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Enhancing Learning Motivation through Augmented Reality: A Study of Orang Asli Children

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Abstract

This study explores the use of Augmented Reality (AR) technology to enhance learning motivation among Orang Asli primary children in non-formal settings in Pahang, Malaysia. Through qualitative interviews with children and observations during engaging AR activities, the research examines how AR influences children's engagement, emotional responses, and motivation in learning. Findings indicate that AR fosters an interactive and immersive learning environment, significantly increasing children's emotional engagement and promoting real-world relevance in their learning experiences. The study highlights how AR technology can create a stimulating learning atmosphere that captivates children's attention and curiosity. Furthermore, the use of AR allows children to interact with educational content in innovative ways, helping them grasp complex concepts more easily. By connecting their learning to real-life situations, AR makes the content more meaningful and relatable. This study underscores the potential of AR as an effective educational tool, particularly in culturally diverse and marginalized communities. By integrating AR technology into educational practices, there is an opportunity to bridge gaps in traditional learning methods, enhance motivation, and ultimately improve educational outcomes for indigenous children in Malaysia. The findings contribute to the growing body of literature on technology-enhanced learning and its implications for educational equity.

Keywords: augmented reality, learning motivation, non-formal education, educational technology, orang asli children

1. Introduction

Augmented Reality (AR) is emerging as a transformative technology in educational settings, providing interactive and immersive experiences that enhance learning outcomes

(Carmigniani & Furht, 2011). Research has shown that AR can increase student engagement and improve retention of information by creating a more interactive learning environment. By overlaying digital content onto the real world, AR fosters experiential learning, allowing students to visualize and manipulate concepts that may be abstract or challenging to grasp through traditional methods.

In Malaysia, the application of AR has shown significant potential in engaging students, particularly among indigenous communities like the Orang Asli. These communities face unique educational challenges, including limited access to quality education, cultural barriers, and a lack of resources (Radziwill, 2018). The Orang Asli, who represent the indigenous population of Peninsular Malaysia, often struggle with educational inequalities, as many children do not attend formal schools due to geographical, social, or economic factors (Keller, 2010). These challenges underscore the need for innovative educational interventions that are tailored to their cultural context and learning needs.

AR technology offers a means to bridge the gap between traditional education and the diverse learning needs of these children, fostering greater motivation and engagement. By providing interactive and culturally relevant learning experiences, AR has the potential to not only captivate students' attention but also enhance their understanding of complex subjects. Moreover, AR's ability to contextualize learning in real-world environments can help make education more relevant and meaningful for Orang Asli children, who may benefit from connections between their daily lives and the educational content presented (Pappas, 2015).

Despite the increasing interest in AR technology within educational contexts, there is limited research focusing specifically on its effectiveness in enhancing learning motivation among Orang Asli children in non-formal settings. The existing literature primarily addresses AR's impact on general student populations, often neglecting the unique cultural and educational contexts of marginalized groups. Understanding how AR can be leveraged to improve educational experiences for this population is crucial for developing effective teaching strategies that cater to their specific needs.

This study aims to explore the impact of AR technology on learning motivation among Orang Asli primary children in non-formal educational settings. Specifically, it seeks to address two research questions: (1) How do Orang Asli children perceive AR technology in the non-formal learning process? and (2) How does AR enhance Orang Asli children's motivation in learning? By investigating the perceptions and experiences of these children, the research aims to contribute to the growing body of literature on AR in education, particularly within the context of indigenous learning.

This study contributes to the understanding of educational technology by providing insights into the use of AR as an effective tool for enhancing learning motivation among indigenous children. By focusing on the specific context of Orang Asli children, the study aims to inform educators and policymakers about the potential benefits of integrating AR into non-formal educational practices. Furthermore, it highlights the importance of culturally relevant teaching methods in promoting engagement and motivation among marginalized groups.

While this study offers valuable insights, it is essential to acknowledge its limitations. The research is context-specific, focusing on a small sample of Orang Asli children, which may limit the generalizability of the findings. Additionally, the reliance on qualitative methods may introduce biases based on the researchers' interpretations.

