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Developing Tri Hita Karana-Based Balinese Klakat Tradition Augmented Reality Media to Enhance Creativity of Elementary School Students

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Abstract: This research aims to develop Augmented Reality (AR) media based on Tri Hita Karana to increasing the creativity of elementary school students and fostering a love for local culture. The research method used is Research and Development (R&D) with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). In the Analysis stage, students' needs in understanding spatial concepts through culturally based media were identified. The Design stage involved designing the AR Klakat Bali concept, including interactive content and cultural value integration. Next, the Development stage encompassed the creation and expert validation of the media by teachers and professionals using Aiken's V to ensure content validity. In the Implementation stage, the media was applied in learning at SD Negeri 6 Denpasar, with 46 first-grade students as research subjects. The final stage, Evaluation, assessed practicality and effectiveness using questionnaires and observations. Data analysis techniques included descriptive statistical analysis and qualitative data triangulation to ensure accuracy. The validation results showed that this media had a very high level of validity with an average Aiken's V value of 0.995, indicating that the content, presentation, and characteristics of the application are very suitable for use in learning. In addition, the questionnaire results showed that students had a high interest in using AR Klakat Bali, with an average score of 3.137 on the aspects of interest, loyalty, care, and appreciation of local culture. The use of AR Klakat Bali not only helps students understand the concept of building space in mathematics learning, but also introduces them to the philosophy of Tri Hita Karana, which emphasizes the balance of human relationships with God, others, and the environment.

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Introduction

In the rapidly growing digital era, technology plays an important role in improving the effectiveness of learning. The use of technology in education is increasingly needed to create a more interactive and engaging learning experience. One innovation that is starting to be applied is Augmented Reality (AR), which is a technology that is able to combine the real world with virtual elements directly (Loureiro, 2020). With this technology, students can see, hear, and interact with digital objects in a real environment. The application of AR in education provides a great opportunity to develop learning methods that are more creative, innovative, and in accordance with the needs of students in the modern era. In the context of learning, AR is able to improve concept understanding through a more real visual experience. Students can explore the material more deeply and experience more enjoyable learning. In addition, the use of AR in education can also increase student engagement and encourage their creativity. With an interactive approach, this technology allows students to understand

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the material better and increase their learning motivation. Therefore, the integration of AR in learning becomes an effective strategy to create a more interesting, innovative, and up-to-date learning environment (Hidayat, 2021).

In Bali, the use of Augmented Reality (AR) in education is an innovative solution to introduce traditional values to students from an early age. The integration of this technology with local culture allows students to learn cultural heritage in a more interactive and interesting way. One of the media that has the potential to be developed is Klakat Bali, a woven bamboo container that has a deep philosophy in the lives of Balinese people. With the help of AR, students can explore the form, function, and symbolic meaning of Klakat Bali through a digital-oriented learning experience (Pratista, 2024) . This technology provides an opportunity for students to better understand and appreciate local culture in a more interesting and in-depth way. In addition, the application of AR in culture-oriented learning is able to increase student engagement in the learning process. This technology not only presents a more real visual experience, but also encourages students to be more active and creative in exploring their culture (Pramerta, 2023). With an interactive approach, the utilization of AR can be an effective strategy in preserving local traditions while improving the quality of learning. Therefore, the integration of AR technology in culture-oriented education in Bali plays an important role in building the younger generation's awareness of cultural heritage, as well as adapting learning to the development of the digital era.

The concept of learning Augmented Reality (AR) oriented to Tri Hita Karana is an innovative approach in improving the creativity of elementary school students. The principle of Tri Hita Karana emphasizes the balance of human relationships with God, others, and the environment, so it can be the basis for developing learning methods that are not only modern but also full of cultural values (Hartayani, 2022). By applying AR, students can gain a more interactive and interesting learning experience. This technology allows them to understand the form, function, and meaning of Balinese Klakat visually and deeply. Through digital-oriented exploration, students can more easily absorb information about the cultural heritage that has been passed down by their ancestors. In addition, the integration of AR in cultural learning can enrich students' insights and foster appreciation for local wisdom (Adiputra, 2022) . With an interactive experience, students can see firsthand how Klakat Bali is used in various aspects of Balinese life. This digital interaction not only makes learning more interesting but also encourages students' creativity in understanding the relationship between culture and technology. Therefore, the application of Tri Hita Karana-oriented AR is expected to be an innovative solution to introduce cultural values early on while improving the quality of education in the digital era.

