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The Effect of Augmented Reality on Improving Arabic Vocabulary Mastery in SMP Al-Azhar Medan Students

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ABSTRACT
This study aims to examine the effect of Augmented Reality (AR) on the improvement of Arabic vocabulary mastery among eighth-grade students at SMP Al-Azhar Medan. The population of this study included all eighth-grade students in the 2024/2025 academic year, with samples selected using purposive sampling to ensure comparable initial abilities. Two homogeneous classes were assigned as the experimental group, which received AR-based instruction, and the control group, which followed conventional teaching methods based on lectures and written exercises. The primary research instrument was a vocabulary test measuring recognition, comprehension, and contextual use of mufradat. Additionally, observation sheets were employed to assess student engagement during learning, and a student perception questionnaire was used as supporting data. Data were analyzed using descriptive statistics to calculate means, pretest-posttest differences, and standard deviations, as well as inferential statistics using an independent sample t-test to determine the significance of differences between the two groups. The results indicate that the experimental group achieved a significantly higher posttest mean score (84.5) compared to the control group (71.8), with a significance value of 0.001. These findings suggest that AR strengthens visual memory, enhances student motivation and engagement, and facilitates contextual internalization of vocabulary. Teachers are encouraged to integrate AR in mufradat instruction, while schools should provide technological support. Further research is recommended to evaluate the effectiveness of AR for other language skills and at different educational levels.

Keywords: augmented reality, Arabic, vocabulary

Pengaruh Augmented Reality terhadap Peningkatan Penguasaan Kosakata Bahasa Arab pada Siswa SMP Al-Azhar Medan

ABSTRAK
Penelitian ini bertujuan untuk menganalisis pengaruh media Augmented Reality (AR) terhadap peningkatan penguasaan kosakata bahasa Arab pada siswa kelas VIII SMP Al-Azhar Medan. Populasi penelitian mencakup seluruh siswa kelas VIII pada tahun ajaran 2024/2025, dengan sampel dipilih secara purposive sampling untuk memastikan kesetaraan kemampuan awal. Dua kelas yang homogen dipilih sebagai kelompok eksperimen, yang menggunakan media AR, dan kelompok kontrol, yang mengikuti pembelajaran konvensional berbasis ceramah dan latihan tertulis. Instrumen utama penelitian berupa tes kosakata yang mengukur pengenalan, pemahaman, dan penggunaan mufradat dalam konteks yang bermakna. Selain itu, lembar observasi digunakan untuk menilai keterlibatan siswa selama proses pembelajaran, dan kuesioner persepsi siswa disediakan sebagai data pendukung. Data dianalisis menggunakan statistik deskriptif untuk menghitung rata-rata, selisih skor pretest-posttest, dan standar deviasi, serta uji inferensial independent sample t-test untuk mengetahui signifikansi perbedaan hasil belajar antara kedua kelompok. Hasil penelitian menunjukkan bahwa kelompok eksperimen mengalami peningkatan rata-rata posttest yang signifikan (84,5) dibandingkan kelompok kontrol (71,8), dengan nilai signifikansi 0,001. Temuan ini menunjukkan bahwa AR mampu memperkuat memori visual, meningkatkan motivasi dan keterlibatan belajar siswa, serta memfasilitasi internalisasi kosakata secara lebih kontekstual. Berdasarkan hasil tersebut, guru dianjurkan untuk mengintegrasikan AR dalam pengajaran mufradat, sementara sekolah disarankan menyediakan dukungan teknologi. Penelitian lanjutan direkomendasikan untuk mengevaluasi efektivitas AR pada keterampilan bahasa lain dan di jenjang pendidikan berbeda.

Keywords: augmented reality, kosakata, bahasa Arab

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INTRODUCTION

Vocabulary mastery is an essential foundation in second language acquisition, including in the context of Arabic language learning. Without adequate vocabulary mastery, students will experience difficulties in understanding the meaning of utterances and constructing sentences communicatively (Nisa' et al., 2023). At the junior high school level, limited vocabulary is a major obstacle to text comprehension and language production. Conventional teaching practices that focus on memorizing vocabulary lists isolated from context actually hinder students' cognitive engagement and reduce retention. Therefore, an innovative, technology-based approach is needed that can stimulate learning interest and strengthen vocabulary retention on an ongoing basis (Egan & Gilic, 2021).