2. Literature Review

2.1 Augmented Reality (AR) in Education: A Motivation-Enhancing Tool

In recent years, Augmented Reality (AR) has gained significant traction in educational research due to its potential to enhance learning outcomes and boost motivation among students. AR technology overlays digital information onto the real-world environment, providing an immersive and interactive learning experience. This innovation allows for a deeper, more engaging learning experience compared to traditional classroom-based methods. Scholars have emphasized the effectiveness of AR in stimulating both intrinsic and extrinsic motivation, particularly in non-formal learning contexts (Faridi et al., 2021; Manisha & Gargrish, 2023).

In the context of learning motivation, AR serves not just as a tool for engagement but as an active facilitator of meaningful learning experiences. Studies have demonstrated that learners are more likely to engage with content when it is presented in a dynamic and interactive format, making AR particularly valuable in maintaining students' focus and interest (Gargrish & Mantri, 2023). Moreover, AR offers the ability to create novel and exciting educational environments that foster curiosity and stimulate critical thinking (Radziwill, 2018). This aligns with findings that show how AR's ability to bridge the gap between theory and practice makes abstract concepts more tangible and easier to understand for learners of all ages (Keller, 2010).

2.2 Keller's ARCS Model of Motivation and Its Application to AR in Education

Keller's ARCS Model of Motivation (Attention, Relevance, Confidence, Satisfaction) has been widely applied to understand how various instructional strategies, including AR, can motivate students. Each component of the ARCS Model is particularly relevant in the context of AR, as it offers unique opportunities to engage students in ways that traditional teaching methods cannot.

2.2.1 Attention

AR's ability to capture and sustain learners' attention is one of its most celebrated features. According to Faridi et al. (2021), AR can immediately engage students with its immersive features, providing visually rich and stimulating experiences that are more engaging than traditional media. For example, AR-enabled simulations of natural environments or historical events create a sense of presence and realism that is highly effective in grabbing students' attention. Additionally, interactive elements in AR applications allow for active participation, which further contributes to maintaining engagement (Manisha & Gargrish, 2023). In the context of marginalized communities, such as the Orang Asli in Pahang, this capability can be critical, as it helps overcome common barriers to attention and focus that many students may face due to contextual and environmental distractions (Gargrish & Mantri, 2023).

2.2.2 Relevance

One of the most significant benefits of AR in educational settings is its ability to make learning material relevant to the student's personal experiences. The Relevance component of the ARCS model stresses the importance of connecting learning content to real-life situations. AR provides opportunities to contextualize learning within the student's own environment, making it easier for learners to relate to and understand the material. For instance, Radziwill (2018) suggests that AR can integrate local cultural elements, which is particularly useful in non-formal settings where the content needs to resonate with the learners' everyday

experiences. By adapting AR content to reflect local knowledge and cultural practices, educators can increase students' sense of connection to the material, making it more meaningful and motivating (Faridi et al., 2021). This is particularly significant for indigenous communities like the Orang Asli, where learning is often disconnected from formal schooling practices and traditional methods.

2.2.3 Confidence

AR offers unique advantages in building learner confidence, which is critical to sustaining motivation over time. As noted by Pappas (2015), AR's interactive nature allows students to engage in self-paced learning, fostering a sense of autonomy. By offering immediate feedback, AR can also help learners track their progress and celebrate small achievements. This continual feedback loop strengthens the learner's self-efficacy and belief in their ability to succeed (Faridi et al., 2021). In addition, Gargrish & Mantri (2023) highlighted that AR technology allows students to solve problems in a virtual environment without the pressure of making mistakes in front of peers, thus reducing anxiety and boosting their confidence. This is particularly important in non-formal educational settings where students may have limited access to teacher guidance and may struggle with feelings of insecurity about their learning abilities.

