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Augmented Reality in Primary Education: Exploring Teachers' Readiness and Needs for Innovative Learning Media

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ABSTRACT

The rapid advancement of modern technology has had a significant impact on various sectors, including education. This study aims to analyze the teacher readiness and needs to find the inovative augmented reality (AR)-based learning media in elementary schools. Using a qualitative approach, data was collected through classroom observations, In-depth interviews with 57 teachers., and needs assessment questionnaires from 684 fifth grader students who currently use conventional teaching media. The data was analysed using thematic analysis to identify patterns and themes that emerged from students and teachers' needs and preferences regarding learning media. The findings show that there is a need for more interactive and immersive learning media, which can help students understand abstract concepts more effectively. Students' preference for dynamic learning media, such as videos, animations, and interactive simulations, was identified as a solution to improve material understanding. These results suggest that AR has the potential to be a powerful tool to improve student participation and learning outcomes, making the learning process more adaptive and responsive to individual needs.

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Introduction

The development of modern technology has driven significant changes in various sectors, including education (Ramdani et al., 2024; Li et al., 2024; Saeed et al., 2024). The use of technology in the learning process not only facilitates teachers in delivering material but also enhances student engagement and understanding through more dynamic interactions (Ilham, 2022). One of the interactive learning media, such as augmented reality (AR), offers a more engaging and immersive approach compared to conventional learning methods

(Yuniawatika et al., 2023; Ilham, 2022). AR technology enables the integration of the real world with digital elements in real time, creating visualizations that not only enrich the learning experience but also strengthen memory and deepen concept comprehension (Listiawan et al., 2022; Purba & Silitonga, 2021; Abadiya & Fatmaningtyas, 2021). With its ability to present three-dimensional objects, simulations, and other interactive experiences, AR becomes a highly effective tool in explaining abstract concepts that are difficult to understand through traditional methods (Yuniawatika et al., 2023). Thus, the implementation of AR in education has great potential to build a more innovative and adaptive learning ecosystem that can respond to the individual needs of each student.

Currently, students need a more interesting learning approach that can support a deeper understanding of the material (Rambe & Mirna, 2022; Suwoto, 2021; Adini et al., 2022). The use of methods that are more interactive, attractive, and relevant to everyday life is needed to improve learning effectiveness (Utami et al., 2023; Adini et al., 2022). In this context, Augmented Reality (AR) technology has the potential to be an ideal solution (Latifah et al., 2022). AR technology has the ability to visualise complex objects that are difficult to explain through words, thus facilitating a clearer and more concrete understanding for students (Listiawan et al., 2022; Yuniawatika et al., 2023).

Nowadays, many students still think that folklore often seems old-fashioned and less interesting, especially for the younger generation who prefer dynamic and visual technological developments today (Cintya, 2023). Augmented reality applications can be a solution to introduce traditional culture, such as folklore, in a more interactive and interesting way, so that it can help revitalise cultural heritage that is starting to be forgotten (Sirumapea et al., 2021; Abadiya & Fatmaningtyas, 2021). In addition, the use of augmented reality is also proven to make it easier for students to understand abstract concepts in Indonesian language lessons, such as on narrative text material (Yuniawatika et al., 2023; Rachmi et al., 2022; Pramana et al., 2021; Saputri & Susilowati, 2022). Augmented reality can help students visualise the storyline and characterisation of characters more realistically, so that it can support better understanding (Setiawan & Setiawan, 2023; Suratman & Ismail, 2021; Tresnawati et al., 2021).

Through the use of augmented reality in learning, students can not only learn in a more interesting and interactive way, but also help them understand the material more deeply (Solikhatun et al., 2021; Pflieger et al., 2024; Li et al., 2024;). The interactive features and 3D visualisation offered by AR can increase student engagement and clarify difficult concepts, thus supporting a more effective learning process (Purba & Silitonga, 2021).