Besides the cultural aspect, the application of Augmented Reality (AR) in learning provides significant pedagogical benefits. This interactive technology is able to increase student engagement in the learning process in a more interesting and immersive way. Through real visual experiences, students can more easily understand abstract concepts and relate them to everyday life. The use of AR in education also contributes to the development of students' critical thinking skills, problem solving, and creativity (Purnam, 2021). With this technology, students not only receive information passively, but also actively explore learning materials. The ability to understand the relationship between culture and technology can be developed more effectively through AR-oriented media, so that learning becomes more contextual and meaningful. The development of Augmented Reality Klakat Bali media not only functions as an educational tool, but also as a tool that can stimulate students' creativity and innovation. This technology provides an opportunity for students to understand

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Klakat Bali from various perspectives, both in terms of form, function, and philosophical value. Direct interaction with digital objects that represent local culture allows students to build closer connections with their cultural heritage (Sudipa, 2022). Thus, the application of AR in culture-oriented learning not only enriches students' insights, but also helps them in developing creativity as well as 21st century skills that are highly needed in the digital era.

The results of research Hartayani (2022) show that the application of Tri Hita Karana in learning can improve students' creative character. STEAM-oriented Augmented Reality (AR) media development is needed in elementary school learning to increase student interest and motivation. Teachers and students need interactive media that represent the material in depth through six initial AR designs, namely Batik, Wayang, Klakat bali, Borobudur, Kereta Kencana, and Keris (Daryanto et al., 2022) . Augmented reality-oriented interactive media can increase elementary school students' interest in learning Balinese Script. By applying the play while learning method, this application combines three-dimensional animation and sound to help students understand the script more interestingly. In addition, teacher assistance and parental involvement play an important role in supporting the effectiveness of learning, so that students are more motivated to practice writing the script correctly (Wibawa, 2022) .

The main issue at the research location is the low level of student creativity in understanding mathematics concepts based on local culture, particularly in utilizing Augmented Reality (AR) learning media oriented toward Tri Hita Karana. Many students still struggle to connect spatial concepts with cultural heritage, such as Klakat Bali, which should serve as a bridge between scientific knowledge and local wisdom. This problem is exacerbated by limited access to interactive technology in schools, which hampers the effectiveness of AR-based learning (Purnama, 2021). Furthermore, the lack of teachers' understanding of AR implementation in education poses a significant challenge, preventing the method from being optimally applied. The urgency of addressing this issue is extremely high, given the importance of innovation in education to enhance students' interest and creativity. If left unresolved, the vast potential to integrate local culture with modern education will be hindered, and students will miss out on an opportunity to learn in a more engaging and contextual manner. Therefore, solutions such as improving teacher training, developing more adaptive AR media, and increasing access to interactive technology must be immediately implemented to enhance learning effectiveness and support cultural preservation through education.

Local wisdom-oriented mathematics learning, especially with Klakat Bali, can enhance students' creativity by linking the concepts of space, pattern, symmetry, and proportion in the learning process. With this method, students not only understand the theory, but also develop creative thinking skills through hands-on experimentation and design. This approach helps students feel more connected to cultural heritage, strengthen cultural identity, and foster a sense of pride in local traditions. To optimize this learning, the Tri Hita Karana-oriented Balinese Klakat Augmented Reality (AR) can be an innovative solution in facilitating students' creativity. AR technology allows students to interact with digital models of Balinese Klakat, understand geometric structures, and explore weaving patterns interactively (Wahyu et al., 2022) . In addition to improving understanding of mathematical concepts, this approach also introduces the value of balance in human relationships with God, others, and the environment as reflected in Tri Hita Karana. With this technology, students can create a variety of digital wicker designs, connect culture with science, and see that math is not only about numbers, but also has a close relationship with everyday life. Therefore, the application of AR in local wisdom-oriented mathematics learning can encourage innovation,

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creativity, and appreciation of local culture in the digital era. Based on the background that has been described, this study aims to develop AR media based on Tri Hita Karana to increasing the creativity of elementary school students and fostering a love for local culture.