2.2.4 Satisfaction

Satisfaction is a key component of the ARCS model, as students are more likely to continue their engagement in learning activities if they find them enjoyable and fulfilling. AR applications often incorporate gamification elements, such as rewards, achievements, and interactive challenges, that make the learning process more enjoyable. Farzeeha (2020) emphasizes that learner satisfaction is strongly linked to engagement, with happy and motivated learners more likely to persist in their educational journeys. AR has been shown to foster this kind of enjoyment by creating an atmosphere where students feel challenged but also supported through interactive features and instant rewards (Gargrish & Mantri, 2023). Additionally, Manisha & Gargrish (2023) found that students who engaged with AR applications reported higher satisfaction with their learning experiences compared to those in traditional settings, attributing this increase in satisfaction to the immersive nature of AR and the instant gratification it provides.

2.3 AR in Non-formal Learning Environments: Relevance for Orang Asli Children

In non-formal educational settings, AR's ability to present content in a way that is both engaging and contextually relevant can be transformative, particularly for underserved communities like the Orang Asli children in Pahang. Many of these children have limited access to formal educational resources and face unique challenges in terms of language, cultural relevance, and engagement in traditional educational settings. AR can address these challenges by offering a more flexible and inclusive learning environment.

As Radziwill (2018) suggests, AR can serve as an equalizing tool by providing educational resources that are engaging and adapted to the learners' specific needs and cultural contexts. AR applications that include local cultural references or incorporate community-based learning models can significantly improve motivation and help students see the value in their education (Faridi et al., 2021). Moreover, the immersive nature of AR creates a learning experience that feels more like play than work, encouraging students to participate actively without the fear of failure.

Additionally, the use of AR in non-formal settings enables learners to explore and interact

with concepts at their own pace, providing more opportunities for independent learning and discovery. This autonomy is crucial for boosting students' intrinsic motivation, as it allows them to feel more in control of their learning process. This is particularly beneficial for students who may not have the same level of access to structured, teacher-guided learning environments.

The integration of AR into educational contexts, particularly in non-formal learning settings, offers promising potential for enhancing motivation among students. By leveraging Keller's ARCS Model, AR addresses key components of motivation—Attention, Relevance, Confidence, and Satisfaction—providing an engaging and rewarding learning experience. In marginalized communities, such as the Orang Asli children in Pahang, AR has the potential to bridge the gap between formal education and the unique needs of these learners. Through its ability to offer culturally relevant content, provide immediate feedback, and foster a sense of autonomy and satisfaction, AR can play a critical role in improving both learning outcomes and motivation in non-formal settings. Future research should continue to explore how AR can be adapted to further meet the needs of these and other underserved populations.

3. Methodology

3.1 Research Design

This study employed a qualitative research approach to explore the experiences of *Orang Asli* children with augmented reality (AR) technology in non-formal learning settings. Qualitative research was chosen for its strength in capturing rich, nuanced perceptions and emotions, which allowed for a deep understanding of how AR influences learning motivation (Creswell & Poth, 2018). A phenomenological research design was used to uncover the essence of participants' experiences, providing insights into their interactions with AR technology and its impact on their learning.

3.2 Setting and Sampling

The research was conducted in Kampung *Orang Asli* Dayok, Pahang. This location was selected for its unique cultural context and the opportunity to engage with a marginalized community, creating an authentic setting for the children to share their experiences. Conducting the research in the participants' community enhanced the validity of findings by facilitating a deeper understanding of their interactions with AR technology (ca et al., 2020).

Participants were selected using purposive sampling, focusing on children from the *Orang Asli* community who had engaged with AR technology in non-formal learning contexts. Purposive sampling was chosen as it ensures that selected participants provide data directly related to the research questions (Flick, 2018). A total of five Orang Asli children participated, allowing for a diversity of perspectives drawn from a homogenous sample. Table 1.0 as follow provides the Respondent Profiles.

