Augmented Reality Applications in Education: A Case Study on PAIZAP and Qur'anic Education

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ABSTRACT: Augmented Reality (AR) can connect modern technology with traditional Qur'anic education, offering a solution to the challenge of engaging learners. This study investigates the potential of AR to enhance Qur'anic education through interactive and immersive experiences and examines the difficulties of integrating AR into traditional teaching methods. The ADDIE model, comprising analysis, design, development, implementation, and evaluation phases, was utilized to create the AR application PAIZAP for community college students. Data analysis revealed that AR can significantly boost engagement with digital learning materials, though maintaining consistent user interest and retention is difficult. The findings indicate AR's promise in aiding pronunciation and recitation for beginners while underscoring the need for strategies to ensure ongoing user engagement and ease of use. As AR technology becomes more accessible, there are opportunities to develop richer, more immersive content that enhances learning experiences in religious education.

1. INTRODUCTION

The advent of technology has revolutionized numerous aspects of daily life, including education. Among the transformative innovations, augmented reality (AR) has emerged as a potent tool for enhancing educational experiences [1]–[6]. AR provides interactive and immersive learning opportunities by overlaying digital information onto the physical world. This technological advancement holds significant potential for improving Qur'anic education, an essential skill for millions of Muslims globally.

Qur'anic education entails more than mere recitation; even though the call to read the Qur'an is motivated by the hadith quoted by Ibn Mas'ud a.s stated below, it requires precise pronunciation (tajweed), comprehension of the text, and an appreciation of its linguistic nuances.

Ibn Mas'ud (May Allah be pleased with him) reported: The Messenger of Allah (ﷺ) said, "Whoever recites a letter from the Book of Allah, he will be credited with a good deed, and a good deed gets a ten-fold reward. I do not say that Alif-Lam-Mim is one letter, but Alif is a letter, Lam is a letter and Mim is a letter." [At- Tirmidhi].

Traditional methods of teaching Qur'anic recitation rely on face-to-face instruction, which, while effective, can be limited by geographical and temporal constraints [7], [8]. Augmented reality offers a solution by providing access to high-quality instructional resources regardless of the learner's location. This accessibility is particularly beneficial in regions where qualified Qur'anic teachers are scarce [9]. Integrating AR into Qur'anic education can enhance traditional learning methods by providing real-time feedback and interactive practice sessions [10]–[12]. For instance, AR applications can display correct pronunciation, intonation, and rhythm, allowing learners to self-correct and improve their recitation skills. This immediate feedback mechanism accelerates the learning process and ensures that mistakes are addressed promptly, fostering more accurate recitation.

Moreover, AR can make the learning experience more engaging. Interactive features such as 3D visualizations, voice recognition, and gesture control can transform a traditional lesson into an immersive experience [13]. These features make learning more enjoyable and cater to different learning styles, ensuring that visual, auditory, and kinesthetic learners all benefit. This personalized approach to learning is particularly advantageous for young learners, who may find traditional methods less engaging. The potential of AR in enhancing Qur'anic education extends beyond individual learning. In a classroom setting, AR can facilitate

collaborative learning experiences. For example, students can engage in group activities where they practice recitation together, guided by AR-enabled feedback. This collaborative approach fosters community and encourages peer learning, a powerful educational tool. Furthermore, the urge to read the Qur'an fluently and correctly is recorded in the following words of Allah:

Do not you (O Muhammad) - Because you want to quickly memorize the Quran that was revealed to you - move your tongue to read it (before it is finished being read to you). (Al-Qur'an 75:16)

The implementation of AR in Qur'anic education is supported by empirical evidence from other fields of study. Research has shown that AR can improve language learning, spatial understanding, and memory retention. These cognitive benefits directly apply to Qur'anic studies, which require memorization, comprehension, and the ability to navigate complex textual structures. However, the integration of AR into Qur'anic education is not without challenges. Technical issues, such as the need for high-quality hardware and software, can hinder widespread adoption [14].