Augmented reality provides a learning experience that is more personalised and tailored to the needs of each student (Tuwoso et al., 2021). Through this technology, learning can be designed in such a way that students can learn according to their own pace and learning style (Solikhatun et al., 2021; Suratman & Ismail, 2021; Guntur & Setyaningrum, 2021). For example, in science learning, students can repeat simulations or interactions with virtual objects until they fully understand the concepts presented (Wardani et al., 2024; Hidayati et al., 2022). This provides flexibility that is not always found in traditional learning, where time and physical limitations often become obstacles (Amalia, 2023; Zinchenko et al., 2023; Listiawan et al., 2022). Thus, AR is able to facilitate more individualised learning, while encouraging increased student motivation in the learning process.

Augmented Reality (AR) as an interactive technology in education has been extensively studied, particularly in the context of digital-based learning. However, most prior research has primarily focused on its effectiveness in specific subjects such as science or mathematics and has largely been conducted at the secondary or tertiary education levels.

This study offers a novel contribution by analyzing the readiness and needs of elementary school teachers in developing AR-based learning media that are cross-disciplinary and locally contextualized. Such an approach remains underexplored, especially in the context of primary education in Indonesia, which presents unique challenges in terms of technological access, curriculum alignment, and student characteristics. Additionally, this study adopts an empirical approach involving data collection from five geographically diverse elementary schools, thereby providing a more comprehensive and grounded understanding of on-the-ground realities.

The novelty of this research lies in its focus on integrating two important yet rarely studied aspects simultaneously, namely the readiness of elementary school teachers and their needs for augmented reality (AR)-based learning media. Unlike previous studies that primarily focused on the effectiveness of AR on student learning outcomes, this research makes a unique contribution by deeply exploring teachers' perceptions, readiness, and expectations regarding the implementation of AR in the classroom. This approach allows for the identification of gaps between the potential of technology and the actual capacity at the elementary education level, as well as generating recommendations based on real needs that can serve as the foundation for developing teacher training and more relevant and sustainable educational innovation policies.

The findings of this study are significant to the broader field of education, particularly in Indonesia and in regions where conventional teaching methods still dominate. By identifying teachers' readiness and specific needs in adopting AR, future development of learning media can be more targeted not only from a technological standpoint but also in terms of pedagogical appropriateness. The study is expected to support the acceleration of digital transformation in elementary education, enhance student engagement and motivation, and promote the integration of culturally relevant content into immersive educational technologies.

Thus, this research aims to deeply analyse the need for augmented reality (AR)-based learning media development, which can be applied to various subjects to improve learning effectiveness. This analysis includes identifying important elements in the design and implementation of AR media, such as the appropriate type of content, the optimal level of interactivity, as well as how this technology can be integrated with the existing curriculum. In addition, this research also focuses on technical and pedagogical aspects, with the aim of ensuring that the learning media developed is able to provide an intuitive, immersive, and relevant learning experience for students at various levels of education.

Method

This study employs a qualitative descriptive approach (Johnson & Christensen, 2024), focusing on analyzing the needs for the development of Augmented Reality (AR)-based learning media in elementary schools. This approach was chosen because it allows for an in-depth exploration of phenomena, particularly in revealing the experiences and perspectives of teachers and students regarding the learning media they require. The study involved 684 students and 57 teachers from 76 elementary schools across 19 sub-districts in Tulungagung Regency.

Data collection techniques included observations, in-depth interviews, and needs analysis questionnaires. Observations were conducted in fifth-grade classrooms to examine the learning process using conventional media. In-depth interviews with teachers were carried out to uncover their perceptions, experiences, and expectations related to AR-based learning media. Meanwhile, the questionnaire was used to collect data on students' preferences for learning media.

The qualitative data analysis in this study follows the interactive model proposed by (Miles & Huberman, 1994), which consists of three main stages: (1) Data Reduction, which involves selecting, focusing, simplifying, and abstracting relevant data; (2) Data Display, which involves organizing the reduced data into narrative forms or thematic categories that are easy to understand; and (3) Conclusion Drawing, which involves interpreting the meaning of the analyzed data.