Table 1. Respondent Profiles

	Pseudonym	Gender	Age/Primary Class	Ethnicity
1.	Kemboja	Female	10 years old	Semai
2.	Kekwa	Female	10 years old	Semai
3.	Ros	Female	10 years old	Semai
4.	Lily	Female	10 years old	Semai
5.	Melur	Female	10 years old	Semai

3.3 Data Collection Methods

Data were collected through semi-structured interviews and non-participant observations. Semi-structured interviews allowed participants to express their thoughts freely while ensuring that essential topics were covered (Kvale & Brinkmann, 2015). Observations provided contextual data on children's interactions with AR technology in real time, enhancing the richness of the findings.

3.4 Data Collection Procedure

Data collection took place in Kampung *Orang Asli* Dayok, in a familiar environment to help participants feel comfortable and willing to share authentic insights. The researcher began with an orientation session to explain the study's purpose and build rapport with the children, reducing any potential anxiety**.** Semi-structured interviews were conducted individually, fostering a conversational atmosphere that encouraged open responses. Observations were carried out both before and after the interviews to capture participants' interactions with AR in their natural environment. Field notes were maintained throughout to document additional context, body language, and patterns of interaction.

3.5 Data Analysis Methodology

Thematic analysis was used to analyze the data, following Braun and Clarke's (2006) approach. Interview transcripts and observation notes were coded to identify recurring themes related to children's experiences with AR technology. The analysis process began with open coding to capture a wide range of insights, followed by axial coding to link related codes into coherent themes. Reflexivity was emphasized throughout, with the researcher documenting personal biases and assumptions to maintain objectivity (Finlay, 2002).

3.6 Ethical Considerations

Ethical approval was granted by *Jabatan Kemajuan Orang Asli* (JAKOA) on 17 February 2022, which allowed the researcher to conduct the study within the *Orang Asli* community. This approval was essential for respecting the cultural sensitivities of the community. Informed consent was secured from the parents or guardians of all participants, and the children's assent was also obtained to respect their autonomy. Confidentiality and anonymity were maintained by using pseudonyms for all participants. The researcher emphasized the voluntary nature of participation, giving children the freedom to withdraw at any time without repercussions.

3.7 Trustworthiness

To ensure the credibility of the findings, several strategies were employed. Member checking was conducted to allow participants to review and confirm the data's accuracy. Peer debriefing with colleagues provided additional perspectives, reducing potential biases. A detailed audit trail was maintained to document all decisions and changes during the research process, enhancing transparency and rigor (Lincoln & Guba, 1985). These strategies collectively ensured that the findings were credible and reflective of the participants' lived experiences.

4. Findings

This study investigates the impact of augmented reality (AR) technology on the learning experiences of Orang Asli children in non-formal educational contexts. Through a qualitative analysis of interviews and observational data, four major themes emerged that highlight the children's motivations and perceptions of AR as a tool for learning. These themes, grounded in Keller's ARCS model of motivation (Keller, 2010), reveal how AR facilitates active

engagement, cultural relevance, emotional satisfaction, and autonomy in learning. While the positive impacts of AR are evident, critical analysis of these findings also brings to light the limitations and challenges associated with AR integration in marginalized communities.

4.1 Theme 1: Active Engagement (Attention)

A core finding of this study is that AR significantly enhances children's engagement in learning activities. The immersive nature of AR, which combines interactive visuals with real-world elements, captured the children's attention more effectively than traditional teaching methods. Many children described the AR activities as "fun" and "exciting," suggesting that the novelty and interactive qualities of the technology kept them intrigued. This corresponds with Keller's (2010) concept of "attention," which emphasizes the need to capture and maintain students' interest through novelty, surprise, and interaction. According to Carmigniani and Furht (2011), AR can indeed serve as a powerful tool to sustain attention by creating dynamic learning environments that offer multiple sensory inputs.

However, while the children's engagement was high during the AR sessions, a critical consideration is the potential diminishing effect of novelty over time. The "novelty effect" (Carmigniani & Furht, 2011) implies that the initial excitement generated by AR may fade with repeated use, which could reduce its effectiveness as a long-term motivator. Moreover, not all children may experience the same level of engagement due to individual differences in attention span and cognitive preferences. For some, the sensory overload typical of AR experiences might become overwhelming, leading to disengagement or even anxiety (Keller, 2010). These considerations highlight the need for adaptive AR content that can respond to varying levels of learner engagement, ensuring that both the novelty and the educational value of AR are sustained over time.

