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The augmented reality game on inspirational figures to enhance literacy and creative thinking

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Abstract: In response to current educational needs, researchers have identified the importance of integrating innovative learning media, specifically augmented reality (AR) technology. This study aims to develop an augmented reality–based educational game, inspirational figure game, to support learning in Social Sciences. The game is designed for Android devices, published via the Play Store, and includes a scannable barcode to assist teachers in classroom implementation. The application presents 4D images and animations with motion, enhancing students' understanding of historical content through interactive educational games tailored to specific topics. The research employed a Research and Development (R&D) approach, utilizing the Lee & Owens development model, which includes five phases: Assessment/Analysis, Needs Assessment, Front-End Analysis, Design, Development, Implementation, and Evaluation. The results indicate that the inspirational figure game, integrated into a teaching module, is highly valid and suitable for history-based Social Science instruction at the elementary school level. Validation was conducted through expert reviews in media and subject content, as well as student trials. Furthermore, the study demonstrates potential for improving students' creative thinking skills, suggesting the model's continued application and further exploration in future research.

Keywords: augmented reality; creative thinking; inspirational figure game; learning media; student literacy

1. Introduction

Developments in the past two decades have occurred rapidly, especially in sophisticated technology (Wang et al., 2018; Wyness & Dalton, 2018). Currently, man competes to develop various technologies to meet his needs effectively and help in daily life (Tortorella & Cauchick-Miguel, 2018; Waite et al., 2020). Progressive technology continues to develop and will significantly influence every generation in the future. In education, technology has been proven to positively affect the learning process through learning media based on augmented reality (Fidan & Tuncel, 2019; Sahin & Yilmaz, 2020). Augmented reality technology offers great potential in education by presenting engaging 3D media that appears realistic (Joshi et al., 2020).

Using augmented reality (AR) in educational games can help teachers create a more open, enjoyable, and focused learning environment for students (Chytas et al., 2020; Duarte et al., 2020; Rahimpour et al., 2020). Teachers also need to adapt so students can better understand the material and enjoy the learning process, which can increase motivation and interest (Ahmadi et al., 2018; Parrado-Martínez & Sánchez-Andújar, 2020). AR brings students into a more engaging and expressive learning situation (Wilcox et al., 2020). It lets students interact with 3D objects and access contextual information, making learning fun and interesting (Mastroianni et al., 2019; Saunders et al., 2019). Learning becomes more exciting and better suited to students' needs when teaching methods are

innovative and creative (Ismail et al., 2018; Kaur et al., 2020). AR fits today's digital generation, who are already familiar with gadgets and technology (Harun et al., 2020; Sahin & Yilmaz, 2020).

This technology uses WebAR and QR codes from Zappar to make it easier and more flexible for users to access the content (Soltani & Morice, 2020; Xiao et al., 2020). Augmented reality is then combined with draft design visual communication for needs promotion (Alt & Raichel, 2020; Garzón et al., 2020). Development of Augmented Reality games in the form of virtual portals. The virtual portal is an entry portal to the monument area hero (Bakke, 2020; Cho et al., 2020). The games developed offer an atmosphere and a real-life experience, with visuals of the heroic monument (Wake et al., 2020). The virtual portal game shows good results in its implementation; users can improve their experience, Study history, and take a tour in a new atmosphere and appearance (Chytas et al., 2020; Duarte et al., 2020). Games are evolving quickly throughout the world, including Indonesia. The game has a role besides entertainment and education for old, young, men, and women, especially children (Rahimpour et al., 2020; Salmas et al., 2020). However, this also becomes a problem in education, especially in learning.

Problems that occur are low interest in learning and the ability to think creatively in students, which can be proven by the confusion among students regarding various assignments given by the teacher. Students cannot take the initiative to decide on or look for solutions to existing problems (Aytug et al., 2018; Yang et al., 2018). Games played by children and teenagers now, especially among students, are not educational, so they are just a general game, which sometimes forget everything, including the fun of playing games (Comunian & England, 2019; Humble et al., 2018). So, from that, digital-based games are very popular among teenagers, specifically among students, but they need to be integrated into the learning process (Lin et al., 2018; Mendez et al., 2020).