One promising approach is the use of Augmented Reality (AR) technology, which can create an interactive and engaging learning experience for students, particularly in Arabic language learning (Jasni et al., 2019). With AR, students can more easily understand vocabulary through engaging visualizations, thereby increasing their motivation and retention of the material being taught (Fauzan et al., 2020). The use of AR in Arabic language learning can overcome the weaknesses of conventional methods and increase student interaction with the material, as demonstrated in previous research. This technology integration also has the potential to enrich the learning experience and improve students' academic outcomes (Fauzan et al., 2020).

Augmented Reality (AR) technology has emerged as a relevant educational solution to address the dynamic learning needs of the 21st century. This technology allows the simultaneous integration of virtual elements into real-world environments, resulting in a more immersive, realistic, and interactive learning experience (Guntur et al., 2020). In learning practice, AR supports vocabulary visualization through three-dimensional objects combined with audio and text. This approach brings students closer to the meaning of words in the context of their use, rather than simply symbolic representations (Sadikin & Martyani, 2020). The principles of AR-based learning are consistent with constructivist theory, which emphasizes the active role of students in shaping understanding through direct interaction with learning materials (Krüger & Bodemer, 2022).

In this context, the use of AR technology in Arabic language learning has the potential to increase student motivation and teaching effectiveness, as has been demonstrated in previous research (Jasni et al., 2019). Thus, AR can be an effective tool for improving student vocabulary mastery and comprehension.

The main question in this study is: How does the use of Augmented Reality media affect the improvement of Arabic vocabulary mastery of students at Al-Azhar Medan Middle School? The purpose of this study is to evaluate the effectiveness of AR as an innovative learning medium in improving students' vocabulary competence (Binhomran & Altalhab, 2021). This research has strategic significance, especially in responding to the needs of the digital native generation for attractive and adaptive learning methods. Al-Azhar Junior High School Medan, as a modern Islamic educational institution, is the perfect context for implementing a progressive technology-based learning approach.

Thus, this research is expected to make a significant contribution to the development of Arabic language learning media in educational settings, particularly through the innovative use of Augmented Reality technology (Shorman & Al-Shoqran, 2019). This research also aims to provide new insights into how AR technology can enhance the learning experience in junior high schools, in line with current innovation trends in education (Sahin & Yilmaz, 2020).

METHODS

This research employed a quantitative approach with a quasi-experimental approach, using a pretest-posttest control group design. In this design, two groups of students received a pretest

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and a posttest, but only the experimental group received the intervention of Augmented Reality (AR)-based learning media (Zhang et al., 2022). This design allowed researchers to objectively examine the effect of AR use on Arabic vocabulary mastery. The presence of a control group served as a comparison, allowing the pure effect of the independent variable on the dependent variable to be identified more validly and reliably (Cahyani & Kholisin, 2022).

The study population included all eighth-grade students of Al-Azhar Middle School, Medan, in the 2024/2025 academic year. The sampling technique used purposive sampling, considering the equivalence of students' initial abilities as measured by their previous Arabic language grades. Two homogeneous classes were selected as samples, each consisting of approximately 30 students; one class was designated as the experimental group and the other as the control group. The experimental group participated in learning with the aid of AR media, while the control group continued to use conventional methods based on lectures and written exercises. This determination was made to ensure equivalence of initial characteristics between the groups.

The main instrument in this study was an Arabic vocabulary test, consisting of a pretest and posttest developed based on competency indicators covering recognition, comprehension, and use of vocabulary in appropriate contexts. The instrument's content validity was tested through consultation with Arabic language experts and learning evaluation experts. In addition to the test, the researchers also used observation sheets to record student engagement and participation during the learning process. A questionnaire on students' perceptions of the use of AR media was also provided optionally as supporting data in interpreting the results (Dabrowski, 2022).

Data collection was conducted systematically through three main stages. First, a pretest was administered to both groups to obtain baseline vocabulary skills. Second, the learning process was implemented over four sessions, with the experimental group using AR media while the control group received conventional learning. Third, a posttest was administered to both groups using instruments equivalent in terms of content and difficulty level. The entire learning process was documented in video and field notes, which served as data triangulation (Khan et al., 2023).