Further, although AR facilitated active engagement, it is essential to examine the depth of this engagement. While children were keen to interact with AR content, the quality of their learning might have been affected by how well the technology was integrated into the broader curriculum. For instance, if AR was primarily used for entertainment purposes or without adequate educational scaffolding, children might have been engaged on a superficial level but without a deeper understanding of the content. This highlights the importance of ensuring that AR is integrated in a way that aligns with clear learning objectives rather than being employed simply for its entertainment value (Keller, 2010).

4.2 Theme 2: Connection to Cultural Context (Relevance)

A significant finding was the children's strong connection to the cultural relevance of AR content. Many children noted how AR depictions of animals, such as tigers and elephants, reminded them of the stories told by their families, reinforcing the relevance of the learning material to their own cultural and personal experiences. As Farzeeha (2020) suggests, when educational technology aligns with a learner's cultural context, it not only increases the relevance of the content but also fosters a sense of belonging and identity. In this case, AR provided a meaningful connection to local wildlife and traditional stories, allowing children to bridge their cultural heritage with modern learning technologies.

However, critical reflection raises the concern of cultural misrepresentation. While AR can provide a highly visual and engaging means of presenting culturally relevant content, there is also the potential for oversimplification or distortion of cultural symbols and narratives. Without careful attention to cultural accuracy and authenticity, AR content could inadvertently reduce complex cultural elements to mere visual representations or stereotypes,

undermining the depth of the learning experience (Budiman, 2016). For example, if AR depictions of animals fail to accurately represent their significance in Orang Asli culture, or if they present them in overly simplistic or fantastical ways, this could diminish the cultural learning experience.

To mitigate these risks, AR content should be co-designed in collaboration with the Orang Asli community, ensuring that the depictions are respectful, accurate, and culturally grounded. This approach would not only enhance the educational value of the technology but also promote cultural pride and sustain traditional knowledge (Radziwill, 2018). Moreover, AR should be seen as a complement to traditional forms of learning, such as storytelling and oral history, rather than a replacement. As Farzeeha (2020) argues, technology should work in tandem with, rather than supplant, the lived experiences and wisdom passed down through generations, ensuring that the cultural context is preserved and valued.

4.3 Theme 3: Emotional Engagement (Satisfaction)

The study found that AR technology elicited strong emotional reactions from the children, with many expressing feelings of excitement, joy, and wonder when interacting with the life-sized representations of animals. Emotional engagement is a key component of Keller's ARCS model (2010), which posits that positive emotions can enhance learners' motivation and facilitate deeper learning. According to Radziwill (2018), emotional responses are critical for ensuring that learners remain engaged and satisfied with the learning experience, ultimately fostering retention and continued interest.

However, while emotional satisfaction was high, a critical concern is the potential for emotional dependency on AR for motivation. The sensory appeal of AR might create a form of "edutainment" where children come to associate learning with external stimuli like visual excitement rather than with intrinsic curiosity or intellectual challenge (Carmigniani & Furht, 2011). This could lead to a form of emotional reliance on technology, where children might struggle to engage with less interactive or more traditional learning environments. In this context, emotional engagement through AR could unintentionally stifle the development of intrinsic motivation if not carefully managed.

Additionally, the emotional impact of AR could be affected by technological limitations. For instance, unreliable access to devices or internet connectivity issues could disrupt the learning experience, leading to frustration and disappointment. This points to the need for infrastructural support to ensure that emotional engagement with AR is sustained over time. By integrating AR within a well-supported and stable learning environment, educators can maximize the potential for emotional satisfaction without creating undue reliance on technology.

