. Therefore, effective communication between

schools and parents can strengthen trust and reduce resistance to technology use.

The availability of infrastructure also supports technology implementation. The school provides Smart TVs and Wi-Fi to facilitate classroom learning. Students are already accustomed to using digital media, especially videos and visual presentations. This familiarity makes technology integration easier because students do not need extensive adaptation to basic digital tools. The teacher's statement about the school's effort to continuously follow technological developments also reflects institutional support. This means that the success of technology use is supported by three interrelated factors: infrastructure, parental involvement, and institutional commitment(Alubthane, 2026; Mendonça et al., 2024).

These supporting conditions are relevant to the future development of metaverse-based learning. Metaverse implementation requires not only devices but also social acceptance, teacher readiness, technical support, and student familiarity with digital environments. Therefore, the current support system at the school provides an important foundation, although additional preparation would still be required(Petrovic & Jaksic, 2026).

4. Inhibiting Factors in Technology Implementation

The fourth research question concerns the barriers that affect technology-based learning. The teacher identified electricity disruption, network problems, and difficulties connecting laptops to Smart TVs as the main technical obstacles. The teacher explained:

"The obstacles usually involve network problems or power outages. It is not because there is no Wi-Fi, because the Wi-Fi at this school is generally reliable. The difficulty that sometimes occurs is with the connecting cable used to connect the teacher's laptop to devices such as the Smart TV provided in the classroom." (G1)

This statement shows that the main problem is not the absence of technological facilities. Instead, the barriers arise from technical reliability and supporting infrastructure.

Students expressed similar experiences. One student stated:

"What often makes technology difficult to use is the occurrence of rotating power outages. This certainly affects the network, and sometimes we also experience difficulties connecting the teacher's laptop to the Smart TV." (S2)

The similarity between teacher and student responses strengthens the credibility of this finding. Both groups identified electricity disruption and device connectivity as recurring technical problems. These findings show that

the availability of technology alone does not guarantee smooth implementation. Technology-based learning requires stable electricity, reliable connectivity, functioning cables, compatible devices, and rapid technical assistance. This issue becomes more significant when considering metaverse-based learning. Metaverse technologies generally require more stable infrastructure than conventional digital media. Interactive virtual environments may depend on consistent internet access, compatible software, higher processing capacity, and specialized devices. Therefore, existing technical barriers must be addressed before schools move toward more demanding immersive technologies(Klarin et al., 2026; Manfredi et al., 2024).

The findings also suggest the importance of preventive maintenance and technical preparedness. Schools need regular equipment checks, standardized connection systems, and clear procedures for addressing technical problems. Such measures can reduce classroom disruptions and strengthen technological readiness.

5. Contribution of Technology to the Learning Process

The fifth research question concerns the contribution of technology to learning. The teacher emphasized that technology provides a substantial contribution because it makes learning more attractive, understandable, and less monotonous. The teacher stated:

"Its contribution is very significant. Technology helps us deliver learning materials in a much more interesting way, making them easier to understand and less boring. We can directly display images, videos, and interactive learning materials." (G1)

The teacher further explained that technology also provides faster access to additional information:

"Technology also makes it easier for us and the students to find additional information quickly, so that the teaching and learning process runs more smoothly, effectively, and efficiently." (G1)

These statements indicate that technology contributes in at least four ways: improving material presentation, increasing access to information, making learning more engaging, and improving instructional efficiency. Student responses also show that technology contributes to their learning experience. They emphasized that visual content helps them understand learning materials more easily. Their preference for YouTube videos indicates that visual representation plays an important role in supporting comprehension and

memory(Huh et al., 2026). Technology also contributes to student expectations for future learning. One student stated:

"Hopefully, the technological facilities will become more complete and continue to run smoothly, so that we can learn more easily, enjoyably, and understand the material faster. Hopefully, in the future, we will be more prepared to face increasingly advanced technological developments." (S2)

This statement shows that students do not perceive technology merely as a current learning tool. They also associate technological development with future readiness. This is particularly relevant in the context of digital-based schools because technology use can contribute to students' adaptation to broader digital changes. For Islamic Religious Education, this contribution has further implications. Digital technology can support the visualization of worship practices, Islamic history, moral situations, and contextual religious issues. Students can access learning resources that complement textbooks and classroom explanations. In the future, metaverse technology could potentially extend this contribution. While current learning primarily allows students to view digital content, immersive environments could allow them to interact with virtual spaces, objects, and simulations. However, such possibilities should be understood as future development rather than evidence of current implementation at the school(Conti, 2025; Viet Tran & Khoa, 2025).