To ensure data validity, triangulation techniques were applied by comparing and confirming findings from observations, interviews, and questionnaires. Through this approach, the study is expected to provide a comprehensive understanding of the needs for AR media development that is contextual, engaging, and aligned with the characteristics of elementary school students.

Results and Discussion

This study shows that teachers tend to rely on narrative from the package book as the main source of learning. Although it aligns with the curriculum, student participation in question-and-answer sessions remains low, indicating a predominantly one-way learning process. Additionally, teachers have not fully utilized concrete learning media such as pictures, videos, or teaching aids, making learning less dynamic and hindering students' understanding of abstract concepts. The limited availability of interactive learning media in schools also affects the effectiveness of the learning process

Table 1 presents the results of interviews with grade 5 teachers regarding the teaching methods used and the challenges faced. These interviews highlight the importance of more varied and interactive learning media in enhancing student engagement. Table 1.

Table 1. Teacher Interview Results

No	Interview Questions	Interview Question Answers
1	What is the main reason why you chose to use the narrative story from the Package Book as a teaching material in this lesson?	Package books already exist and follow the curriculum, so they are considered the safest option. However, teachers admit that the use of package books feels less alive for students because the available learning media is still limited.
2	Do you realize that students are still less active in asking questions and answers when you use the narrative medium?	Yes, teachers realize that students tend to be passive, perhaps because the material presented only from teaching materials and stories feels less interesting.
3	Have you ever considered using concrete learning media (such as pictures, videos, props, etc.) in explaining this material?	Teachers are eager to use other aids such as images or videos, but school facilities are limited so it is not possible to use these media.
4	What do you think causes students to be not so active in the Q&A session? Are there any media factors that influence it?	Teachers argue that less varied media is one of the reasons. If students only see and hear from package books without more interesting media, they tend to get bored and not interested in asking questions. Teachers also emphasized the importance of using the right learning media so that students are more interested and active in learning activities.

Teachers find package books less engaging, leading to passive students. Limited learning media and monotonous methods reduce student participation. Teachers stress the need for more varied media to enhance engagement, including integrating local wisdom and AR technology. The results in Table 1 clearly show that limitations in school facilities significantly affect teachers' ability to implement engaging media. This condition also has a direct impact onstudents' motivation to learn. When students are not exposed to diverse and stimulating learning resources, such as digital media or multimedia presentations, their

interest tends to decline. Studies by Kember & McNaught (2007) and Al-Furaydi (2013) have shown that well-equipped school environments significantly influence learners' motivation, focus, and achievement. Conversely, under-resourced classrooms often lead to disinterest and reduced academic performance.

Moreover, the lack of varied learning media also influences students' emotional engagement and motivation. As indicated in the interviews, monotonous learning using only package books results in student boredom and passivity. Previous research by (Mayer, 2009) emphasizes that multimedia learning enhances cognitive and affective engagement. Similarly, a study by (Neo & Neo, 2001) found that students exposed to interactive and visually rich media show greater interest and deeper understanding of content. Therefore, the absence of concrete media in the classroom not only limits teachers' pedagogical strategies but also diminishes students' intrinsic motivation and learning attainment.

Teacher Competence in the Development of Augmented Reality-Based Learning Media

The survey results reveal teachers' perceptions of their competence, including their understanding and application of local wisdom in learning and openness to using technology like Augmented Reality for interactive teaching. This aligns with the responses of the teachers that shows as many as 55% of teachers feel that they understand the concept of local wisdom in the surrounding environment, while 45% feel that they understand quite well. However, despite this understanding, many teachers have not integrated local wisdom in the learning materials they teach.