4.4 Theme 4: Autonomy in Learning (Confidence)

A key observation in this study was that children valued the autonomy AR afforded them in exploring content at their own pace. Many participants expressed a sense of control and independence in choosing what they wanted to learn, which contributed to a heightened sense of self-efficacy and confidence in their ability to navigate the AR platform. This aligns with Keller's (2010) concept of "confidence," where learners are motivated when they feel capable and empowered to direct their own learning. According to Nathan (2017), autonomy fosters a sense of ownership over the learning process, which can enhance motivation and lead to more effective learning outcomes.

However, while autonomy can enhance confidence, it also poses challenges. One potential

issue is that children may become overwhelmed by the variety of choices available, especially if they lack guidance in making informed decisions about what to learn. As Nathan (2017) notes, too much freedom can lead to choice overload, where learners struggle to focus or make meaningful progress. This can result in superficial learning or the avoidance of more difficult but essential content. For example, a few children consistently chose content related to arts and crafts, neglecting more complex tasks like problem-solving exercises or math challenges. A more structured approach to autonomy where children have the freedom to explore but within a guided framework could prevent this from happening, ensuring that learners develop confidence while also acquiring necessary knowledge. This could be achieved by incorporating learning milestones within the AR system, where children earn badges or progress through different levels that encourage deeper engagement with more challenging content.

Moreover, the freedom to explore may inadvertently result in some learners gravitating toward content that aligns with their immediate interests, potentially neglecting more foundational concepts. This challenge could be addressed by integrating scaffolded learning paths within the AR content, which provide learners with structured options that encourage both autonomy and coherence in the learning process. This would ensure that confidence-building does not come at the expense of a well-rounded education.

The findings of this study underscore the potential of AR technology to engage and motivate Orang Asli children in non-formal learning settings. By fostering active engagement, cultural relevance, emotional satisfaction, and autonomy, AR aligns with Keller's ARCS model to support both intrinsic and extrinsic motivation. However, these findings also point to critical considerations, such as the risk of cultural misrepresentation, emotional dependency on technology, and the challenges of sustaining engagement over time. To fully realize the benefits of AR, its integration into educational settings must be carefully designed, ensuring that it complements traditional learning practices and aligns with the broader educational objectives of the community.

5. Discussions

The findings of this study illuminate the multifaceted role that augmented reality (AR) can play in enhancing learning motivation among Orang Asli children in non-formal educational settings. By closely examining the participants' experiences, several key themes emerged that not only align with Keller's ARCS model but also shed light on broader implications for educational practice and technology integration.

The active engagement demonstrated by children during AR activities highlights the immersive and interactive nature of this technology. Throughout the study, participants expressed enthusiasm and excitement while interacting with AR content, which effectively transformed traditional learning experiences into dynamic interactions. This active engagement is critical for fostering motivation and sustaining attention, particularly among children who may not respond well to conventional teaching methods. As indicated by Keller (2010), capturing and maintaining learners' attention is a crucial precursor to effective learning, and this study contributes further evidence supporting AR's ability to do so. Previous studies (Carmigniani & Furht, 2011) have also emphasized AR's potential to create captivating educational experiences that resonate with students' interests and motivations. However, it is important to consider how the novelty of AR might wear off over time, and future research should address how its long-term effects on engagement can be maintained.

Moreover, the strong connection that children felt with the AR content, especially concerning

their cultural context, underscores the importance of relevance in learning. Participants articulated how the AR experiences resonated with their local stories, traditional knowledge, and personal lives, suggesting that culturally relevant education significantly enhances motivation (Farzeeha, 2020). By integrating elements of children's cultural heritage into AR experiences, educators can create a more meaningful learning atmosphere. This connection not only bridges traditional knowledge with modern technology but also empowers children to engage with their own culture in an innovative way. The importance of culturally responsive pedagogy (Nathan, 2017) is evident in these findings, as learning materials that reflect students' backgrounds can foster deeper connections and motivation to learn. However, attention must also be paid to avoiding over-simplification or stereotyping when designing culturally relevant content.