Because it is truly an integrated game with learning, it is a game that attempts to make learning more fun through various student participation (Liu et al., 2019; Wake et al., 2020). Essentially, it is an educational game media designed with augmented reality technology. The PBL (problem-based learning) model is used with several figures, including inspiring figures of Indonesian independence (Barbieri et al., 2020; Hussain et al., 2019; Tortorella & Cauchick-Miguel, 2018). Problem-based learning models can involve students in contextually solving problems through various stages of the scientific method. This allows students to learn knowledge (interest) related to existing problems, thereby increasing their critical thinking and creative skills (Chou et al., 2019; Dring, 2019).

The PBL model augmented reality technology makes learning more interactive and contextually connected between warriors in a real way through the world of educational games with reality that allows the characters to be spun around (Liu et al., 2019; Montepara et al., 2021). Learning model based on the problem through game media figures, inspiring a big impact on skills, and thinking creatively (Jalani & Sern, 2015). The learning model designed by the teacher helps students develop practical and cognitive abilities, especially thinking creatively and sustainably (Waite et al., 2020; Wyness & Dalton, 2018). PBL model as a learning model is innovative, starting with a real-world problem context, which creates active learning through a systematic approach , such as character games, inspiring students to think creatively and increase their literacy and skills (Joshi et al., 2020; Tortorella & Cauchick-Miguel, 2018).

Improving interest literacy in children's schools requires using technology as an effective and enjoyable approach (Fidan & Tuncel, 2019; Hussain et al., 2019). Because of its suitability, literacy in schools is one of the government's initiatives. This is done sustainably (Barbieri et al., 2020; Tsybulsky & Muchnik-Rozanov, 2019). Increase children's literacy ability through the PBL model by using character games, inspiring augmented reality rock can help increase students' focus in the learning process (Ahmadi et al., 2018; Parrado-Martínez & Sánchez-Andújar, 2020). Interest in reading is in question here as a strong desire and willingness to get material reading based on awareness alone (Csima et al., 2018; Hammons, 2020). Interest in literacy among students becomes a main

factor in cultivating habits among students at school (Mastroianni et al., 2019; Saunders et al., 2019).

Students become inspired and capable through the PBL model with character games, increase their skills, and think creatively (Cleovoulou & Beach, 2019; Wechsler et al., 2018). Skills, such as thinking creatively, must be owned by each student from the moment. This becomes part of the most important supply for level education (Humble et al., 2018; Lin et al., 2018). Skills, such as thinking creatively, can be made into a habit by a student. For practice, think with notice, intuition, turn on imagination, and so on (Comunian & England, 2019; Yang et al., 2018). Therefore, it can be confirmed that one of the skills considered important for development in education is creativity (Garzón et al., 2020; Lucchiari et al., 2019). Because the skills that students have enable them to find solutions to problems. On the other hand, those skills are considered creative, such as methodical, original, and reflective thinking, and producing a solution (Ismail et al., 2018; Sun et al., 2020).

The description above shows that game media character development is inspired by the augmented reality-based problem-based learning model in elementary schools, as part of an integrated learning process. With this initiative from the study, the implementation of character game media inspires an effort to increase interest in reading and thinking on a school basis. Based on that, what becomes an objective study? This is a character game media inspired by augmented reality to increase interest, literacy, and skills. Think of creative students in the eyes of history to plant a level understanding of students to understand several figures inspiring those who have fought for Indonesian independence.

2. Materials and Methods

2.1. Types of Research

Based on the objectives of the study, this research employs a Research and Development (R&D) approach, using the Lee & Owens development model. This model consists of five key stages: Assessment/Analysis, Needs Analysis, Front-End Analysis, Design, Development, Implementation, and Evaluation. The initial analysis focused on identifying the need for learning media, specifically examining the media and instructional models currently used in classrooms. Data were collected through observations involving both teachers and students as respondents.

The analysis addressed the relevance of the teaching module, character-based game learning media, implementation of inspirational learning strategies, and assessment processes. Results from curriculum document analysis, independence standards, and supporting instruments in the Pancasila and Civic Education subjects revealed a clear need for contextually relevant and engaging learning media. The next step involved designing a character-based educational game utilizing Android-based Augmented Reality (AR) technology, easily accessible via the Play Store. After the design phase, the learning media were validated by nine expert validators who assessed both the instructional materials and the AR-based game product. The final product—a character game infused with Pancasila content—was judged feasible for implementation. It aims to improve students' creative thinking skills and engagement with values-based education.

