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DESIGNING ARABIC LANGUAGE LEARNING MATERIALS WITH AUGMENTED REALITY: A 3D ASSEMBLERWORD-BASED MEDIA INNOVATION

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Abstract

Arabic language learning at MIN 1 Gorontalo still relies heavily on conventional methods, which result in low student motivation and limited engagement. This study aims to explore the integration of Augmented Reality (AR) technology in developing Arabic teaching materials using 3D Assemblerword-based media. By leveraging AR technology, the learning process is expected to become more interactive and engaging. The research employed a Research and Development (R&D) approach using the ADDIE model. The study involved fifth-grade students from MIN 1 Gorontalo Regency, with two groups comprising a total of 60 students. The findings indicate that AR-based media significantly improved students' understanding of Arabic materials and increased their learning motivation. This study contributes to the advancement of innovative and effective instructional strategies in Arabic language education.

Keywords: Augmented Reality; Instructional Material Development; 3D Assemblerword Media.

مستخلص البحث

لا يزال تعليم اللغة العربية في مدرسة الإبتدائية الحكومية الأولى غورونتالو يعتمد على الأساليب التقليدية، مما يؤدي إلى انخفاض دافعية الطلاب وحدود مشاركتهم. ويهدف هذا البحث إلى استكشاف دمج تقنية الواقع المعزَّز في تطوير مواد تعليم اللغة العربية باستخدام وسائط ثلاثية الأبعاد. ومن خلال توظيف هذه التقنية، يُتوقَّع أن تصبح عملية التعلّم أكثر تفاعلية وجاذبية. وقد استُخدم في هذا البحث منهج البحث والتطوير وفق نموذج "أدي" (التحليل، التصميم، التطوير، التطبيق، التقييم). وشملت عينة الدراسة طلاب الصف الخامس في مدرسة الإبتدائية الحكومية الأولى غورونتالو، وبلغ عددهم ستين طالبًا موزعين على مجموعتين. وتشير النتائج إلى أن الوسائط التعليمية القائمة على تقنية الواقع المعزَّز قد حسَّنت بشكل ملحوظ من فهم الطلاب لمواد اللغة العربية وزادت من دافعيتهم للتعلّم. ويسهم هذا البحث في تعزيز الاستراتيجيات التعليمية المبتكرة والفعّالة في ميدان تعليم اللغة العربية.

كلمات أساسية: تقنية الواقع المعزز؛ تطوير المواد التعليمية؛ وسائط أسمبلروورد ثلاثية الأبعاد.

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Introduction

The rapid advancement and development of technology have significantly impacted and transformed the field of education.[1] Education must be able to adapt to the demands of the times. The rapid growth of knowledge, population increase, declining educational efficiency, individual differences among learners, the need to improve academic quality, student motivation, and the effectiveness of teaching methods are among the key factors driving the integration of technology into education.[2] In today's contemporary era, technology has become an essential element in education in general, and in Arabic language instruction in particular.[3]

Information and communication technology has transformed the way we teach and learn. One of the latest innovations is the use of Augmented Reality (AR) technology, which offers a more interactive and engaging learning experience.[4] AR combines the real world with digital elements, providing students with opportunities to interact directly with instructional content.[5] In the context of education, especially Arabic language teaching, AR can help bridge the gap between theory and practice.

As an international language with millions of speakers worldwide, Arabic plays a vital role in religion, culture, and science.[6] However, Arabic instruction often faces challenges, such as students' difficulty in understanding vocabulary, sentence structure, and the lack of innovative learning media. Therefore, implementing AR in Arabic instructional material development is expected to enhance students' motivation.[7] In this context, AR serves not only as a visual aid but also as a medium for creating more engaging and interactive learning

[1] Owoseje Fiyinfoluwa, "Impact of Technology on Education, Analysis, Implications, and Solutions," *International Journal of Applied Research in Social Sciences* 7, no. 4 (2025): 321–31, https://doi.org/10.51594/ijarss.v7i4.1898.

[2] Di Yuna et al., "Technology Integration in Education Management: Challenges, Benefits, and Future Directions," *Forum for Linguistic Studies* 7, no. 2 (2025), https://doi.org/10.30564/fls.v7i2.8358.

[3] Andrina Granić, "Educational Technology Adoption: A Systematic Review," *Education and Information Technologies* 27, no. 7 (2022): 9725–44, https://doi.org/10.1007/s10639-022-10951-7.

[4] Juan Garzón et al., "Systematic Review and Meta-Analysis of Augmented Reality in Educational Settings," *Virtual Reality* 23, no. 4 (2019): 447–59, https://doi.org/10.1007/s10055-019-00379-9; Antigoni Parmaxi and Alan A. Demetriou, "Augmented Reality in Language Learning: A State-of-the-art Review of 2014–2019," *Journal of Computer Assisted Learning* 36, no. 6 (2020): 861–75, https://doi.org/10.1111/jcal.12486.

