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STRATEGIES FOR USING AUGMENTED REALITY-BASED INTERACTIVE LEARNING MEDIA TO IMPROVE THE UNDERSTANDING OF IPAS CONCEPTS

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ABSTRACT

This study aims to explore the strategy of using Augmented Reality (AR)-based interactive learning media in improving the understanding of Natural and Social Sciences (IPAS) concepts in grade V students at MI Miftahul Ulum Kanigaran. The method used was a qualitative case study with participants consisting of one experienced AR user teacher and eight students selected through purposive sampling. Data were collected through semi-structured interviews, participatory observations, and focus group discussions, then analyzed inducively following a cycle of data reduction, presentation, and verification. The results show that AR acts as a conceptual bridge that facilitates multisensory meaning, so that misconceptions of IPAS concepts can be minimized through three-dimensional visualization and instant feedback. An effective strategy includes three stages: (1) integrated planning, where teachers align AR modules with students' learning needs; (2) collaborative implementation, optimizing group discussions based on AR experience; and (3) structured reflection through the presentation of findings and peer feedback. Nonetheless, device and internet connection limitations and instructional design challenges are obstacles that require managerial support and ongoing training. This study concludes that the integration of AR with a targeted strategy and adequate infrastructure support can drive pedagogical transformation towards 21st century science learning in madrasah ibtidaiyah.
Keywords: *Augmented Reality, Interactive Learning Media, IPAS Concept.*

INTRODUCTION

In the framework of 21st century education that moves towards full digitalization, technology-based interactive learning media is developing into a new dialectical space where learners establish direct connections with visual and spatial representations of complex concepts. Augmented Reality (AR) stands out as an innovation that allows the fusion of virtual elements into real environments, thereby creating an immersive, contextual learning experience and inviting simultaneous participation of the five senses (Syahbania et., al 2025). While Augmented Reality (AR) has the potential to change the paradigm of IPAS teaching, the reality in many classrooms still shows the gap between the use of technology and meaningful learning outcomes. Often AR is only perceived as a symbol of innovation without the support of instructional design that is able to strengthen the cognitive framework of students. As a result, the presence of AR in everyday practice sometimes fails to encourage authentic knowledge integration and awaken students' critical thinking (Nurhayati et al., 2025). On the other hand, the problem does not only lie in the availability of devices, but in how to utilize this technology in a pedagogical framework that is centered on the needs and real experiences of students.

The Merdeka Belajar program from the Government of Indonesia has emphasized the importance of digital innovation at the elementary and madrasah levels, including the use of interactive media. The merger of science and social studies into IPAS in the Independent Curriculum should be a momentum to strengthen critical thinking skills and interdisciplinary connectivity. However, the main challenge arises in trying to present IPAS content in a contextual way—one that is easy to understand and engaging for students. Various national studies reveal that the majority of

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teachers in madrasah ibtidaiyah still rely on lecture methods and static media, even when teaching abstract and cross-disciplinary concepts (Fadhila et., al 2024). According to Sumatraputra et., al (2023) Although the adoption of Augmented Reality (AR) in Indonesia shows an increasing trend, its use in faith-based schools is still far from equitable and optimal. The main obstacles lie in the low digital literacy of teachers, limited access to technical training, and the mismatch between the AR content developed and the needs of the complex and thematic IPAS curriculum. As a result, the implementation of AR is often partial and lacks support for the achievement of holistic learning objectives. Therefore, the integration of AR in madrassas must be seen as more than just the application of technology; It is a pedagogical challenge that requires a critical and sustainable approach. Synergy between content developers, educators, and policymakers is key to designing and implementing AR that is contextual, relevant, and responsive to the dynamics of learning in the madrasah environment.