Additionally, there may be cultural and religious considerations regarding the use of technology in religious education. Addressing these concerns through dialogue with religious scholars and developing culturally sensitive AR applications is essential. In conclusion, augmented reality holds substantial promise for enhancing Qur'anic education. By providing interactive, engaging, and accessible learning experiences, AR can complement traditional teaching methods and address some of their limitations [15]. As technology continues to evolve, further research and development will be crucial in optimizing AR applications for Qur'anic education, ensuring they meet the needs of learners and adhere to cultural and religious values. This technological integration represents a significant step forward in making Qur'anic education more effective and widely accessible.

This research addresses the gap in traditional Qur'anic education, constrained by geographical and temporal limitations, by exploring the significant potential of augmented reality (AR) and improve the overall effectiveness of Qur'anic education. The objectives of this paper are simplified as below:

i. To explore the potential of augmented reality (AR) in enhancing engagement and learning experiences in Qur'anic education through interactive and immersive methods.

ii. To develop and implement the AR application PAIZAP using the ADDIE model to improve pronunciation and recitation skills for community college students.

iii. To identify and address the challenges of integrating AR into traditional Qur'anic teaching methods, focusing on maintaining consistent user interest and retention.

2. LITERATURE REVIEW

The integration of augmented reality (AR) into Qur'anic education is gaining significant attention due to its potential to enhance the learning experience and improve recitation accuracy. Several studies have explored various aspects of AR in the context of Tajweed learning, which refers to the rules governing the pronunciation of the Qur'an. This literature review synthesizes the findings from multiple sources to comprehensively understand AR's impact on Qur'anic education. A study by Sesmiarni *et al.,* [16] investigated the use of an Android-based AR application to teach Tajweed. This research utilized a Research and Development approach to create an application visually displaying Tajweed rules when a camera identifies specific markers. The application includes audio playback features to aid in learning proper recitation. Although the study concluded that the application is practical in teaching basic Tajweed, it highlighted the need for further development to expand the content and improve accessibility across different platforms, such as laptops and computers.

Similarly, Andriyandi *et al.,* [17] applied AR in Tajweed learning using the Features from Accelerated Segment Test (FAST) corner detection method. This technique effectively recognized Tajweed objects and displayed corresponding AR visuals, with a survey showing that 88.2% of students responded positively to the application. This high level of student approval suggests that AR can significantly aid in understanding and applying Tajweed rules, making the learning process more interactive and engaging. The potential of AR to captivate young learners is further supported by recent research highlighting various AR applications in educational contexts, including its use in teaching the Hijaiyah alphabet and Tajweed to children [18]. The study by N. Ginting *et al.,* [19] developed an AR application that utilizes marker-based tracking to teach these fundamental elements of Qur'anic recitation. The results indicated that this method effectively addressed children's addiction to smartphone games by redirecting their attention to educational content, thus enhancing their engagement and learning outcomes.

Furthermore, Noor *et al.,* [20] explored the combination of gamification and AR in Tajweed education. Their research introduced the Tajweed Augmented Reality-based Gamification Learning Model (TARGaLM) to make Tajweed learning more appealing to children. The studies demonstrated that this approach significantly increased students' enjoyment and engagement, leading to improved learning performance. The integration of gamification elements, such as points, badges, and leaderboards, with AR technology resulted in a more interactive and motivational learning environment. These studies collectively underscore the transformative potential of AR in Qur'anic education. By providing real-time feedback and interactive practice sessions, AR applications can enhance the accuracy of Tajweed recitation and make the learning process more engaging. Students' positive

responses and improved learning outcomes suggest that AR can effectively complement traditional teaching methods, making Qur'anic education more accessible and enjoyable.