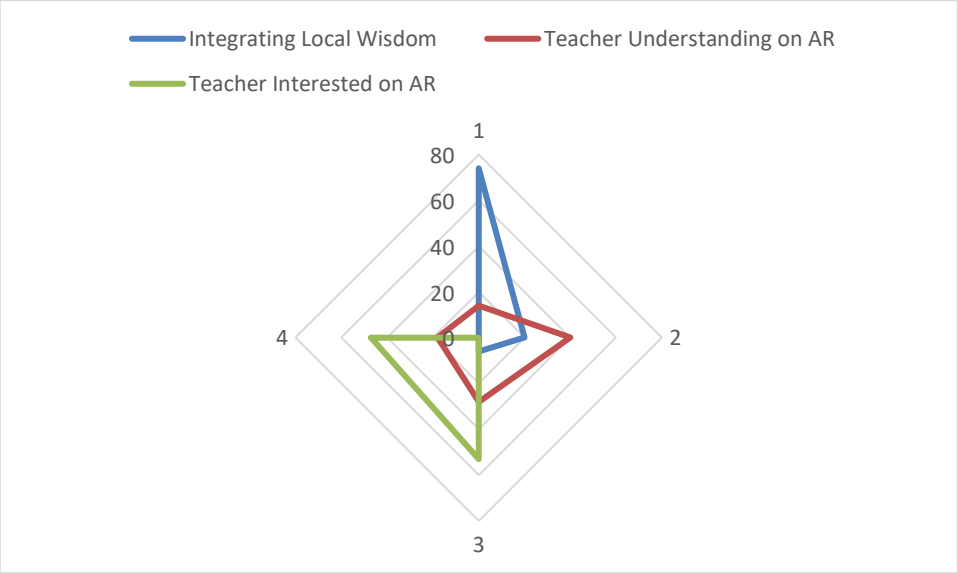

Figure 1. Local Wisdon Integration in learning, Teacher aUnderstanding and Interested in Augmented Reality Reults

Based on the data presented in Figure 1 above, it can be explained that no teacher feels that they integrate local wisdom very often in learning (0%), while teachers admit that they integrate local wisdom quite often (6%). Most teachers stated that they rarely or even never integrate local wisdom into the learning materials they teach (74%). This hesitation may stem from several factors, such as a lack of confidence in their understanding of how to relate local wisdom to the curriculum, limited access to relevant teaching resources, or concerns that incorporating local culture might not align with standardized learning targets. Previous research by Dewi et al. (2025) found that many teachers felt unprepared to integrate local content due to the absence of structured training and teaching materials that explicitly

connect local wisdom with core subjects. Similarly, research by Rahmawati et al. (2023) highlighted that despite recognizing the value of local culture, teachers often hesitate to include it in the classroom due to time constraints and a perception that such content is less academically rigorous. Although most teachers feel that they have not fully integrated local wisdom in learning, this could be related to their readiness to use more innovative learning media, such as Augmented Reality (AR) technology. Therefore, the next step is to explore how much teachers understand about the use of AR technology as a learning media, which can be an alternative to support more interactive and engaging teaching for students.

Based on the data presented in the Figure 1, it can be seen that 18% of teachers feel that they understand the use of Augmented Reality (AR) in learning, while 28% of teachers stated that they quite understand the use of AR. Most teachers, 40%, are hesitant about the use of AR in learning, and 14% of teachers reveal that they do not understand the use of AR in an educational context. This data shows that although there are a small percentage of teachers who understand AR well, most of them still feel unsure or do not have enough understanding of this technology in learning. Teachers' interest in developing AR-based learning media is notably high, as it facilitates the visualization of abstract concepts, enhances student engagement, and fosters interactive learning experiences. This is supported by previous studies, which found that teachers despite initial unfamiliarity demonstrated strong enthusiasm for AR after exploring its applications, and that both teachers and students showed increased motivation and acceptance of AR as a tool to enrich the learning process (Khan t et al., 2019; Wang et al., 2023; Petrovych, 2023; Ramdani et al., 2024; Li et al., 2024; Elamrani & Moughit, 2023; Saeed et al., 2024). This shows that despite the challenges in understanding, many teachers are interested in exploring and developing AR-based learning media, which can be an innovative solution to improve interactivity and quality of learning in the classroom.