2.2. Research Subjects and Objects

The research was conducted at Muhammadiyah Elementary School 18 Surabaya during the first semester of the 2023/2024 academic year. The school operates under the guidance of the Muhammadiyah Council for Primary and Secondary Education in Surabaya. The study involved students from classes VA, VB, and VC, with a total of 45 students divided into three groups with similar cultural and academic backgrounds.

2.3. Types and Sources of Data

This study utilized both qualitative and quantitative data. Qualitative data were obtained through interviews with the school principal, classroom observations during Social Studies instruction in Grade V, observation sheets, and validation instruments from subject-matter experts and media specialists. Quantitative data were collected using pretest and posttest scores to measure students' cognitive learning outcomes in the history component of Social Studies.

2.4. Data Collection Technique

To obtain accurate empirical data, the study employed both test and non-test methods. The test method assessed students' creative thinking and knowledge acquisition, while the non-test methods included classroom observations of the Problem-Based Learning (PBL) implementation using the character-based AR game. These observations evaluated model practicality and student engagement. Additional data were collected through interviews with respondents to explore existing problems in classroom instruction, and questionnaires were administered to gather student feedback on the newly implemented learning model and media.

2.5. Data Analysis Techniques

Data analysis involved organizing, categorizing, and interpreting information systematically from field notes and instruments. Both quantitative (statistical) and qualitative descriptive analyses were used to evaluate the development outcomes of the AR-based learning media. Descriptive analysis focused on each research variable, and validation of the AR-assisted Problem-Based Learning model was presented in tabular form, including media suitability criteria (Table 1 and Table 2).

Table 1. Criteria for the validation of learning models

Score	Validity Category	Information
25 – 40	Invalid	Should not used
41 – 55	Less valid	Should not used
56 – 70	Quite valid	Yes, used after revision big
71 – 85	Valid	Yes, used after revision, small
86 – 100	Very valid	Very good for use

The validation process—covering instructional materials, teaching modules, and media—confirmed alignment with the Independent Curriculum. Validation criteria were used as benchmarks by media experts, content experts, and practitioner validators (teachers).

Table 2. Criteria for the validity of teaching module

Score (%)	Category Validation	Criteria Validity
85, 01 – 100	Very Valid	Can be used without revision
70.01 – 85.00	Quite Valid	Can be used; however, it needs revision.
50.01 – 70.00	Less Valid	Recommended No used
01.00 – 50.00	Invalid	Should not used

3. Results

3.1. Analysis

Interviews with the principal and classroom teachers at Muhammadiyah Elementary School 18 Surabaya revealed that the learning process primarily utilizes conventional models and unmodified instructional media. Specifically, while educators use visual media to teach about historical figures, the materials are not integrated with digital

technology. As a result, the classroom experience is often monotonous and disengaging for students. Without innovation, learning lacks the interactive elements expected in today's digital era. Therefore, it is essential to introduce breakthroughs and modifications that promote student-centered learning. Despite challenges, the school continues to strive for excellence in varying circumstances.

3.2. Needs Analysis

The needs analysis involved interviews and direct observations with both teachers and students at Muhammadiyah Elementary School 18 Surabaya. Key findings include:

a. Teachers require instructional media to support effective classroom teaching. Although some digital videos are used, many teachers lack the skills or confidence to create engaging, interactive content.
b. Students often lose interest during lessons due to the limited and simplistic media used. There is minimal opportunity for students to interact with digital learning tools, resulting in a lack of meaningful and impactful learning experiences.
c. Students need varied and enjoyable learning approaches that align with their interests and abilities. Traditional, one-size-fits-all teaching methods tend to reduce engagement, making the classroom environment less dynamic.

3.3. Front-End Analysis

To gather comprehensive data, the researchers employed several methods:

a. Creative thinking tests and questionnaires were administered to Grade V students.
b. Students' technological proficiency was assessed using questionnaires and validation sheets.
c. Key instructional content and effective delivery methods were identified.
d. Classroom observations were conducted to understand the current learning environment.
e. Development goals for AR-based learning media focused on the topic of historical figures were established.
f. Media selection was based on classroom needs and conditions.
g. All collected data were analyzed to propose solutions for issues related to learning engagement, digital literacy, collaboration, and creative thinking.