3.   METHODOLOGY

The ADDIE model serves as a strong framework for developing educational programs and instructional design, comprising five systematic phases: Analysis, Design, Development, Implementation, and Evaluation [21]–[23]. This model offers a structured approach to creating effective educational tools, making it well-suited for research focused on employing augmented reality (AR) to enhance Qur'anic education.

3.1 Analysis Phase

The initial phase involves identifying the learning needs and objectives. This step requires a thorough understanding of the target audience, which includes learners seeking to improve their Qur'anic recitation skills. Analyzing the current limitations of traditional Tajweed education methods is crucial, as this provides insights into the specific areas where AR can offer improvements. Essential tasks in this phase include conducting needs assessments, defining the learning environment, and outlining the desired outcomes of the AR application. Identifying these elements helps in setting clear, measurable goals for the project. This phase aims to explore how augmented reality (AR) can enhance engagement in Qur'anic education. The target audience will be Community College students in Malaysia. Needs assessment identified the need for interactive and immersive learning tools to improve student engagement and understanding of Qur'anic education. The key findings suggest that students are more likely to engage with digital and interactive content.

3.2 Designing Phase

Following the analysis, the design phase involves planning the instructional strategies and selecting appropriate AR features. This phase focuses on the pedagogical aspects, such as determining how AR can visually and audibly represent Tajweed rules to enhance understanding and retention.
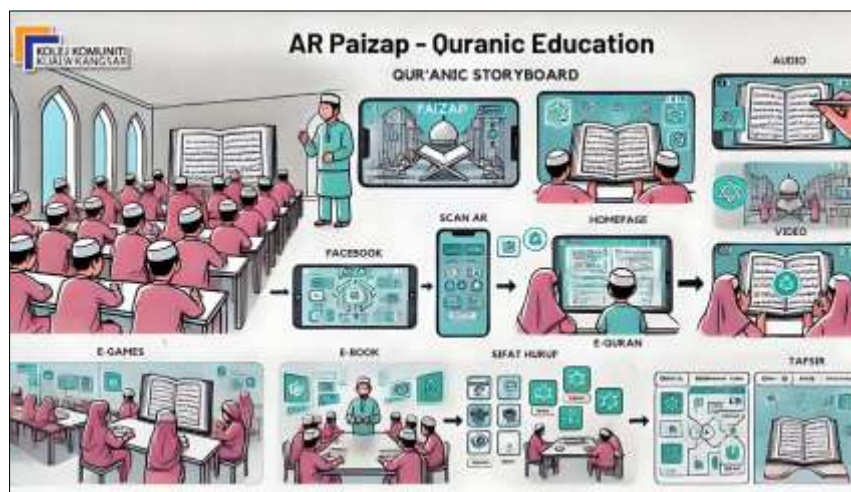

Fig. 1. Paizap's Storyboard

Designing the user interface and experience is critical to ensure that the application is intuitive and engaging for learners. Storyboarding (see Figure 1) is essential step in this phase, allowing for the visualization of how the AR application will function and interact with users. In this instructional design phase, an interactive module incorporating AR for Qur'anic lessons was developed. The content structuring was structured into manageable units with AR components to visualize concepts. Through storyboard, we created detailed storyboards and flowcharts to outline the user experience and interaction with AR features.