The second and third stages consisted of the learning process and the posttest. During the learning phase, the experimental group received material through Augmented Reality (AR) media, while the control group followed the learning process using conventional classroom methods. The learning process was conducted in four sessions, designed around the same vocabulary topics but presented with different approaches according to each group's treatment. After the learning sessions were completed, the third stage, a posttest, was administered using instruments equivalent in content and difficulty to the pretest (Manurung et al., 2023; Razak, 2005).

In addition to quantitative data from the pretest and posttest, the learning process was also thoroughly documented through video recordings and field notes. This documentation was used as supporting qualitative data and triangulation material to strengthen the findings and provide a more holistic picture of the learning process and outcomes (Ricks & Liu, 2018).

The data analysis techniques in this study included descriptive and inferential statistical approaches. Before testing the hypotheses, the data were first analyzed using normality and homogeneity tests to verify basic statistical assumptions. Next, an independent sample t-test was used to determine the significance of differences in results between the experimental and control groups. This analysis served as the basis for drawing conclusions regarding the effectiveness of AR media use in improving vocabulary mastery (Bicen & Demir, 2020).

The interpretation of the analysis results highlighted not only statistical significance but also the pedagogical significance of AR use in Arabic language learning. Quantitative findings were

analyzed in depth and compared with findings from observations and, where available, student questionnaire responses. This triangulation approach strengthened the validity of the results and enabled a more comprehensive understanding of the effectiveness of AR use. Thus, this study is expected to make a significant scientific contribution to the development of innovative technology-based learning strategies (Majid & Salam, 2021).

RESULT

This study aims to evaluate the extent to which the use of Augmented Reality (AR) media can improve Arabic vocabulary mastery in eighth-grade students at Al-Azhar Middle School, Medan. Initial data obtained through a pretest on both groups indicated relatively equal initial abilities; the experimental group achieved an average score of 58.70, while the control group achieved 59.10. After the treatment, scores improved in both groups, but the experimental group showed a more significant jump, with a posttest average of 84.50 compared to the control group's 71.80. This difference provides an initial indication of the positive impact of AR use on learning outcomes.

Visual representations of the descriptive data are presented in the form of bar graphs and distribution tables. The graphs show a sharper increase in scores in the experimental group compared to the control group. The average difference between pretest and posttest in the experimental group was 25.80 points, while the control group only experienced an increase of 12.70 points. Furthermore, the frequency distribution of scores indicates that most students in the experimental group achieved high scores, while the control group was more concentrated in the middle range. This visual representation strengthens the evidence of a significant difference in learning outcomes due to the treatment.

An inferential test using an independent sample t-test was conducted to examine the difference in posttest means between the experimental and control groups. The test results showed a significance value of 0.001, less than the 0.05 threshold. Therefore, the null hypothesis (H0) was rejected and the alternative hypothesis (H1) was accepted, indicating a statistically significant difference between the two groups. These findings indicate that the use of AR media significantly impacted students' vocabulary development. These results support the assumption that interactive technology can enhance the effectiveness of foreign language learning (Chung & Hsieh, 2017).

Qualitatively, observations of the learning process revealed that the use of AR media not only improved students' academic achievement but also deepened their understanding of the meaning and use of vocabulary in appropriate contexts. Students in the experimental group demonstrated better ability to recognize word meanings and apply them contextually. They were more active in constructing sentences and responding to questions related to the vocabulary learned. These findings suggest that the visual and interactive dimensions of AR contribute to more effective and meaningful vocabulary internalization.

Furthermore, student engagement in the learning process in the experimental group appeared more active and dynamic. Students demonstrated high enthusiasm when using AR media, as reflected in their activities of constructing sentences, responding to questions, and discussing the vocabulary being studied. They appeared more confident in expressing themselves in Arabic, as AR media provided clear context for word usage and supported their understanding of word function within sentence structure. This demonstrates that AR-based learning experiences can create a more communicative, exploratory, and meaningful learning environment.