3.4. Design

In the design stage, the researchers developed a detailed plan for the creation and implementation of an Augmented Reality (AR)-based learning module. This plan included the preparation of a development timeline and the integration of character education through educational games supported by AR technology. The application was designed to enhance the quality of education in Indonesia by using marker-based AR technology to display 3D objects. These markers, which are distinctive images of various sizes, could be accessed through the Play Store (https://goto.now/nMeu7). The home page view of LegendARy Application can be seed in Figure 1.

Upon launching the application, users are directed to a homepage featuring a central circular image that navigates to the next screen when tapped (Figure 1). An information icon in the upper-right corner links to the developer's biography. The second page displays AR content along with character-based educational games. To support classroom learning, the app includes instructional modules, student worksheets (LKPD), evaluation instruments (tests), and reflection tools such as observation and questionnaire sheets (see in Figure 2).

Each historical figure—such as Cut Nyak Dien, Dr. Soetomo, and General Soedirman—is represented by a unique marker (QR code), enabling AR features when scanned (see Figure 3). The game component is designed to enhance recognition and understanding of national heroes. A correct answer triggers a checkmark, while an incorrect answer displays a cross. This interactive format supports student engagement and reinforces character education. In addition to interactive learning, the application

offers educational pages containing modules, assignments, assessments of creative thinking, and non-test instruments such as observation guides and feedback questionnaires. Navigation within the app includes options to exit or proceed with the activity, enhancing usability and learner control.

Figure 1. The home page view of LegendARy Application

Figure 2. Second Page Application LegendARy

3.5. Development

During the development phase, the AR-based educational game focused on historical content was systematically created and validated by instructional media and design experts. This phase began with pre-production activities, including the creation of storyboards and visual design elements for vertebrate animal content using software such as CorelDRAW and Canva. In the production stage, the AR-based learning content was built by integrating the Problem-Based Learning (PBL) model to foster digital literacy and creative thinking. The post-production phase involved rigorous quality checks to address any technical or pedagogical issues. Validation was conducted through expert reviews, focusing on both instructional feasibility and media quality.