[5] Jule M. Krüger and Daniel Bodemer, "Application and Investigation of Multimedia Design Principles in Augmented Reality Learning Environments," *Information* 13, no. 2 (2022): 74, https://doi.org/10.3390/info13020074.

[6] Wasfy Ashour Abuzaid, "The Impact Of The Arabic Language On The Integration Of Religious and Human Sciences: A Reading On The Perspectives Of Jurists And Linguists," *Ijaz Arabi Journal of Arabic Learning* 6, no. 3 (2023), https://doi.org/10.18860/ijazarabi.v6i3.23772.

[7] Wan Ab Aziz Wan Daud et al., "M-Learning Boost Students' Motivation in Learning Arabic Language Proficiency for Elementary Level," *Universal Journal of Educational Research* 8, no. 10 (2020): 4384–92, https://doi.org/10.13189/ujer.2020.081004.

experiences.[8] Through this technology, students can more easily comprehend vocabulary and sentence structures, ultimately improving their learning outcomes.

Several previous studies have explored the integration of technology, particularly AR, in language learning and have demonstrated its potential to enhance student engagement and motivation. Savazzi et al. emphasized the effectiveness of AR in supporting immersive and contextualized language learning experiences, showing positive outcomes in learner performance and attitude.[9] Lai and Chang investigated AR-based learning applications for first graders learning English vocabulary, finding significantly higher motivation and performance compared to traditional methods.[10] Similarly, Ibrahim et al. developed the ARbis Pictus system. They showed that learners using AR scored 7% higher on same-day productive recall and 21% higher on a delayed recall test compared to flashcard learning.[11] A broader systematic review further confirmed that approximately 38% of studies reported sustained gains in motivation, enjoyment, and reduced anxiety when AR was applied to language learning contexts.[12] In addition, Sidik et al. directly investigated AR in the context of Arabic learning and found that it significantly boosted students' motivation to learn Arabic.[13]

While these studies highlight the positive role of AR in enhancing language learning, most of them are limited to the context of English or general language acquisition, and only a few directly address Arabic language learning. Moreover, the existing research tends to focus on vocabulary recall or short-term performance outcomes, without giving sufficient attention to the systematic development of instructional materials that are integrated into the formal curriculum at the primary school level. This gap indicates a lack of studies that not only apply AR in Arabic learning but also design and develop AR-based instructional materials tailored to students' characteristics, needs, and classroom contexts.

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[8] Gloria Yi-Ming Kao and Cheng-An Ruan, "Designing and Evaluating a High Interactive Augmented Reality System for Programming Learning," *Computers in Human Behavior* 132 (July 2022): 107245, https://doi.org/10.1016/j.chb.2022.107245.

[9] Federica Savazzi et al., "Engaged in Learning Neurorehabilitation: Development and Validation of a Serious Game with User-Centered Design," *Computers & Education* 125 (October 2018): 53–61, https://doi.org/10.1016/j.compedu.2018.06.001.

[10] Jung-Yu Lai and Li-Ting Chang, "Impacts of Augmented Reality Apps on First Graders' Motivation and Performance in English Vocabulary Learning," *Sage Open* 11, no. 4 (2021): 21582440211047549, https://doi.org/10.1177/21582440211047549.

[11] Adam Ibrahim et al., "ARbis Pictus: A Study of Vocabulary Learning with Augmented Reality," *IEEE Transactions on Visualization and Computer Graphics* 24, no. 11 (2018): 2867–74, https://doi.org/10.1109/TVCG.2018.2868568.

[12] Isabel Schorr et al., "Foreign Language Learning Using Augmented Reality Environments: A Systematic Review," *Frontiers in Virtual Reality* 5 (February 2024): 1288824, https://doi.org/10.3389/frvir.2024.1288824.

[13] Jafar Sidik et al., "The Influence of the Use of Augmented Reality Technology in Learning Arabic in Increasing Students' Learning Motivation," *International Journal of Language and Ubiquitous Learning* 2, no. 1 (2024), https://doi.org/10.70177/ijlul.v2i1.773.

Therefore, the present study seeks to fill this gap by developing Arabic instructional materials using AR through 3D Assemblerword media, specifically designed for fifth-grade students at MIN 1 Gorontalo Regency. The novelty of this research lies in its emphasis on curriculum-based material development supported by AR technology, while also evaluating its impact on student motivation and gathering direct feedback from teachers and learners regarding its classroom implementation.