Research Method

This method of research is development research with the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) is a systematic instructional design framework that ensures the effectiveness of educational programs. The Analysis phase identified learning needs and challenges. The Design phase involved creating instructional strategies and media. In the Development phase, learning materials are produced and tested. The Implementation phase put these materials into practice, followed by the Evaluation phase to assess their effectiveness and make necessary improvements. This model is highly effective for integrating technology, such as Augmented Reality (AR), into education, ensuring that learning experiences are engaging, interactive, and aligned with educational objectives. The research and development method can be interpreted as a scientific way to research, design, produce, and test the validity of products that have been produced (Sugiyono, 2017). The R & D research development method is a type of research that makes or develops new products using certain steps (Sudipa et al., 2022). The subjects in this study were 46 first grade students of SD Negeri 6 Denpasar to implement.

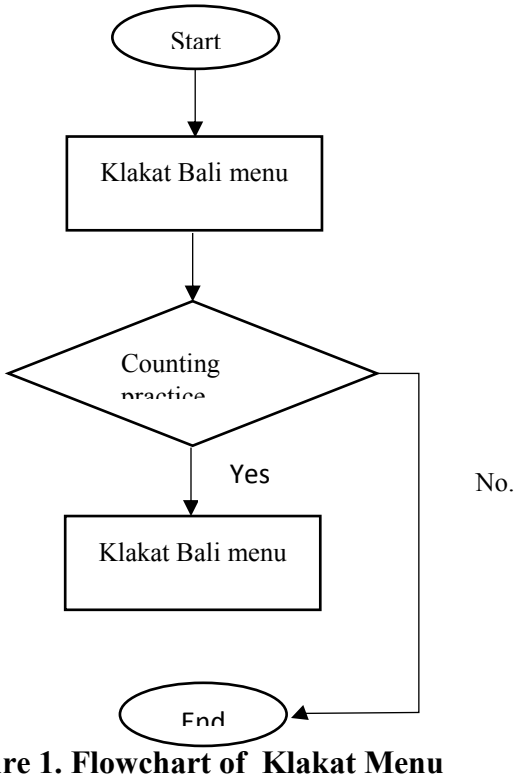

Figure 1. Flowchart of Klakat Menu

In Figure 1 Klakat Bali Flowchart illustrates the flow of navigation in a system related to the counting exercise feature. The process starts from Start, which indicates the beginning of the system running, then the user will be directed to the Klakat Bali menu, which serves as the main display or homepage of the system. From this menu, the user is given the option to enter the counting exercise menu, which is an important part of user interaction. At this stage, the system asks the user to choose whether they want to enter the counting exercise or not.

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This decision is visualized with a rhombus symbol in the flowchart, indicating a branching in the system flow. If the user selects "Yes", they will be redirected back to the Klakat Bali menu, allowing them to continue using the available features or repeat the exercise process. Conversely, if the user selects "No", the system will go straight to End, meaning the process is terminated. This flowchart shows a simple yet efficient navigation system, where users can easily select the activity they want to do without having to start over. For further development, this system can be improved by adding additional features, such as setting the difficulty level in the counting exercise or an interactive help menu, so that the user experience becomes more interesting and interactive.

The validation data used in this study included data from the validation questionnaire of material experts, teaching material experts, as well as questionnaire data on the practicality of Augmented Reality (AR) containing local wisdom, especially AR Klakat Bali oriented to the concept of Tri Hita Karana. In addition, data related to students' love for local culture is also obtained through a questionnaire that is specifically designed to assess this aspect. The research instrument used in collecting this data is a questionnaire sheet, which is designed to measure the level of validity and practicality of teaching materials and AR applications developed (Noviana et al., 2023). Assessment from experts was carried out to assess the feasibility of teaching materials in supporting interactive and technology-oriented learning. At the expert test data analysis stage, researchers aim to find out whether the teaching materials and AR applications developed are up to standard or require improvement (Hidayat et al., 2021). If the expert gives a disagreeing response or proposes improvements, the researcher will make revisions based on the input. The data analysis techniques used in this study involved quantitative and qualitative approaches to ensure result accuracy. Quantitative data is analyzed using descriptive statistics, such as mean and standard deviation, to measure the effectiveness of the developed learning media. Additionally, validity testing is conducted using Aiken's V method to assess content suitability based on expert opinions. Qualitative data was obtained through interviews and observations, which were then analyzed using data reduction, data presentation, and conclusion drawing techniques. Data triangulation was applied to ensure the validity of findings by comparing results from various sources and methods. Reflective analysis was also carried out to evaluate the effectiveness of Augmented Reality (AR)-based learning implementation. The results of this analysis served as a basis for further improvement and development, ensuring that the applied learning model is optimized to enhance students' creativity and support the preservation of local culture within the educational environment.