3.3 Development phase

PAIZAP, a digital content application for interactive Qur'anic learning experiences through AR platform, is not a ground-up development but rather a compilation of existing materials consolidated into a single platform. Due to the content developer's limited expertise in content development, technical teams were not directly involved. Testing primarily focused on assessing content management suitability, content alignment, and overall content quality. This phase may involve iterative testing and refinement cycles to achieve the desired level of quality and usability. PAIZAP development integrated with AR technologies to provide interactive Qur'anic learning experiences. The content creator compiled digital materials integrated with AR, including e-books, e-games, and video tutorials. In term of technical development, the digital content focused on using a user-friendly interface and ensuring compatibility with various devices (Figure 2).
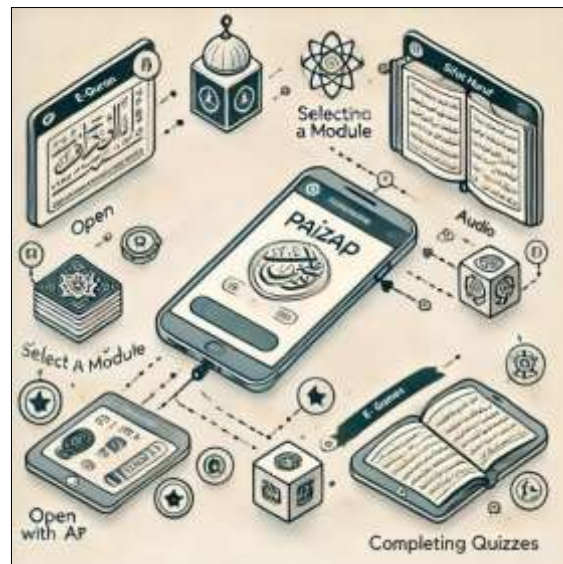
Fig. 2. Content Development Flow

3.4 Implementation phase

Implementation involves deploying the AR application in real-world educational settings. Effective implementation ensures that the application is accessible and beneficial to all users, addressing any barriers to its adoption. We conducted a pilot testing with a small group of students to gather initial feedback and identify issues. Time by time, we improve the applications based on the feedback received.

3.5 Evaluation phase

The final phase centers on assessing the effectiveness of the AR application in meeting its educational objectives. This evaluation will be conducted using bit.ly and Google Analytics user engagement metrics. By analyzing user interaction data, insights can be gained into how effectively the application engages learners and enhances their Qur'anic education. Continuous monitoring and analysis of these metrics will help identify areas for improvement.

4. RESULTS

The analysis of the user engagement data for the AR-based "PAIZAP" material, which is integrated with Google Sites, reveals significant insights into user interaction and the effectiveness of this digital educational resource. This material can be accessed using Zappar code for augmented reality display. Alternatively, it can also be accessed using bit.ly links which are condensed from links generated by Google. The first indicator in Table 1 shows the total interaction with the material since its launch on March 18, 2023. The PAIZAP site has experienced a remarkable increase in user engagement over the past week, highlighted by a 400% rise in interactions. This positive trend reflects successful recent efforts and presents an opportunity to build on this momentum. The site has recorded 493 engagements, which indicates interactions such as visits, clicks, or other user activities. Thirty-five engagements have been recorded in the past week. This shows active user interaction within a short timeframe, suggesting that the content or site features are currently attracting attention. The substantial increase in weekly engagements highlights effective strategies in place, whether through marketing efforts, new content, or improved user experience.

Table 1

Engagement table

Attribute	Value
Title	PAIZAP
Date of Establish	March 18, 2023 11:35 AM GMT+8
Engagements	493
Last 7 days	35
Weekly change	+400%

This level of engagement recorded by bit.ly demonstrates the appeal and usefulness of the AR-enhanced content in attracting and maintaining user attention. The high number of engagements suggests that the interactive and immersive nature of AR is effectively enhancing the learning experience for users, aligning with the study's objective of exploring the potential of AR in improving engagement in Qur'anic education. Using a URL shortener for easy sharing and integration with a widely used platform like Google Sites likely contributes to high engagement levels. This setup facilitates access and allows for efficient tracking and analysis of user interactions. The overall positive engagement metrics underscore the potential benefits of integrating AR into traditional Qur'anic education, providing a compelling case for its broader adoption and highlighting the need to address any arising challenges to maximize its impact.

Although the original purpose of developing this material was for student use in community colleges, the recorded data indicates that it has been disseminated beyond the initial target users. The significant engagement across various platforms suggests that AR technology can reach a diverse audience, making it a versatile tool for enhancing Qur'anic education. The following figure (Figure 4) offers a detailed breakdown of user engagement with various components of the "PAIZAP" AR material, highlighting which sections are most popular and how users interact with them. Please note that this data (Figure 4) was only extracted for seven days and may not reflect the total data from the day it was introduced.