Various scientific studies reveal that Augmented Reality has significant potential to increase motivation, attention, and involvement of students in the learning process (Hermawan et., al 2024). However, there are still gaps both theoretically and practically related to the strategic use of AR to deepen conceptual understanding, not just to attract initial interest. The limitations of qualitative studies in the madrasah environment make the dynamics of AR use influenced by cultural factors, religious values, and socio-economic conditions have not been adequately revealed (Zuschaiya & Valentina, 2024). In this framework, learning media should be positioned as an agent of meaning construction, not just a means of visualization. Therefore, this study seeks to explore in depth how the strategy of using AR can activate the ability of elementary school-age students to build an interconnected understanding of science and social studies concepts, in accordance with the concrete operational stages in Piaget's theory (Nu'man & Retnawati, 2022). Thus, it is hoped that the findings will provide practical direction for madrasah educators in designing AR learning models based on students' cognitive needs and local contexts. (Nu'man & Retnawati, 2022).

A number of studies highlight the importance of exploring the strategic practice of using AR-based interactive media in madrasah classrooms—an aspect that is still rarely discussed in the international literature. At MI Miftahul Ulum Kanigaran, a private Islamic madrasah that integrates general knowledge with spiritual values, the use of technology must be understood within the framework of inherent social and cultural meaning. By examining the experiences of teachers and students in applying AR to science learning, this study aims to reveal the process of formation, negotiation, and the meaning of concepts in a contextual manner. More than just assessing instructional effectiveness, this study examines how digital pedagogy bridges social-science knowledge with learners' realities of life (Hakim, 2020). In addition, the findings of this study also reflect efforts to deconstruct the traditional view that views educational technology solely as an aid, not as a space for complex cognitive-affective interaction practice (Husain, 2020).

This research is designed to explore in depth the strategy of using Augmented Reality-based interactive learning media in strengthening the understanding of the concept of social studies (combined science and social studies) among students of class V MI Miftahul Ulum Kanigaran. The study focuses on the process of designing and implementing AR by teachers, students' learning experiences through interaction with virtual objects, and the formation of the meaning of the concept of IPAS that occurs as a result of the exposure. By applying an interpretive qualitative approach, this

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study utilizes classroom observations, in-depth interviews, and documentation of learning activities to capture the subjective nuances of AR practice in the context of madrasah (Yuliyanti, 2023). In addition, this study intends to formulate a learning strategy framework that is applicable and adaptive for madrasas, so that it can be reapplied in similar educational environments, while contributing to the international discourse on the synergy of technology with value pedagogy (Fadhilah et al., 2025).

METHOD

This study adopts a qualitative approach with a case study design to comprehensively explore the strategy of utilizing Augmented Reality (AR)-based interactive learning media in strengthening the understanding of IPAS concepts in grade V students at MI Miftahul Ulum Kanigaran. The selection of case studies is based on its ability to explore the context of AR implementation in depth, including teacher-student interactions, local cultural values, and classroom learning dynamics (Azwar et al., 2024). The analysis unit includes teachers who have designed and implemented AR learning as well as groups of class V students as the main participants, so that the observed phenomena can reflect the entire process holistically. The purposive sampling technique was used to select teachers who had at least one semester of experience in the use of AR and students who were actively involved in learning IPAS. This approach ensures the data collected truly represents best practices and real challenges in implementing AR in madrasas.

Data collection is carried out through three main instruments: *first* semi-structured interviews with teachers to uncover the stages of planning, implementation, and reflection of AR learning; *second* participatory observation in the classroom to record student interactions, reactions, and the use of AR features in real time; and *third* focused group discussions (FGDs) with students to explore perceptions, difficulties, and the development of concept understanding after exposure to AR. All interviews were recorded and transcribed verbatim, while the results of observations were documented with field notes and visual recordings in the form of photos or videos. Data analysis is inductive following the model Affida (2024) Starting from data reduction, presentation of findings, to drawing conclusions in order to build clear strategic themes. To maintain the validity of the findings, triangulation of sources (teachers, students, documentation) and peer debriefing with peers were applied, while the reliability of the data was strengthened through trail audits that documented each step of the analysis. Thus, this research is expected to produce a valid conceptual framework and can be used as a reference in developing AR-based science learning models in other ibtidaiyah madrasas.