Results and Discussion

Figure 2. Guidance in Using Augmented Reality (AR) Containing Tri Hita Karana-Oriented Balinese Klakat

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Figure 2 displays an Augmented Reality (AR) usage guide containing Tri Hita Karana-oriented Balinese Klakat, designed to facilitate user interaction with the application. The guide includes practical steps, from accessing the app, scanning objects, to virtually playing the Balinese Klakat instrument. Each stage is accompanied by visual and text instructions that explain how to use key features, such as selecting a learning mode, adjusting audio settings, and understanding the interconnectedness of Tri Hita Karana values in Balinese culture. With this approach, users can more easily understand and explore the Balinese Klakat instrument interactively through AR technology.

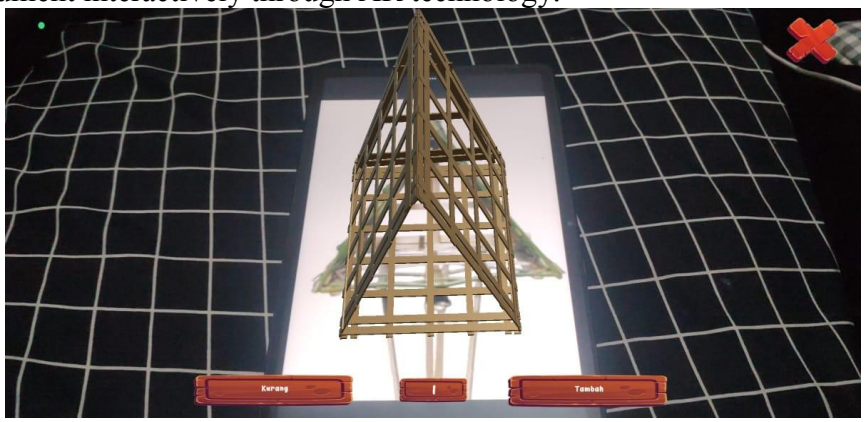

Figure 3. Display in the Augmented Reality (AR) application containing Tri Hita Karana-oriented Balinese Klakat

Figure 3 shows the interface of an *Augmented Reality* (AR) application containing Tri Hita Karana-oriented Balinese Klakat, where visual and interactive elements are harmoniously integrated. This application interface shows the Balinese Klakat instrument in digital form that can be accessed virtually through AR devices, complete with details of traditional Balinese ornaments. Inside the app, users can view various features such as a Balinese Klakat drawing tutorial, information about the Tri Hita Karana philosophy, and interactive learning mode options. The user-friendly design allows for easy navigation, with intuitive buttons and clear visual cues to guide the virtual Balinese counting experience.

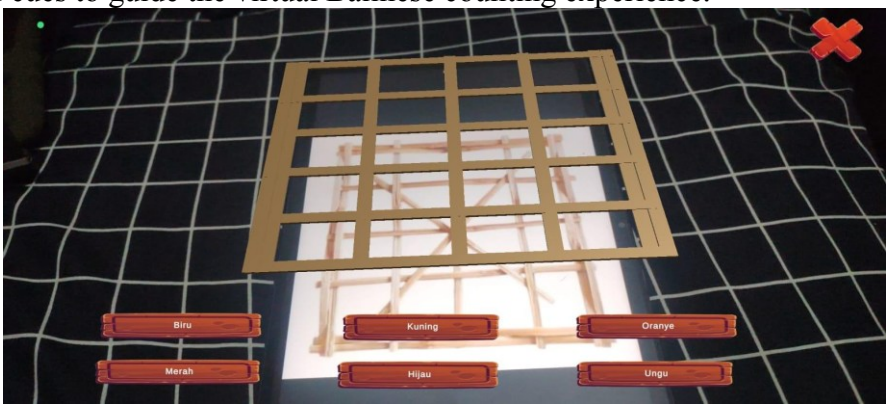

Figure 4. Live visual display of Augmented Reality (AR) application containing Tri Hita Karana-oriented Balinese Klakat

Figure 4 displays an Augmented Reality (AR) application containing the Tri Hita Karana-based Balinese Klakat showing the integration of technology with local wisdom in an interactive and educational form. In this visualization, the structure of Klakat Bali is displayed in digital form with precise construction details, allowing users to virtually explore the building elements. The application provides an intuitive interface with various color

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options and interactive elements, making it easy for users to understand and modify the appearance of Klakat Bali according to their preferences. In addition, clear navigation buttons and color selection system enrich the interactive experience, supporting learning about Tri Hita Karana values in traditional Balinese architecture. By utilizing AR, the app provides an immersive experience that not only visually introduces Balinese culture but also supports the understanding of the philosophy of sustainability and harmony in traditional building design.