Based on the provided Google Analytics data, several insights analyzed the potential of augmented reality (AR) in enhancing engagement with Qur'anic education. The table includes various digital materials and their corresponding views, users, views per user, average engagement time, event count, and critical events.

4.1 Page Views and User Engagement
The page "homepage" has the highest number of views, 62 views, and users to 32 users. However, the average engagement time is relatively low (18 seconds), suggesting that while many users visit the page, they do not stay long. The page "e-Qur'an" has fewer views, ten views, but the highest average engagement time is 1 minute 12 seconds. It indicates that users who visit this page are highly engaged with the content. Pages with interactive content, such as e-games, specific Qur'anic features, "sifat huruf", show higher engagement and repeated visits. It aligns with the potential of AR to provide immersive and interactive learning experiences, which can lead to higher engagement levels.

4.2 Views per User
Pages like "sifat-huruf" and "e-games" show higher views per user, indicating repeated visits. It could suggest that these pages have interactive elements encouraging users to return. Longer average engagement times on pages like "sifat huruf" suggest that detailed and possibly interactive content captures user attention more effectively. AR can enhance this by providing 3D visualizations and interactive exercises that keep users engaged for extended periods [24].
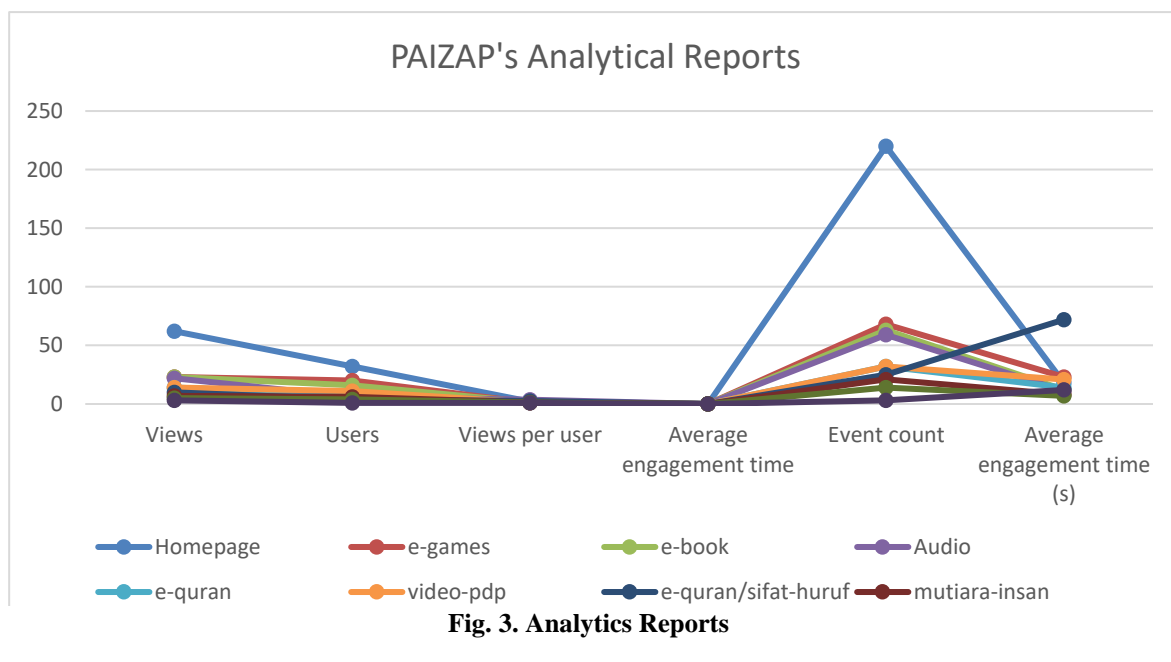

**Fig. 3. Analytics Reports**

4.3 Event Count
The highest event count is on the main page, recorded as 220 events, followed by "e-games" which is 68 events, and "e-book" showing 63 events. High event counts can be associated with interactive content that prompts user actions.