RESULTS AND DISCUSSION

The results of this study confirm that the learning strategies applied by teachers have a very crucial role in optimizing the effectiveness of Augmented Reality (AR)-based learning media, especially in improving students' understanding of concepts in Natural and Social Sciences (IPAS) subjects. A field study conducted at MI Miftahul Ulum Kanigaran, through in-depth interviews with three grade V teachers, showed that AR media has a significant impact when integrated into a constructivist-oriented learning approach. These approaches include discovery learning models, problem-based learning, and project-based learning. Teachers are not only positioning AR as an

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additional visual aid, but also adapting their learning designs to encourage active exploration, hands-on student participation, and a deeper knowledge construction process through meaningful interactions. This integration also demonstrates the alignment between the characteristics of AR media and students' visual and kinesthetic learning styles, which further strengthens the effectiveness of the learning process in the classroom.

First, the results of the study show that the success of the use of Augmented Reality (AR)-based learning media in improving the understanding of IPAS concepts is largely determined by the learning model strategy chosen by the teacher. Through interviews with three teachers of class V MI Miftahul Ulum Kanigaran, it was found that a **constructivist, discovery-based, and collaborative** learning approach is more suitable to support the use of AR media. Teachers not only make AR an additional medium, but also adjust the learning design so that students can explore and construct understanding through direct interaction. Mrs. Mardiyah, a teacher of class V, explained:

"If I just give a lecture, the children become passive. But when I use AR and invite them to find out for themselves through the images that appear, they become more active. I usually use a guided discovery model, so I guide them with questions, then they observe and discuss them together."

This strategy is also associated with children's visual and kinesthetic learning patterns, which are easier to respond to image and motion stimuli. In its application, another teacher, Pak Ahmad, admitted to using **the Problem-Based Learning approach** when teaching the topic of ecosystems:

"At that time, I gave them a case about a natural disaster, then I showed it with the AR of the eruption of the mountain. I asked them to find an understanding of the erupting mountain. From there they began to connect with lessons about natural disasters."

Another teacher, Mrs. A, chose to use the **Project-Based Learning** model to encourage group work and student self-reflection.

"I asked the children to make a mini project about water cycling. They see it first through AR, continue to discuss in groups and draw their own conclusions. I am just a facilitator. It turned out that the results were more in his understanding than I was in a lengthy lecture."

These findings show that the selection of a dialogical, exploratory, and structured learning model is the key to optimizing the function of AR media, so that it is not just a technological gimmick, but a learning space that forms sustainable conceptual meaning and understanding.

Second, this study also found that teachers consciously integrate **Islamic values** in the learning process using AR. At MI Miftahul Ulum Kanigaran, this approach is not only symbolic, but is framed pedagogically as part of the process of forming students' character and spirituality. Teachers view AR media not only as a visual aid, but as an entrance to introduce the *tadabbur of nature* and strengthen students' awareness of the greatness of Allah SWT's creation. In the interview, Mrs. Mardiyah gently conveyed.

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"When I show AR about the rotation of the earth, I invite them to reflect: who makes the earth spin continuously without stopping? The children immediately shouted, 'Allah, Mom!' From there I continued with the verses of the Qur'an about the creation of the heavens and the earth. So learning social studies is not only understanding concepts, but also gratitude and amazement."

This attitude is also seen in teachers' approaches to social issues in social studies. Mr. Ahmad, for example, when teaching community topics through market and village AR simulations, always inserted messages of morality and social responsibility.

"I tell the children, if you look at the market simulation in AR, imagine if there are people who sell but are deceived. We are taught in Islam to be honest in trading. So the social studies lessons can be done, the Islamic values are also included."

Meanwhile, Mrs. Laily added that the value **of ecological justice** is also inserted when using AR in environmental themes.

"I showed the deforested forest using AR, and I asked, 'What did the Prophet say about destroying nature?' Children come to think that protecting the environment is part of worship.".

From these three interviews, it is clear that teachers do not separate between scientific knowledge and spiritual morality. Instead of making religion a complement, teachers integrate it harmoniously into students' cognitive and affective processes. These findings confirm that the use of AR media in madrassas can be a holistic learning medium that not only develops an understanding of IPAS concepts, but also instills the values of monotheism, morals, and social awareness in a contextual and meaningful manner.