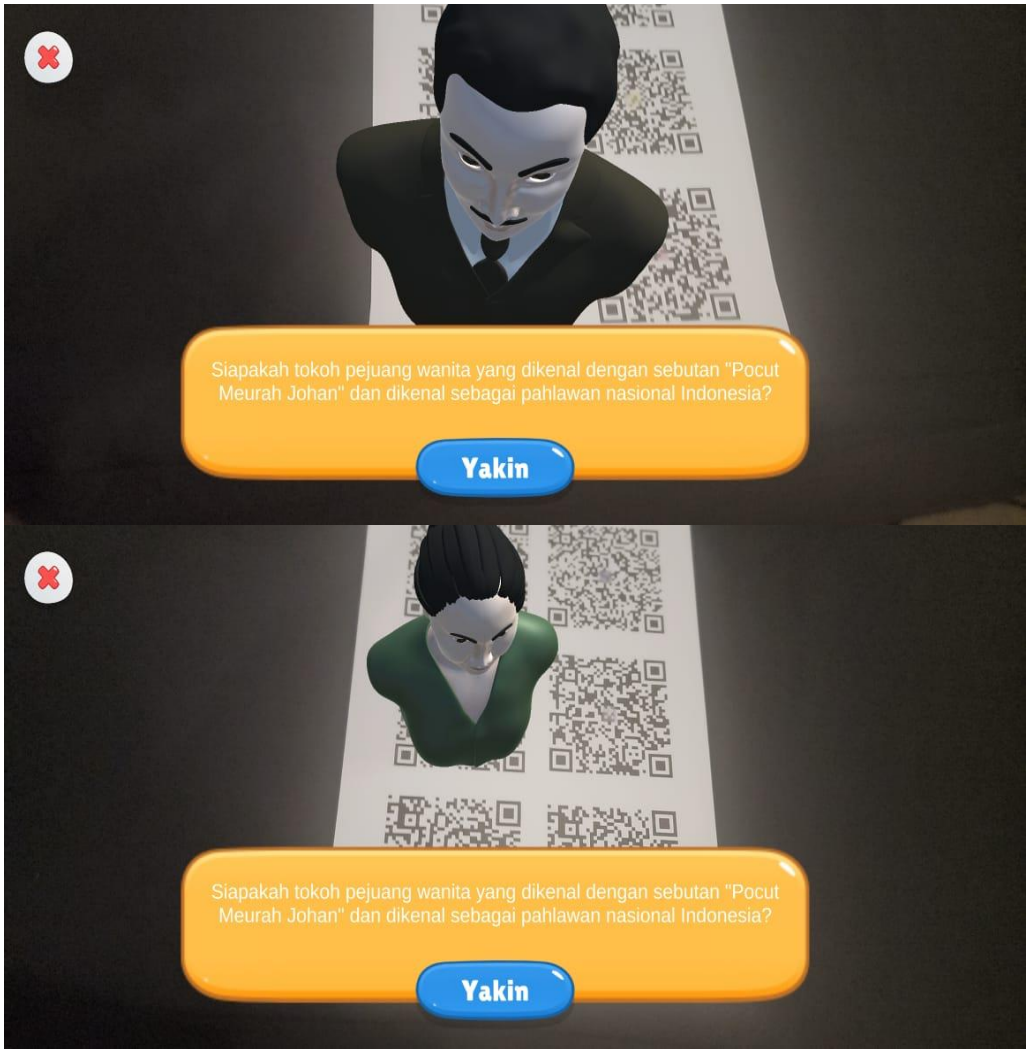

Figure 3. The QR code marker for each historical figure

The feasibility assessment of the learning model considered several aspects: the appropriateness of the syntax, the effectiveness of social interaction patterns, the relevance of response principles, the adequacy of support systems, and the overall instructional impact. Media quality was evaluated in terms of content accuracy, presentation structure, visual clarity, 3D rendering quality, language use, and layout design. Based on the results presented in Table 3, the teaching module received a mean score of 3.60, placing it in the "very valid" category. This indicates that the module met high standards of instructional design and was considered ready for use in classroom learning activities. Similarly, the AR-based character game media achieved a mean score of 3.40, also falling into the "very valid" category. This confirms the media's suitability for educational implementation, demonstrating that it met expert expectations in both content delivery and technological functionality.

Table 3. The result of validation process

Data	Indicators									Mean	Score	Category
	1	2	3	4	5	6	7	8	9			
Teaching module	3.8	3	3.6	3.6	3.8	3.9	4	4	4	3.60	90	Very valid
AR-based game media	2.6	3.7	3.9	3.3	3.9	3.4	4	3.7	3	3.40	85	Very valid

3.6. Implementation

Following the completion and expert validation of the product, the implementation stage involved testing the developed media on students from Muhammadiyah

Elementary School 18 Surabaya. The trial was conducted in three classes, each comprising 15 students, for a total of 45 participants. The learning media used was the *Character Game Inspired by Augmented Reality* (GTI-AR), which integrates character education into an augmented reality-based digital game. The research employed a purposive sampling technique to ensure that participants met specific criteria relevant to the study's objectives. This approach allowed the selection of students whose characteristics aligned with the purpose of the research, ensuring relevance and contextual appropriateness.

GTI-AR was implemented using the Problem-Based Learning (PBL) model to foster student engagement, enhance digital literacy, and develop creative thinking skills. This integrated approach aimed to create meaningful, student-centered learning experiences. The implementation process followed structured stages: introductory activities, core learning sessions, and closing activities (see in Table 4).

Table 4. Stages of the PBL implementation using *Character Game Inspired by Augmented Reality* (GTI-AR)

Learning stages	Activities
Orientation students on the problem	The teacher explains objective learning, explains the logistics required, presents existing problems in learning videos, and motivates the student to be involved in activity breakdown problems of his choice through existing learning media presented. Students explain that game media operation, integrated with educational content and augmented reality, provides a fun learning process.
Organize students For Study.	The teacher helps the student determine and organize learning-related tasks, using inspiring character game media integrated with augmented reality. Students can use Android accordingly with the material to be delivered. Then, the teacher gives LKPD, which can be used as a reference for the student in follow-up learning.
Guide individual and group investigations.	The teacher encourages the student to gather the right information from various sources, referring to the educational game used and a test. The teacher also helps students understand the settlement problem using character game media, inspiring them via Android in a previously formed group.
Develop and present results.	The teacher helps the student plan and prepare suitable work, such as educational reports and posters, according to the student's level of understanding, and helps the student share tasks with their group. Then, the results of his work served as a basis for other groups to provide responses and criticism.
Analyze and evaluate the problem-solving process.	The teacher helps the student reflect on or evaluate the investigation conducted in the learning process with the student's process. This is to show that learning is more meaningful or pleasant for students in the learning process.