4.4 User Retention

Higher views per user indicate that engaging content leads to repeated visits. AR's ability to create a captivating learning environment can improve user retention, making students more likely to return and continue their studies. The data supports the hypothesis that interactive and immersive content enhances user engagement in Qur'anic education. Pages with elements that could benefit from AR (such as interactive games or detailed Qur'anic study features) show higher engagement metrics. This justification suggests that implementing AR in Qur'anic education could increase engagement, making the learning experience more effective and enjoyable. In conclusion, AR has the potential to significantly enhance engagement in Qur'anic education by providing interactive and immersive learning experiences, as evidenced by the observed trends in user interaction with digital materials.
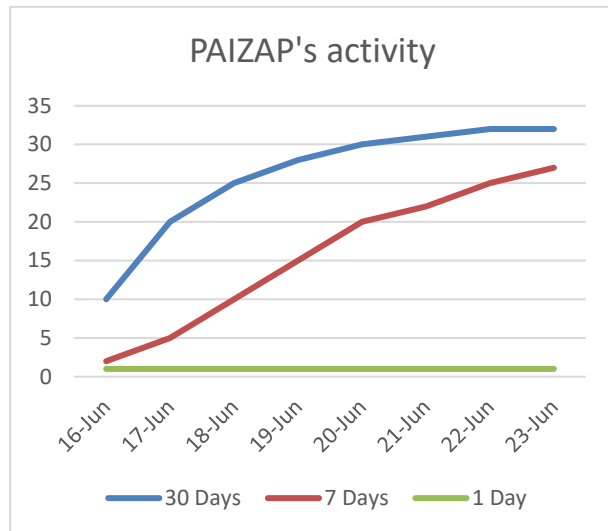
Fig. 5. User Activity Over Time
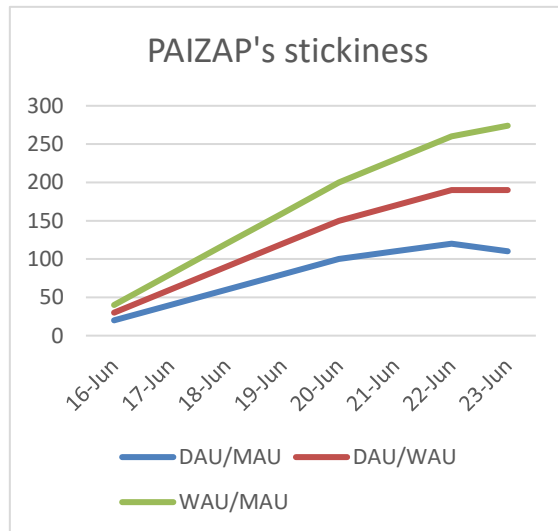
Fig. 4. User Stickiness

4.5 User Activity Over Time

The user count shown in Figure 5 over the thirty days is 32, with a notable spike towards the end of the period. Within the last seven days, user activity reached 27, indicating a significant recent interest or activity. The latest day shows only one user, suggesting a sharp decline after the recent spike. The sharp increase and subsequent drop in user activity over the observed period indicate that while there was a surge of interest at a certain point, it was not sustained. This reason could suggest initial curiosity or a specific event that drew users but lacks ongoing engagement. Maintaining consistent user engagement might be difficult, possibly due to the novelty of AR or the learning curve associated with it.