The feasibility of Augmented Reality (AR) containing Tri Hita Karana-oriented Balinese Klakat was assessed by expert validators using Aiken's V index. This assessment involves three assessors who evaluate the content validity of AR based on the formula formulated by Aiken (1985). Aiken's V index is used to calculate the validity coefficient based on the experts' evaluation of the extent to which each item represents the construct being measured. Data analysis of the validation test was carried out by applying Aiken's V formula, as described in Retnawati's research (2016), to ensure that this AR is suitable for use in learning.

$$V = \frac{\sum s}{\eta(c-1)}$$

Description: V = The respondent's approval index of item validity, s = the score set by the respondent minus the lowest score (s = r-1), r = the score of the category of choice on the respondent, n = number of respondents, c = number of categories of choice filled by the respondent.

Table 1. Expert Test Validity Criteria

Average Score	Validity Level
$0.8 < V \leq 1.0$	Very Valid
$0.4 < V \leq 0.8$	Valid Enogh
$0 < V \leq 0.4$	Invalid

The table above shows the data validity categories based on the average score obtained, with a three-level scale. Data with a score of 0.8 to 1.0 ($0.8 < V \leq 1.0$) is categorized as "Very Valid", which means very valid and trustworthy. Data with a score of 0.4 to 0.8 ($0.4 < V \leq 0.8$) falls into the "Valid Enough" category, indicating that the data is valid enough although it still has minor flaws. Meanwhile, data with a score of 0 to 0.4 ($0 < V \leq 0.4$) is considered "Invalid", which means it is invalid and not worth using for further analysis.

Table 2. Assessment of Media Validators of Augmented Reality (AR) Klakat Bali Based on Tri Hita Karana

Validator	Aiken's V	Category
Validator 1	0.975	Very Valid
Validator 2	1	Very Valid
Average	0.995	Very Valid

Table 2 shows the results of the validation of the Tri Hita Karana-oriented Balinese Klakat Augmented Reality (AR), which was assessed by two experts. Based on the material assessment analysis, the first validator gave an Aiken's V value of 0.975, which is included in the very valid category. Meanwhile, the second validator gave an Aiken's V value of 1.0, which is also categorized as very valid. Thus, the overall validation of AR Klakat Bali obtained an Aiken's V value of 0.995, which confirms that this system is very valid and feasible to use.

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Table 3. Aiken's V Index on each Aspect

Aspect	Aiken's	Category
Content	1	Very Valid
Presentation	0.962	Very Valid
Characteristics	1	Very Valid
Average	0.991	Very Valid

Based on Table 3, there were four aspects evaluated in the validation of Augmented Reality (AR) Klakat Bali, namely Content, Presentation, Characteristics, and Average value. In the Content aspect, the Aiken's V value of 1 indicates that the content is considered very valid without significant deficiencies. The Presentation aspect scored 0.962, which is still in the Very Valid category, indicating that the presentation of information is very good, although there is little room for improvement. Meanwhile, the Characteristics aspect also received a perfect score of 1, indicating that the characteristics of the product or object being evaluated are very much in line with the validation criteria and are considered very valid. The overall average of the three aspects is 0.991, which means that the overall evaluation shows very high validity. These results confirm that the instrument or object being tested has strong reliability in all aspects of the evaluation, making it highly suitable for use.