The emotional engagement reported by participants further emphasizes the profound impact of positive feelings on motivation. Many children expressed joy and excitement during AR interactions, which facilitated not only immediate engagement but also long-term interest in learning. This emotional dimension is critical, as research indicates that emotional responses significantly influence learning outcomes and can lead to deeper learning experiences (Radziwill, 2018). While emotional engagement was apparent, the impact of such emotional responses on sustained learning outcomes remains unclear, and future studies could investigate how AR content can continuously evoke these positive emotions over extended learning periods.

Finally, the findings indicate that AR promotes a sense of autonomy among children, allowing them to navigate their learning journeys at their own pace. This autonomy is crucial for developing confidence and self-efficacy, as learners who feel empowered to control their educational experiences are more likely to engage deeply with the content (Nathan, 2017). The ability to choose which aspects of AR content to explore enables children to take ownership of their learning, fostering a sense of responsibility and agency. Such autonomy not only boosts motivation but also encourages critical thinking and problem-solving skills, which are essential for lifelong learning. However, autonomy also requires sufficient scaffolding to ensure students do not feel overwhelmed by the range of choices available, and further research could explore the balance between autonomy and guidance in AR-based learning environments.

6. Implications

The findings of this study suggest that AR has significant potential for enhancing learning motivation, particularly in marginalized or underserved communities. For educators, incorporating AR into non-formal education settings can engage children in a manner that traditional methods might not. However, the design of AR content must carefully consider both accessibility and cultural relevance to ensure that it effectively supports the learning of all students. Culturally relevant content, as demonstrated in this study, creates a more meaningful learning environment and can significantly increase engagement. Therefore, it is critical for educational practitioners to receive adequate training on the integration of AR in ways that are both pedagogically sound and culturally sensitive.

For policymakers, the study calls for greater investment in educational technologies that can help bridge the digital divide, ensuring that marginalized communities have access to tools that foster engagement and motivation. Moreover, AR adoption requires infrastructural support, such as internet connectivity and hardware, as well as professional development for educators to fully harness the technology’s potential.

Additionally, future research should explore the long-term impacts of AR on learning motivation and outcomes, particularly in marginalized communities, as well as the scalability of such interventions in various educational contexts. Understanding how AR can be effectively implemented in different settings will provide valuable insights for educators and policymakers alike. Further studies could examine how specific AR content types (e.g., gamified learning, interactive storytelling) affect engagement and motivation, thus offering more tailored recommendations for AR integration into curricula.

By continuing to investigate the intersection of technology and culturally responsive pedagogy, we can better understand how to effectively support the learning journeys of all students, fostering a love for learning that transcends boundaries. In sum, AR's potential to engage students on an emotional, cultural, and cognitive level offers promising avenues for the future of education, but its success hinges on thoughtful, context-sensitive implementation.

7. Conclusion

This study highlights the significant role of augmented reality (AR) in enhancing learning motivation among Orang Asli children in non-formal educational settings. The findings demonstrate that AR effectively fosters engagement, promotes cultural relevance, and supports emotional responses, all of which are crucial for motivating learners, as suggested by Keller's ARCS model (Keller, 2010). By integrating AR into educational practices, educators can create immersive and meaningful learning experiences that resonate with students' lives and cultural backgrounds.

The implications of this study suggest that AR has the potential to address challenges in education, particularly in marginalized communities. By bridging traditional and modern pedagogies, AR offers a promising tool for enhancing engagement and motivation among diverse learners. It underscores the importance of culturally responsive pedagogy, as AR content that reflects students' cultural experiences can promote deeper connections to the learning material. Therefore, educators are encouraged to adopt AR in ways that prioritize both technological integration and cultural sensitivity.

Looking forward, future research should explore the long-term effects of AR on learning outcomes and motivation in different educational contexts, particularly in marginalized or low-resource settings. Further studies should also examine how different types of AR applications and content can be optimized to maximize student engagement. Investigating how AR can be scaled and implemented across diverse educational environments will provide valuable insights for educators and policymakers.

In conclusion, this study contributes to the growing field of educational technology by demonstrating how AR can be effectively utilized to engage and motivate students. While the findings provide evidence of AR's potential, further exploration into its long-term impact and best practices for implementation will be crucial for its broader application in education.

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