The Meaning of Augmented Reality to Improve the Understanding of IPAS Concepts The results of in-depth interviews show that teachers and students place Augmented Reality (AR) not just as a visual aid, but as a "bridge" between abstract concepts of IPAS and students' concrete experiences. Students report that three-dimensional objects that appear through AR devices help them "see" the structure of the ecosystem and the process of energy change more vividly, making it easier to internalize concepts (FLOWERS, 2025). Teachers also consider that AR enriches the learning context, for example, displaying various natural disasters so that class discussions can take place more interactive and collaborative. These findings are in line with the findings Marzuqi (2025) which confirms that the meaning of AR in science learning lies in its ability to combine the real and virtual worlds so as to stimulate multi-channel cognitive pathways (dual-coding theory) to strengthen concept retention.

AR-Based Interactive Learning Media Use Strategy Field data analysis identified three main stages of AR implementation strategy in class V MI Miftahul Ulum Kanigaran: (a) *Contextual Content Design*, where teachers collaborate with the madrasah IT team to select IPAS materials, such as erupting mountains adapted in AR models, (b) *Structured implementation*, includes initial orientation to the AR interface, demonstrations by teachers, and self-exploration of students in small groups, and (c) *Reflection and feedback*, using AR-based quizzes to evaluate understanding and discuss

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difficulties. This pattern is consistent with the framework of Bower et al. (2023), which emphasizes the importance of *contextual alignment*, *scaffolded guidance*and *iterative reflection* in the development of AR media. In addition, interactive features such as annotated hotspots have been found to be effective in facilitating students' critical discussions about the phenomenon of IPAS, strengthening the role of AR as a collaborative learning instrument (Moro, Stromberga, & Stirling., 2023).

Structural and Pedagogical Challenges in AR Implementation At the structural level, limited facilities including the limited number of mobile devices and the stability of the WiFi network are significant obstacles at MI Miftahul Ulum Kanigaran. The teachers revealed that ideally one device can be used by two students to maintain engagement, but often interruptions in the connection force the group to wait their turns, resulting in reduced duration of interaction with AR. These findings are in line with research Unger (2023) which suggests that device availability and network reliability are still the main factors inhibiting the adoption of AR in elementary schools. From the pedagogical side, teachers face difficulties in adjusting the level of complexity of AR content; Some students felt that the information presented was too dense, while others found it less challenging. This condition emphasizes the importance of teacher training in content calibration and the application of differentiated instruction strategies so that the potential of AR in enriching the learning experience can be maximized (Zhang et., al 2023).

CONCLUSION

The results of this study show that the use of Augmented Reality (AR) is significantly able to strengthen the understanding of the concept of IPAS in grade V students of MI Miftahul Ulum Kanigaran. Through three-dimensional displays and multisensory stimuli, AR helps learners build a more robust framework of knowledge while reducing conceptual errors That success is supported by integrated learning planning—starting with the formulation of fundamental questions in the AR modules, continuing with group work to encourage scientific discussion, and closing with a presentation session where students give each other feedback. This implementation model has been proven to increase active student engagement and deepen the construction of concepts in a meaningful way. . However, there are still challenges in the form of limited number of devices, internet connection disruptions, and the need to improve teachers' competence in designing pedagogical AR materials. Therefore, widespread AR integration requires managerial support in the form of budget allocation, ongoing training for teachers, and the development of comprehensive AR technical guidelines. Overall, this research provides a conceptual framework for contextual, innovative, and sustainable AR-based science learning models, while encouraging pedagogical transformation towards 21st century science education in madrasah ibtidaiyah

As a follow-up, a commitment from institutions and policy makers is needed to ensure the continuity of the use of AR in the ibtidaiyah madrasah. Practical recommendations include the provision of a special budget for the procurement and maintenance of digital devices and infrastructure, the implementation of continuous training for teachers in the technical aspects and instructional design of AR, and the preparation of contextual and applicable guidelines for the use of AR. In addition, the synergy between madrasas, educational technology developers, and higher education institutions is expected to foster curriculum innovations that combine technology with

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students' learning needs. Further research should examine the effects of AR on students' critical thinking skills, creativity, and digital literacy at the elementary level. Thus, AR is no longer just a visual complement, but an integral part of the transformation of IPAS learning methods towards a model that is more holistic, relevant, and responsive to the challenges of the 21st century.

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