Overall Interpretation of the Findings

Taken together, the interview findings provide clear answers to the five research questions. First, technology has been implemented through Smart TVs, laptops, PowerPoint presentations, YouTube videos, internet access, and other digital learning resources. Second, teachers and students perceive technology as effective because it makes learning more efficient, attractive, and easier to understand. Third, parental support, school infrastructure, and institutional commitment support successful implementation. Fourth, electricity disruption and device connectivity remain the primary barriers. Fifth, technology contributes to material visualization, information access, learning engagement,

efficiency, and students' readiness for future technological developments(L. Huang et al., 2026; Oyelere et al., 2023).

Table 1. Research Summary Table

Yes	Focus	Key Findings	Implications
1.	**Implementation**	Smart TVs, laptops, PowerPoint, YouTube, and the internet have been integrated in PAI learning.	It becomes the basis for more interactive digital learning.
2.	**Effectiveness**	Technology makes learning more engaging, efficient, and easy to understand.	Supporting student understanding and engagement.
3.	**Supporters**	Parent support, facilities, student readiness, and school commitment.	Strengthening the sustainability of digital learning.
4.	**Inhibitors**	Interruptions of power, network, and device connections.	It is necessary to strengthen infrastructure and technical support.
5.	**Contributions**	Facilitate material visualization, access to information, and make learning less monotonous.	Enriching the PAI learning experience.
6.	**The Potential of the Metaverse**	The existing digital ecosystem is the foundation towards metaverse-based learning.	It requires stronger infrastructure, teacher competence, and pedagogical design.

The direct statements from both teachers and students also demonstrate a consistent pattern. Teachers emphasize institutional commitment, effectiveness, parental support, technical barriers, and the contribution of technology. Students confirm these findings through their classroom experiences, especially regarding Smart TV use, visual learning, technical difficulties, and expectations for future technological improvement.

Therefore, Muhammadiyah Junior High School PK Kottabarat can be understood as having an established digital learning environment. This environment provides an important foundation for the future development of metaverse-supported Islamic Religious Education. Nevertheless, full metaverse implementation would require additional technological infrastructure, teacher competence, pedagogical design, technical stability, and clear educational objectives. The findings also suggest that technological innovation should remain connected to pedagogical needs. The value of technology lies not in its sophistication but in its ability to help teachers explain learning materials and help students understand them more effectively. In Islamic Religious Education, this principle is particularly important because digital innovation must remain aligned with learning objectives and Islamic educational values(Beck et al., 2024).

Conclusion

This study concludes that Muhammadiyah Junior High School PK Kottabarat has established a well-developed digital learning ecosystem that provides a strong foundation for the future implementation of metaverse-supported Islamic Religious Education. Smart TVs, laptops, PowerPoint presentations, YouTube videos, internet-based resources, and visual learning materials have been integrated into classroom learning and are perceived by teachers and students as supporting more engaging, accessible, efficient, and understandable learning experiences.

The findings indicate that the school has developed a strong foundation for advancing metaverse-supported Islamic Religious Education. Metaverse-oriented technology is particularly relevant to IRE because it can strengthen the visualization and contextualization of Islamic history, worship practices, religious environments, and other experiential learning materials. However, further development toward fully immersive metaverse learning requires stronger infrastructure, enhanced teacher competence, reliable technical support, appropriate pedagogical design, and dedicated immersive platforms. Future studies should involve broader participants and directly examine immersive metaverse applications to evaluate their effects on student engagement, understanding, and learning outcomes.

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