Figure 1 also elaborate that 47% of teachers are very interested in developing Augmented Reality (AR)-based learning media, while 53% of teachers are quite interested. Interestingly, no teacher feels hesitant or uninterested in the development of AR media. This shows that all respondents have a positive interest in the application of AR in learning. Most teachers who are interested in developing AR media are likely to already have experience with other digital learning media. The use of digital media such as videos and apps can be an important first step in adopting new technologies, such as AR, to improve the quality of learning in the classroom. Existing digital learning media can be a strong foundation for developing and integrating AR as part of a more innovative learning strategy. The data obtained that 61% of teachers use digital media regularly in their learning, 18% of teachers admit to having used digital media rarely, and 21% of other teachers have never used digital media in the learning process. The data shows the basic capital for implementing technology in learning, where most teachers still frequently use digital media in their teaching. The rest involves how to invite, facilitate, and provide training to teachers who rarely or never use digital media in their teaching. So that, learning in elementary schools becomes more enjoyable and students are motivated, especially since today's elementary school students are digital natives. We can draw the conclusion that although there are some challenges in terms of understanding and applying new technology, the majority of teachers show a positive attitude towards the development of AR-based learning media, which can open up great opportunities for improving the quality of education.

Teachers' Supporting Capacity in the Development of Learning Media Based on Augmented Reality

To continue the discussion on the support provided by teachers in the development of digital media, especially related to the availability of school facilities to develop Augmented

Reality-based learning media, the data collected will provide further insight into the extent to which schools support these efforts. The carrying capacity in question covers various aspects, ranging from technological infrastructure to access to the tools and devices needed to implement AR in the learning process. Furthermore, a more in-depth analysis of this matter will be presented. The data taken from the teacher shows 56% of schools are equipped with sufficient facilities to support the development of AR-based learning media, whereas the remaining 44% report having only moderately adequate facilities. These facilities typically include access to computers or laptops, internet connectivity, and basic digital equipment such as projectors or smartphones. However, limited bandwidth and outdated hardware remain obstacles in some schools. It also in a line with the results data that 30% of schools provide full support for the development of Augmented Reality (AR)-based learning media with full support and actively includes access to necessary facilities, administrative encouragement, and the allocation of time and resources for media development. Meanwhile, the remaining 70% of schools demonstrate a supportive stance, albeit with a lower level of involvement—such as limited infrastructure, occasional encouragement, or partial facilitation. It does not mean that these schools are not supports, but they have an obstacle.

Furthermore, institutional support and condition from schools for teachers' efforts in developing innovative digital media is relatively strong. This shows a variation in institutional readiness, which is a key factor in the successful implementation of AR-based innovations. Furthermore, the role of teachers cannot be overlooked. The majority have participated in professional development programs, such as seminars and workshops on digital media development. Data shows 35% of teachers regularly attend seminars and training programs related to digital media development. Meanwhile, 56% of teachers reported that they had occasionally participated in such professional development activities. The remaining 9% rarely or never attended any seminars or training on digital media development. These findings indicate that most teachers have some level of exposure to digital media development, although the frequency and consistency of their participation vary. Teachers' engagement in professional development is a critical factor in the successful implementation of digital-based learning tools, especially those utilizing Augmented Reality (AR) technology. This is also influenced by the school's support for teachers attending seminars related to digital media, especially Augmented Reality.