4.6 User Stickiness

The user stickiness metrics on Daily Active Users/Monthly Active Users (DAU/MAU) and Daily Active Users/Weekly Active Users (DAU/WAU) are relatively low, with DAU/MAU at 3.1% and DAU/WAU at 3.7%. This data suggests that few users are interacting with the AR content daily. The Weekly Active Users/Monthly Active Users (WAU/MAU) ratio is higher at 84.4%, indicating that while users may not return daily, a significant proportion engage every week. Retaining users every day may be challenging, which could be due to various factors such as the complexity of the AR content, lack of regular updates, or insufficient integration with daily study routines. Figure 6 shows the graph of user stickiness towards the material.

4.7 User Experience

The fluctuation in user stickiness metrics indicates that user experience might not be consistent. Some users might find the AR content highly engaging, while others may not see the value or find it challenging. Ensuring a user-friendly and valuable AR experience is critical. There might be a need for better usability testing, user feedback mechanisms, and iterative improvements to the AR content. Integrating AR into traditional Qur'anic education requires technological infrastructure and cultural acceptance. There might be resistance from educators and students accustomed to traditional methods. Overcoming resistance to change and ensuring that the AR content aligns with educational and cultural values is crucial. Providing training and demonstrating the benefits of AR in enhancing learning could help mitigate this challenge.

The data suggests that while there is potential interest in AR for Qur'anic education, maintaining consistent engagement and user retention is challenging. The fluctuations in user activity and stickiness metrics highlight the need for strategies to ensure sustained interest and ease of use. Addressing technical, educational, and cultural barriers will be essential to successfully integrating AR into traditional Qur'anic education. This includes continuous improvement of the AR content, effective user training, and aligning AR experiences with educational goals.

5.   DISCUSSIONS

The total of 493 engagements since March 18, 2023, indicates a growing user base. This cumulative figure reflects the site's ability to attract and retain visitors over time. There is evidence of sustained user interest with 35 engagements in the last week. Monitoring the retention rate and engaging these users with relevant content can help maintain this momentum. Given the recent spike in activity, focusing on retaining these users is crucial. Strategies such as regular content updates, interactive features, and personalized communication can help keep users engaged. However, despite its positive engagement metrics, maintaining the app requires technical support, which can be cost-intensive due to ongoing development and maintenance needs. Other challenges could be variability in recitation styles by which different reciters have distinct styles of Quranic recitation. AR systems need to adapt to these variations and provide personalized guidance.

Apart from varieties, Arabic phonetics involves intricate sounds and articulations. AR models must handle phonemes unique to Arabic, such as emphatic consonants (e.g., "ق" and "خ"). Currently, a limited number of developers can handle complex phonetics and phonology, which can be cost-intensive. On top of that, AR interfaces should be intuitive, non-intrusive, and supportive. Balancing visual overlays with the sacredness of Quranic text is essential. Designing an engaging and respectful user experience is a multidisciplinary challenge [25].

6.   CONCLUSION

Integrating augmented reality (AR) into Qur'anic education offers significant potential to enhance the learning experience by providing interactive and immersive methods that traditional approaches may lack. The study utilizing the ADDIE model to develop the PAIZAP application demonstrates that AR can significantly boost engagement and learning outcomes for community college students, especially in the context of pronunciation and recitation. While AR technology enhances digital learning materials' interactivity, maintaining user interest and retention remains challenging. The use of AR in Tajweed education, for instance, has shown promising results in improving students' understanding and application of pronunciation rules, as evidenced by various studies that highlight the effectiveness of AR in providing real-time feedback and interactive practice sessions. Incorporating gamification elements within AR applications increases student engagement and enjoyment, making the learning process more appealing, particularly for younger learners. However, technical, cultural, and educational challenges must be addressed to ensure successful implementation. This challenge includes ensuring the applications are user-friendly, culturally sensitive, and aligned with educational goals. Continuous development and user feedback are essential to optimize AR applications for Qur'anic education, making them a viable complement to traditional teaching methods and helping overcome geographical and temporal limitations. The positive engagement metrics and user interactions observed in the PAIZAP application underscore AR's potential to transform Qur'anic education, making it more accessible and effective for a diverse audience.

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