Based on observation and teacher assessment (Table 4), the implementation showed consistently positive results. The introductory stage received an average score of 4.69, categorized as "Good." The core learning activities were rated at 4.68, also classified as "Good," the closing stage received a score of 4.53, still within the "Good" category (Table 5). These findings indicate that the learning process using the GTI-AR media within the PBL framework was effectively executed and positively received by both students and teachers.

Table 5. Implementation of the PBL with GTI-AR

Activity	Total Indicators	Implementation			r	Criteria
		1	2	3		
Introduction	6	4.55	4.67	4.85	4.69	Good
Core activities	16	4.53	4.69	4.83	4.68	Good
Closing	4	4.28	4.55	4.78	4.53	Good

Prior to evaluating the effectiveness of the implementation, the demographic characteristics of the participants were analyzed. The student population consisted of

44.6% male students (21 individuals) and 55.4% female students (24 individuals), showing a gender ratio skewed toward females. The majority of students (57.5%) were aged between 11 and 12 years, while the remaining 42.5% were between 9 and 10 years, confirming that the sample reflected the typical upper-grade elementary school population. Statistical analysis began with prerequisite testing to ensure the data met the assumptions for parametric analysis. A normality test using histograms and the Kolmogorov-Smirnov method showed that the data were normally distributed, as evidenced by the bell-shaped curves and significance values above 0.05. Additionally, a multicollinearity test confirmed that tolerance and Variance Inflation Factor (VIF) values were within acceptable limits, indicating no multicollinearity among independent variables.

With these assumptions satisfied, a t-test was conducted to assess the effectiveness of the PBL model combined with the GTI-AR media. Descriptive statistics, in Table 6, revealed that students' literacy and interest scores post-intervention ranged from 80.00 to 87.00, with an average of 83.48. Creative thinking scores ranged from 87.00 to 97.00, with a mean score of 90.95. These results indicate a positive impact of the intervention on students' engagement, cognitive development, and creative expression.

Table 6. The result of descriptive statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Literacy	45	80.00	87.00	83.4889	1.82933
Creative thinking	45	87.00	97.00	90.9556	2.61078
Valid N (listwise)	45				

Furthermore, a correlation analysis between pre-test and post-test creative thinking scores showed a coefficient of 0.324 with a significance value of 0.030 ($p < 0.05$), demonstrating a statistically significant relationship (see in Table 7). The t-test also produced a significance value of 0.000, indicating a significant difference between pre-and post-intervention scores. This confirms that the GTI-AR media, when implemented through the PBL model, significantly enhanced students' literacy, interest, and especially their creative thinking abilities.

Table 7. The result of paired sample t-test

		N	Correlation	Sig.
Pair 1	Pre-test and post-test creative thinking	45	.324	.030

Additionally, the case processing summary confirmed that 100% of the data was analyzed without missing values, further supporting the reliability of the findings. The results of the Kolmogorov-Smirnov test reaffirmed that the data for each class were normally distributed, strengthening the justification for using parametric tests. These findings collectively validate that the character-based game media supported by augmented reality is not only pedagogically sound and practically viable but also statistically effective in enhancing critical educational outcomes among elementary school students.

4. Discussion

The development of character-based learning media inspired by augmented reality (AR) was designed to enhance students' abilities, interests, literacy, and creative thinking skills in schools. This character game media integrates AR technology, which allows digital content—whether 2D or 3D—to be superimposed in real-time onto the real-world environment (Hidayat et al., 2018; Zhou et al., 2020). Mobile AR technology enables users to view and interact with virtual objects within their physical surroundings, providing a highly engaging and visually stimulating experience that enriches the learning process (Huang et al., 2020; Sahin & Yilmaz, 2020). In this study, the character game based on AR

was specifically developed for use at the elementary school level, notably at Muhammadiyah Elementary School 18 Surabaya.