Table 4. Questionnaire Results of Attitudes of Loving Local Culture of Students for Each Indicator

Indicator	Score	Category
Interest	3.204	Very good
Faithfulness	3.046	Good
Concern	3.032	Good
Award	3.012	Good
Average	3.137	Good

Based on Table 4, the results of the questionnaire showed that the category of students' love of local culture towards the Tri Hita Karana-oriented Balinese Klakat Augmented Reality (AR) was in the very good category. Students showed high interest in participating in learning with the help of this technology, so it can be concluded that their creativity in understanding local culture has been achieved. On the interest indicator, students scored 3.204, which is in the excellent category, indicating that they recognize and love the Balinese Klakat as part of local wisdom and appreciate the traditional regional counting tool. In addition, students were able to connect Klakat Bali with mathematics learning, especially in the material of building space. In the loyalty indicator, the score of 3.046 showed a good category, which means that students have a commitment to preserving the Balinese Klakat and prioritize local culture over foreign culture. They also have insight into local culture, especially related to Balinese Klakat. The concern indicator scored 3.032, which was also in the good category, reflecting that students care about the development of Balinese Klakat as a traditional musical instrument. While in the appreciation indicator, the score of 3.137 showed that students appreciate the diversity of local cultures and understand the benefits of Klakat Bali as local wisdom that can be integrated in mathematics learning. Overall, these results showed that the use of AR Klakat Bali oriented Tri Hita Karana succeeded in increasing students' creativity towards local culture.

The results of this study showed that the development of Tri Hita Karana-based Augmented Reality (AR) media was effective in enhancing elementary school students' creativity. Based on expert validation using Aiken's V method, the developed AR media achieved a very high validity level with an average score of 0.995, demonstrating that the

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content, presentation, and characteristics of the application are highly suitable for learning (Hartayani, 2022). Additionally, student questionnaire results revealed a high level of interest in AR Klakat Bali, with an average score of 3.137 across aspects of interest, loyalty, care, and appreciation of local culture. These findings support Radu's (2014) research, which emphasizes that AR technology in education significantly enhances conceptual understanding and student engagement. Furthermore, the use of AR in culture-based learning has been proven to strengthen students' connection with their cultural heritage, as stated by Pratista (2024), who highlighted that AR can enrich learning experiences with a more engaging visual approach. Thus, this study demonstrates that integrating interactive technology with local culture can serve as an innovative solution for 21st-century learning. The implications of these findings underscore the need for further teacher training to effectively adopt and implement AR in classrooms. As suggested by Sudipa (2022), the successful implementation of AR in education depends largely on educators' readiness to utilize it. Moving forward, further development of AR Klakat Bali could include gamification features and artificial intelligence for adaptive feedback, making it more responsive to students' needs. With this approach, local wisdom-based AR not only enhances learning effectiveness but also contributes to cultural preservation in an increasingly digital era.

Conclusion

Based on the results of the research, the development of Augmented Reality (AR) Klakat Bali oriented Tri Hita Karana proved effective in increasing the creativity of elementary school students and fostering a love for local culture. Validation conducted by experts showed that this media had a very high level of validity with an average Aiken's V value of 0.995, which indicates that the content, presentation, and characteristics of the application were very suitable for learning. In addition, the students' questionnaire results showed that they had a high interest in using AR Klakat Bali, with an average score of 3.137 in the aspects of interest, loyalty, care, and appreciation of local culture. The integration of AR in culture-based learning not only makes it easier for students to understand mathematical concepts, especially in building space, but also introduces them to the Tri Hita Karana philosophy that emphasizes the balance of relationships with God, others, and the environment. With its interactive design and innovative learning experience, AR Klakat Bali becomes a relevant learning solution in the digital era while contributing to the preservation of regional culture.

Recommendation

For further development, the Tri Hita Karana-oriented Balinese Klakat Augmented Reality (AR) can be improved by adding more complex interactive features, such as more realistic three-dimensional animations, authentic voice simulations, as well as gamification features to increase student engagement. In addition, the integration of artificial intelligence (AI) can help provide adaptive feedback to users based on their level of understanding. Improved application compatibility with various devices, including smartphones and tablets, can also expand user accessibility. In addition, the development of a broader AR-based learning module, covering cultural, historical, and mathematical aspects in the context of Klakat Bali, could enrich students' learning experience. Further studies on the effectiveness of this application at different levels of education are also needed to ensure that this technology can be applied optimally. With continuous innovation, AR Klakat Bali has the potential to become an increasingly effective and engaging interactive learning tool for students. Teachers

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are encouraged to integrate Augmented Reality (AR) technology into the learning process to enhance students' creativity and understanding of the concepts being taught. Intensive training on the use of AR should be provided to ensure that teachers can utilize this technology optimally. Additionally, teachers can adapt local wisdom-based learning methods, such as Tri Hita Karana, to enrich students' learning experiences. The use of interactive media should be combined with active learning strategies to engage students directly in the learning process. This approach is expected to make education more engaging, innovative, and contextual.

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