This research is expected to make a meaningful contribution to Arabic language teaching by demonstrating the potential of augmented reality technology to support student comprehension and motivation. The integration of AR-based media is expected to encourage more active participation in the learning process and provide teachers with practical insights for classroom practice. In this way, the study seeks to improve the quality of Arabic instruction while offering a model that can inspire further innovations in technology-assisted language learning.

Based on observations of Arabic language instruction at Madrasah Ibtidaiyah Negeri (MIN) 1 Gorontalo Regency, as well as information obtained from the Arabic language teacher, it was found that students tend to show a lack of interest and become easily bored during the learning process. This condition negatively impacts their mastery of the subject matter and results in the learning objectives not being fully achieved. The students exhibit low enthusiasm and limited participation in class activities, indicating their lack of engagement. One of the main contributing factors is the continued use of conventional teaching methods, which fail to stimulate students' interest in learning Arabic. In light of this, and considering that students today are growing up in an era of rapid technological advancement, the researcher sees the need for innovation through the integration of technology in the learning process as a means to improve learning outcomes.

Given this background, the present study is directed toward three main research questions: 1) How can the 3D Assemblerword media can be developed as Arabic instructional material for fifth-grade students at MIN 1 Gorontalo Regency? 2) How effective is the use of AR-based 3D Assemblerword media is in enhancing students' motivation to learn Arabic? 3) How do both students and teachers respond to the use of this media in the classroom? In line with these questions, the study aims to design and develop Arabic instructional materials by integrating Augmented Reality (AR) technology through 3D Assemblerword media that are tailored to students' needs; to examine the effectiveness of the developed AR-based materials in increasing students' motivation; and to collect feedback from students and teachers regarding their experiences using the media in actual learning practice.

Theoretically, the results of this study are expected to enrich the body of knowledge concerning the integration of AR technology in Arabic language instruction, particularly in the development of vocabulary and sentence structure

learning materials. Practically, this research seeks to provide teachers with an innovative tool to foster student motivation and engagement, while also offering valuable insights for schools that plan to adopt AR-based approaches in their instructional design.

This research is expected to contribute both theoretically and practically to Arabic language teaching. Theoretically, it enriches the discussion on the integration of augmented reality (AR) technology into instructional material development, particularly for vocabulary and sentence structure learning. Practically, the findings provide teachers with an innovative tool that can support student comprehension, foster motivation, and encourage active participation in the classroom. At the same time, this study offers useful insights for schools interested in adopting AR-based media as part of their instructional design, thereby supporting more engaging and effective Arabic learning practices.

Method

The research method of this study was Research and Development (R&D), guided by the ADDIE model (Analyze, Design, Develop, Implement, Evaluate). This model provides a structured process for analyzing learning needs, designing and developing AR-based materials, implementing them in the classroom, and evaluating their effectiveness.[14]

The development of Arabic language learning media in this study adopted the ADDIE model proposed by Reiser and Molenda, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.[15] In the analysis stage, students' needs and curriculum requirements were identified through observation, teacher interviews, and review of syllabus. The design stage involved planning the structure of the AR-based 3D Assemblerword media, including interactive images, animations, and learning objectives, as well as preparing expert validation instruments. In the development stage, the media was produced and validated by two Arabic language experts and two media experts using structured questionnaires to assess content accuracy and technical quality. The implementation stage was conducted with 60 fifth-grade students at MIN 1 Gorontalo Regency, along with teacher response questionnaires to evaluate

[14] Nur Fadila Sari, "Developing Instructional Materials Based on Inquiry Learning Model," *English Language Teaching for EFL Learners* 2, no. 1 (2020): 54, https://doi.org/10.24252/elties.v2i1.11275; Deni Adriani et al., "Teaching Material Development of Educational Research Methodology with ADDIE Models," *Proceedings of the The 3rd International Conference Community Research and Service Engagements, IC2RSE 2019, 4th December 2019, North Sumatra, Indonesia* (Medan, Indonesia), EAI, 2020, https://doi.org/10.4108/eai.4-12-2019.2293793; Robert Maribe Branch, *Instructional Design: The ADDIE Approach* (Springer US, 2009), https://doi.org/10.1007/978-0-387-09506-6.

[15] Michael Molenda, "In Search of the Elusive ADDIE Model: Performance Improvement," *Performance Improvement* 54, no. 2 (2015): 40–42, https://doi.org/10.1002/pfi.21461; Robert A. Reiser et al., *Trends and Issues in Instructional Design and Technology* (Taylor & Francis, 2024).

practicality and classroom applicability. Finally, in the evaluation stage, the effectiveness of the media was assessed through student motivation questionnaires and qualitative feedback from both students and teachers, the results of which were used to refine the developed media.