The development process followed standard instructional media design procedures. Initial steps involved creating prototypes, which were subsequently reviewed and validated by experts in the fields of instructional design, media development, and pedagogy. Validation results showed that the teaching module achieved an average score of 3.60, indicating it was "highly feasible" for classroom use. Similarly, the character game media inspired by AR received an average score of 3.40, also falling into the "highly feasible" category. These findings confirm that both the teaching module and the AR game media meet essential standards for quality and practicality, thus making them suitable for integration into the learning environment (Amponsah et al., 2019; Gube & Lajoie, 2020; Lucchiari et al., 2019).

This media development initiative aimed to address the persistent challenges of low student interest, weak literacy, and limited creative thinking among elementary school learners. Without the introduction of innovative and enjoyable learning methods, students often become passive and disengaged (Mastroianni et al., 2019; Saunders et al., 2019). The incorporation of AR in character game-based learning presents an alternative instructional model that is both interactive and culturally relevant. Through the application of a modified problem-based learning (PBL) framework, the AR character game media seeks to cultivate students' cultural literacy and cognitive abilities (Crampton & Lewis, 2020; Csima et al., 2018). Cultural literacy, in this context, empowers students to approach problems with a deeper understanding and to construct creative, context-sensitive solutions (Cleovoulou & Beach, 2019; Pezoa et al., 2019).

In traditional classroom settings, students frequently encounter difficulties when planning solutions, constructing arguments, and resolving complex problems (Comunian & England, 2019; Humble et al., 2018; Wechsler et al., 2018). The integration of digital media through modified learning strategies provides students with increased opportunities for self-expression and engagement, transforming the classroom into a dynamic and enjoyable environment (Rahimpour et al., 2020; Yang et al., 2018). Conversely, when educational games lack stimulation or variety, student motivation tends to decline, adversely affecting learning outcomes. In the digital era, teachers must act as facilitators, leveraging technology to unlock students' potential and foster holistic development (Cho et al., 2020; Chytas et al., 2020; Salmas et al., 2020).

Fun and engaging learning environments have been shown to enhance student comprehension and retention (Comunian & England, 2019; Wake et al., 2020; Wetzel et al., 2019). Character game media based on AR creates such environments by offering freedom of interaction, immersive learning experiences, and expressive spaces that encourage student participation (Mendez et al., 2020; Montepara et al., 2021). Through this approach, students not only improve in cultural literacy and practical skills but also develop the ability to think critically and respond to challenges with creativity. The implementation of simple yet engaging tools, such as domino cards, has also proven effective in reinforcing these principles through active classroom participation (Jalani & Sern, 2015; Liu et al., 2019). While much of the existing literature focuses on the potential of AR in education, there remains a need for further exploration of its application at the elementary level, particularly in relation to character development, student interest, literacy, skills, and creativity (Gargrish et al., 2020; Terry et al., 2019). This study contributes to that growing body of research by demonstrating that the integration of AR-based character game media within a problem-based learning framework is not only practical but also impactful in improving key student competencies.

5. Conclusions

This study concludes that the development of character-based game learning media inspired by Augmented Reality (GTI-AR), guided by the Lee & Owens instructional design model, was both feasible and effective for implementation in elementary

education. Validation by subject matter experts, media specialists, and field practitioners confirmed that the teaching module and the AR-based game media achieved high levels of suitability, indicating strong potential for classroom integration. The integration of GTI-AR into the learning process not only fostered greater student engagement but also significantly enhanced learners' creative thinking abilities and cultural literacy. By merging interactive digital content with real-world environments, the use of AR provided an innovative and enjoyable learning experience that addressed common challenges in traditional pedagogy—such as low motivation, lack of interest, and limited problem-solving skills. Moreover, the implementation of this technology-rich, character-driven learning media supports the development of essential 21st-century skills, offering a promising alternative for future-oriented education. GTI-AR has proven to be more than just a technological novelty; it serves as a meaningful instructional tool capable of transforming the learning atmosphere into one that is expressive, student-centered, and cognitively enriching.

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