These findings indicate that AR media functions not only as a visual aid but also as a bridge connecting language theory with communicative practice in vocabulary learning. The interactive dimension offered by AR encourages students to actively and independently construct meaningful associations, thus making vocabulary internalization more effective. Therefore, the integration of AR-based technology in Arabic language learning

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has significant potential to improve the overall quality of learning, both in terms of conceptual understanding, student engagement, and the ability to apply vocabulary in appropriate communicative contexts (Sultan Idris University of Education et al., 2023).

In addition to academic achievement, increased learning engagement is also an important indicator of the effectiveness of AR-assisted learning. Based on observations, students in the experimental group demonstrated a higher level of participation, including enthusiasm in responding to the material and using the devices. In contrast, students in the control group appeared less active and tended to be passive during the learning process. This indicates that AR-assisted learning can create a more engaging learning environment and encourage students to actively participate in the language learning process (Montero et al., 2022).

From an effectiveness perspective, learning Arabic vocabulary through AR has proven superior to conventional approaches. This is demonstrated not only by improved posttest scores but also by students' ability to use vocabulary appropriately in communication situations. Optionally collected questionnaire data indicated that most students found it easier to understand and remember vocabulary presented through AR media. Thus, this technology-based learning has a positive impact both cognitively and affectively on students' learning process (Jumah-Alaso & Onisabi, 2020).

Overall, the results of this study support the integration of AR media as an innovation in foreign language learning at the secondary level. These findings make an important contribution to the development of teaching media that are responsive to the characteristics of the digital generation (Tri Wibowo et al., 2023) The effectiveness of AR in improving Arabic vocabulary mastery can be used as a basis for developing more interactive curricula and teaching practices (Riwanda et al., 2021). This research also opens up opportunities for further studies examining the effectiveness of AR on other language skills, such as listening and speaking, and its application at higher education levels.

This section presents the results of research on the effect of Augmented Reality (AR) media on Arabic vocabulary mastery in eighth-grade students at Al-Azhar Middle School, Medan. The results presented include descriptive data, inferential statistical analysis results, and key findings from the treatment given to the experimental group.

The pre-test and post-test results were 58.7 and 84.5 for the experimental group (mean difference 25.8), respectively. For the control group, they were 59.1 and 71.8 (mean difference 12.7).

The graphs shown show a pattern of more pronounced improvement in Arabic vocabulary learning outcomes in the experimental group compared to the control group. This indicates that the use of Augmented Reality (AR) media in learning positively contributes to students' academic achievement. The experimental group experienced a significant jump in scores from pretest to posttest, while the improvement in the control group was relatively moderate. This data visualization supports the initial assumption that an AR-based learning approach can accelerate vocabulary acquisition through more engaging and easily understood presentation of material.

To ensure that the difference in improvement between the two groups is not the result of chance or random variation, further analysis using inferential statistical testing techniques is necessary. In this context, an independent t-test was used to measure whether there was a statistically significant difference between the posttest scores of the experimental and control groups. (Setyaningsih & Abadi, 2018) This test is relevant because the two groups are independent samples and each received a different treatment. By using a statistical approach, the results of this study rely not only on descriptive observations but also gain scientific legitimacy based on the significance of the numerical data.

Through the t-test, information was obtained regarding the significance value (p-value), which is the main indicator for determining the significance of differences in learning outcomes. If the

p-value is below the threshold of 0.05, then it can be concluded that the difference is statistically significant. This will provide a strong basis that the improvement in learning outcomes that occurred in the experimental group was truly caused by the use of AR media, not other external factors. (Bölek et al., 2021) Thus, the combination of visual descriptive analysis and quantitative statistical analysis provides a comprehensive basis for assessing the effectiveness of technology-based learning interventions in the context of teaching Arabic vocabulary.

DISCUSSION

The results of this study confirm that the integration of Augmented Reality (AR) media in Arabic language learning significantly contributes to improving students' vocabulary mastery at the junior high school level. AR serves not only as a visual aid but also as a pedagogical instrument capable of transforming the learning experience into a more interactive and contextual one (Yulian et al., 2022). Through the representation of words in three-dimensional objects complemented by supporting elements such as audio and text, students gain direct access to vocabulary meanings in situations that mimic real-life situations. This multisensory presentation of material makes the learning process more engaging and relevant, thus simultaneously reaching various student learning styles (Marpaung & Situmeang, 2020).