The extent of institutional support provided to teachers in attending seminars related to the development of Augmented Reality (AR)-based learning media. The data show that 74% of teachers acknowledged receiving active support from their schools, such as financial assistance, assignment letters, or time allowances to participate in professional development programs. Meanwhile, 26% of teachers reported receiving moderate support, which typically included encouragement without significant institutional facilitation. This level of support reflects the schools' commitment to enhancing teachers' digital competencies, which is essential for the successful integration of AR technology into classroom practices. It also complements where institutional support for AR media development is evident, albeit with varying intensity. In comparison with previous research, this finding aligns with the study found that schools with strong administrative backing tended to produce more innovative and technology-integrated learning environments (Jain et al., 2025). Conversely, a study conducted by Salam (2023) reported that in schools with minimal support, teachers often faced challenges in sustaining digital media innovation despite having personal motivation and basic technical skills. These findings highlight the importance of synergy between teacher initiative and institutional capacity in the development of AR-based learning media.

Obstacles to Teacher Support in the Development of Augmented Reality-Based Learning Media

Furthermore, the obstacles faced by teachers in developing Augmented Reality-based learning media will be discussed. One of the main challenges that arise is the limited understanding of teachers about this technology. As much as 47% of teachers stated that limited understanding of the use of Augmented Reality is the main obstacle in its implementation. As many as 35% of teachers consider these limitations to be inhibiting, while 18% of teachers feel that the obstacles caused are not too significant. No teacher would argue that this limitation of understanding is not hindering at all. This is also supported by the lack of time available for teachers to develop learning media based on augmented reality. They need more time to understood and could develop the new digital media, such as augmented reality. Teachers revealed that the available time is very insufficient and limited to develop Augmented Reality-based learning media. None of the teachers stated that there was enough time or very much enough. This shows that many teachers need additional training and more time to develop Augmented Reality-based learning media. The majority of teachers 88% expressed an urgent need for additional training related to the development of Augmented Reality (AR)-based learning media. Meanwhile, 12% of respondents indicated that such training is still necessary, although not categorized as urgent. Interestingly, no teachers reported that they required only minimal or no additional training, suggesting a widespread recognition among educators of the need to enhance their competencies in AR-based instructional design. Many teachers possess a basic understanding of digital media but lack the technical skills to utilize them effectively, highlighting the need for targeted training programs (Purwadi et al., 2024). Continuous professional development is essential, as it has been shown to improve teachers' digital skills, regardless of age (Sánchez et al., 2020).

The Need for Augmented Reality-Based Storybook Development

Furthermore, Table 2 presents the data on the results of the Needs Assessment collected from students. This assessment was carried out with the aim of identifying the type of learning media that is most suitable for use in overcoming problems faced during the learning process. Through Need Assessment, students are given the opportunity to express their views on media that they feel are more interesting and effective to support the understanding of the material delivered by the teacher. This data is expected to provide deeper insights into students' preferences for learning media that are able to increase their active participation and understanding of subject matter. The information obtained from the results of the Need Assessment will also be the basis for recommendations in the development and application of more interactive and relevant learning media, which can help answer the challenges faced in the traditional learning process.

Table 2. Needs Assessment

No	Urgency of Needs	Number of Students Vote	Percentage
1	Do you have your own cellphone?		
	Opt 1. Yes	561	82 %
	Opt 2. No	123	18 %
2	Do you like learning that		
	Opt 1. Delivered directly by the teacher	96	14 %
	Opt 2. Done by discussing with friends	273	40 %
	Opt 3. Conducted with practicum	219	32 %
	Opt 4. Done with troubleshooting	96	14 %
3	Do you like using learning media		
	Opt 1. Book	157	23 %

No	Urgency of Needs	Number of Students Vote	Percentage
	Opt 2. Blackboard		
	Opt 3. Picture	157	23 %
	Opt 4. Video	185	27 %
	Opt 5. Animation	185	27 %
	Opt 6. Practicum		
4	Do you feel that learning in the classroom		
	Opt 1. Often boring	123	18 %
	Opt 2. Sometimes boring	369	54%
	Opt 3 is Rarely Boring	96	14%
	Opt 4. Never Boring	96	14 %
5	Do you find it difficult to learn?		
	Opt 1. Yes	527	77 %
	Opt 2. No	157	23 %
6	Do you feel successful in learning		
	Opt 1. Yes	588	86 %
	Opt 2. No	96	14 %
7	Do you prefer learning like what do you like?		
	Opt 1. Listening to music, discussions, lectures, listening to the teacher's explanation	150	22 %
	Opt 2. View images, diagrams, videos, or animations	308	45 %
	Opt 3. Do practicums, experiments, or role-plays.	226	33 %