In the context of vocabulary learning, contextual visual representations from AR media have been shown to strengthen students' ability to associate word forms with meanings and use them in appropriate sentence structures. Through AR-based learning experiences, students don't simply memorize lists of words, but rather develop a deeper understanding of the function and meaning of words in specific contexts (Ibrahim et al., 2018). This process aligns with the principle of meaningful learning, where absorbed information is more easily remembered when linked to concrete experiences or real-life contexts of use. This demonstrates that AR media plays a crucial role in developing comprehensive lexical competence, from vocabulary recognition to active application in communication.

Furthermore, the multisensory exposure provided by AR technology also accelerates the internalization of meaning through the formation of stronger semantic associations. When students see an object, hear its pronunciation, and read the text simultaneously, they are not simply absorbing information from a single source but rather processing it simultaneously through multiple senses. This has a direct impact on strengthening long-term memory and increasing vocabulary retention (Belda-Medina & Marrahi-Gomez, 2023). Thus, the use of AR in Arabic language learning can be a strategic approach that supports mastery of vocabulary more effectively, efficiently, and sustainably, while responding to the needs of 21st-century learning that demands active engagement and immersive learning experiences (Pellerin, 2019).

From a cognitive perspective, AR media can bridge the gap between linguistic symbols and real-life experiences, ultimately facilitating deeper conceptual understanding. When students are exposed to visual objects relevant to the vocabulary being studied, information processing occurs simultaneously through visual and auditory channels. This strengthens working memory capacity and supports the integration of meaning in everyday contexts (Kairu, 2021). Thus, AR acts not only as a presentation aid but also as a learning medium capable of optimally activating students' cognitive engagement.

In addition to the cognitive aspect, the affective dimension of learning also shows a significantly positive response. Based on observations during the intervention process, students involved in AR-based learning demonstrated higher enthusiasm and participation compared to the control group. The interest in technology and the interactivity provided by AR created a more lively, enjoyable, and motivating learning environment (Veide & Strozheva, 2019). In this context, AR plays a role in building students' emotional engage-

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ment, which is crucial for increasing persistence and consistency in learning a foreign language. This aligns with the findings of Billinghurst and Duenser (2012) that AR technology has great potential for fostering active, exploratory, and personalized learning engagement (Marrahí-Gómez & Jose Belda-Medina, 2023).

From the perspective of multimodal learning theory, the success of AR learning can be explained by the principle that learning is more effective when multiple sensory modalities are activated simultaneously. A multimodal approach allows for the delivery of information through visual, verbal, and kinesthetic channels, all of which are facilitated by AR technology. Nation (2001) emphasized that meaningful repetition and exposure to authentic contexts are key to vocabulary acquisition (Philippe et al., 2020). AR simultaneously presents these conditions by displaying vocabulary in the form of interactive images accompanied by correct pronunciation and usage in simple sentences. (Ou et al., 2018) Thus, the results of this study not only strengthen empirical evidence for the effectiveness of multimodal learning but also confirm that AR media is a highly potential tool for application in Arabic vocabulary learning.

The results of this study demonstrate strong consistency with various previous studies that have examined the effectiveness of Augmented Reality (AR) media in language learning contexts. For example, research conducted by Lin et al. (2022) confirmed that AR integration significantly improved vocabulary mastery in learning English as a foreign language (Wedyan et al., 2022). The study found that AR can create a more engaging learning experience and facilitate vocabulary understanding through an immersive and interactive visual approach. The implications of these findings suggest the potential for generalization of AR use across languages ??and educational contexts, including in Arabic language teaching.

Furthermore, findings from Alshammari et al. (2021) further strengthen empirical evidence regarding the superiority of AR media in accelerating the lexical acquisition process. The study emphasized that the use of interactive visual elements in AR not only enhances learning appeal but also contributes to efficient vocabulary comprehension and retention (Poerwanti et al., 2019). In this context, AR is positioned not merely as a visualization tool, but as a learning medium that creates stronger semantic connections between word form and meaning. This process is crucial in foreign language learning, where vocabulary mastery is often a major obstacle.

In the realm of Arabic language learning, a study by Dharmawati and Destiana (2019) demonstrated the effectiveness of interactive animation media in introducing the hijaiyah letters to early childhood at Al Hidayah Kindergarten, Bekasi. Although the age and educational level contexts differ, these findings are relevant because they confirm that Augmented Reality (AR), which presents dynamic letter visualizations, can increase students' interest and understanding of the Hijaiyah letters (Dharmawati & Destiana, 2019).

AR provides multisensory stimulation—combining visuals, audio, and text—that supports children's cognitive and developmental needs. By utilizing interactive animation, AR not only helps recognize the shapes of the Hijaiyah letters but also facilitates deepening of their meaning and correct pronunciation. This process creates a more enjoyable, engaging, and focused learning experience in recognizing basic Arabic letters (Septian & Agustian, 2021)

Thus, the findings from Dharmawati & Destiana (2019) strengthen the argument that AR media can enrich the Arabic language learning experience at various age levels. This empirical evidence provides additional validity that strengthens the use of AR in Arabic language learning, particularly in the letter recognition and basic vocabulary phases. The study conducted in this research expands the scope of previous research by focusing on junior high school (SMP) students in the context of Arabic language learning as part of the formal curriculum. Previously, literature examining the integration of immersive technology in Arabic language learning at this level was relatively limited.

Therefore, the findings of this study not only serve as a replication of previous studies but also serve as a new contribution that enriches the academic discourse on the use of AR in Arabic language education, particularly in the context of primary and secondary education in Indonesia.

Considering the alignment of these findings with international literature, it can be concluded that the effectiveness of AR in supporting vocabulary acquisition is not limited to a particular language or educational level. Instead, AR demonstrates high flexibility and adaptability in various language learning contexts. These results strengthen the generalizability of AR's benefits across languages ??and levels, while also bolstering the argument that immersive technology-based learning approaches are worthy of broader development. This research also opens up space for further exploration, particularly in developing AR-based Arabic language learning models that are more structured, contextual, and tailored to student characteristics in the digital age.

While these findings demonstrate the numerous advantages of using AR to improve vocabulary mastery, it is important to note that this medium also has certain limitations. On the one hand, AR requires adequate technological infrastructure, such as high-spec mobile devices and a stable internet connection. These limited facilities can hinder implementation in schools with limited resources. On the other hand, teacher readiness to operate and integrate AR technology into learning scenarios is also a crucial factor in determining the success of its implementation. Therefore, teacher training and the provision of supporting devices are crucial prerequisites for the effective and sustainable implementation of AR media in formal educational settings.

CONCLUSION

Based on the results of the research conducted, it can be concluded that the use of Augmented Reality (AR) media has a positive and significant impact on improving Arabic vocabulary mastery in junior high school (SMP) students. Integrating this technology into the learning process allows students to experience a more contextual, interactive, and enjoyable learning experience. Through three-dimensional visual displays accompanied by audio and text elements, students are not only able to understand vocabulary more deeply but also retain it more effectively. This demonstrates that AR is not merely a supplementary medium, but rather a pedagogical tool capable of bridging conventional learning with 21st-century learning approaches.

These findings have important implications for education, particularly in Arabic language learning. Teachers, as learning facilitators, are advised to begin adopting AR media as part of their vocabulary teaching strategies. The use of AR can increase student motivation, enrich material delivery methods, and address the challenges of language learning, which students often perceive as abstract. Furthermore, schools, as educational institutions, are expected to provide support by providing adequate technological resources and competency training for teachers to enable them to utilize AR media optimally and sustainably. This institutional support is crucial to ensuring the successful and sustainable implementation of innovative learning technologies in schools.

While the results of this study provide a positive picture, there is still ample room for further research. One important recommendation is to test the effectiveness of AR media on other Arabic language skills, such as speaking and writing. Both of these skills are complex and require innovative learning approaches to optimally master them. Furthermore, further research is recommended in different educational contexts, such as madrasahs or higher and lower levels of education. This will allow for a more comprehensive understanding of the potential and limitations of AR in various Arabic language learning situations.

Overall, this study confirms that the use of AR represents a strategic breakthrough in developing more adaptive, engaging, and effective Arabic language learning. This technology integration aligns with the demands of the digital era and the

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needs of today's learners, who are increasingly familiar with visual and interactive media. Therefore, collaboration between educators, institutions, and technology developers is crucial in optimizing AR's potential to improve the quality of Arabic language learning in the future.

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