Table 2 presents the results of a preference questionnaire conducted on 684 fifth-grade students and 57 teachers from 76 elementary schools in 19 sub-districts in Tulungagung Regency. The data shows that the majority of students (82%) have mobile phones. Regarding learning preferences, most students prefer learning activities that involve discussions (40%) and practical work (32%), indicating a preference for interactive and experience-based learning. Although book media was chosen by 23% of students, pictures by 23%, videos by 27%, and animations by 27%, the majority of students (54%) feel that learning is sometimes boring, while 18% feel bored often. Based on these findings, the researcher suggests creating storybooks integrated with augmented reality (AR) technology. Storybooks featuring local wisdom from Tulungagung, focusing on narrative materials, would appeal to students who enjoy reading books. Additionally, incorporating AR technology—such as images, holograms, videos, and animations—would enhance the learning experience, making it more engaging and potentially increasing student enthusiasm. This approach also serves to introduce local culture, helping prevent national disintegration by fostering connections with local traditions. The findings of the research show that there is an inequality in the development of students' cultural literacy and citizenship competencies, which is still relatively low. This reflects the gap between the potential of local culture that can be used as learning material and the limitations of its development in daily educational practice. Nonetheless, the study also found that the development capacity of local folklore books is very high, which means that there is great potential to harness the richness of local culture in education, including through more innovative media such as Augmented Reality (AR) (Hartati et al., 2022).

In this case, the use of AR as a teaching medium can provide an effective solution to overcome this problem. As revealed by the teachers in interviews, although they have a strong desire to use interactive media such as AR, they are hit by the limitations of existing resources, both in terms of learning materials and funds for the development of new media (Simangunsong et al., 2022). This limitation is rooted in the administrative burden of the school which limits the time that can be used to develop more innovative and relevant teaching materials to the local context, such as folklore books from Tulungagung that reflect the local culture.

However, these findings also show the enthusiasm of teachers to participate in various workshops and seminars related to local wisdom and Augmented Reality media, which shows that there is readiness to integrate this technology in learning. This is in line with previous findings that show that teaching that relies on traditional media tends to result in lower cognitive engagement (Hidayat, 2022). On the other hand, AR that incorporates local folklore can be a powerful tool for introducing abstract concepts through a more lively and interactive way, as has been suggested by previous research on the use of AR to enhance the learning experience (Simangunsong et al., 2022).

The main obstacle faced by teachers in the development of Tulungagung folklore books is the lack of time and funds to produce new, more innovative learning materials. Most of the time teachers are focused on administrative tasks that burden them, thus hindering their efforts to develop and use more creative media in learning. However, these findings confirm that with the right development, AR integrated with local folklore can be an effective alternative to increase student engagement and support their understanding of local culture and improve their cultural and civic literacy skills.

Thus, there is an urgent need for pedagogical innovation in integrating AR into educational media, as revealed in this study, in order to meet the needs of a more modern education and in accordance with technological developments and utilize the richness of local culture as a more interesting and effective learning tool.

Conclusion

This research emphasizes the need for more interactive learning media to enhance student engagement. Although package books align with the curriculum, they are less effective in encouraging active participation, with students often remaining passive. The study also reveals low cultural literacy and citizenship competencies, highlighting the need for culturally-based approaches like folklore books. Despite the potential of folklore books, challenges like time, funding, and a lack of resources hinder the development of AR-based learning media. However, students show greater interest in visual media and group-based learning. Integrating AR with folklore storybooks can boost engagement and cultural awareness. This approach could increase participation and understanding, but requires better support, including reduced administrative burdens and funding, to overcome current obstacles.

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