The development process followed the ADDIE model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation. During the Analysis phase, several sub-steps were undertaken. First, a needs analysis was conducted to identify learning challenges in Arabic, especially regarding students' comprehension and motivation through teacher interviews and student surveys. Second, a learner analysis was carried out to define the learning objectives—primarily increasing student motivation—and to understand learner characteristics, such as age and cognitive level. Third, a content analysis focused on selecting relevant material, including vocabulary introduction and the practice of the four language skills. Finally, a media analysis evaluated the AR application's potential to meet instructional needs and identified the most effective ways to incorporate it into Arabic-based animated video content. Data analysis techniques at this stage included teacher interviews, student surveys, and a literature review on educational media.

In the Design phase, the focus was on developing animated video content using Augmented Reality applications to enhance students' motivation in learning. The design process emphasized engaging elements such as visuals, audio, and interactive features that align with instructional goals. The instructional design included carefully planned learning steps starting from content comprehension using the developed media. Assessment in the form of comprehension tests, were prepared to evaluate students' understanding of the Arabic material. In addition, student questionnaires were designed to measure their learning motivation and perceptions regarding the use of AR-based media, while speaking skills were assessed through a performance-based rubric that evaluated pronunciation, fluency, vocabulary use, and grammatical accuracy. Data analysis during this stage also involved a literature review to determine the most effective design elements and to construct valid evaluation tools.

In the Development phase, the actual production of the learning media was carried out, and animated videos were created according to the instructional design. A small group trial involving 12 fifth-grade students was conducted before full implementation to collect feedback and evaluate the initial effectiveness of the media. Data collection at this stage included classroom observations, short interviews to explore students' experiences, and analysis of their feedback to identify necessary improvements before the media was applied to the larger group of 60 respondents.

During the Implementation phase, the learning media was applied to a larger group of students. Data collection was conducted to assess students' speaking

skills. Analytical techniques included direct observation, interviews, questionnaires, and both pre-tests and post-tests to compare students' speaking performance before and after the use of the learning media.

Finally, in the Evaluation phase, both the quality of the developed media and its impact on student learning outcomes were assessed. The evaluation focused on two main aspects. First, the practicality and suitability of the AR-based media were reviewed through student and teacher feedback, as well as classroom observations, to determine their alignment with instructional goals. Second, the effectiveness of the media in improving student learning was analyzed through pre-test and post-test results, to measure motivation levels using questionnaires and speaking skills with a performance-based rubric. Descriptive analysis was applied to observation and questionnaire data, while comparative analysis was used to examine pre- and post-test differences. Based on these findings, necessary revisions were made to refine the media, and the final results were documented in a research report that includes recommendations for future application and further studies.

Result and Discussion

The study on Augmented Reality Technology in the development of Arabic instructional materials using 3d assemblerword media to enhance students' learning motivation aimed to identify and measure the validity, practicality, and effectiveness of the developed animated learning media. These criteria served as the basis for evaluating the quality of the developed media and its effectiveness in enhancing students' motivation. The development process of the animated video learning media followed the ADDIE model, which consists of the following stages:

Analysis

In the needs analysis stage, the first step was to identify the key problems encountered in Arabic language learning at MIN 1 Gorontalo Regency. To achieve this, surveys and interviews were conducted with both teachers and students. These interactions revealed several challenges, such as the lack of engaging and interactive learning media and the continued use of conventional teaching methods. Teachers reported that students often felt bored and lacked motivation during lessons, which negatively affected their comprehension of the material.

Within the analysis phase, four key subcomponents were addressed. First, a needs analysis was conducted to identify specific issues in Arabic language instruction, especially related to students' understanding of lesson content and the achievement of learning objectives, through teacher interviews and student surveys. Second, a learner analysis focused on defining the learning goal, which was for students to be able to independently review and recall the material. This aspect was assessed by Arabic teachers using specific evaluation instruments to measure the extent of students' comprehension. Third, content analysis aimed to

determine appropriate learning materials, such as presenting vocabulary through animations (moving images), dialogues, or pronunciation drills in relevant Arabic contexts.

In the Analysis stage overall, the focus was placed on identifying students' needs, curriculum requirements, and the learning objectives of Arabic instruction for fifth graders at MIN 1 Gorontalo Regency. This stage also involved reviewing the potential of Augmented Reality (AR) technology through literature and preliminary observations to determine its suitability as a basis for developing Arabic-based animated learning videos.

Design

The next step was the design phase. Based on the results of the prior needs analysis, Arabic instructional materials were designed and then integrated into Augmented Reality technology using 3D Assemblerword media. At this stage, the first step was to establish clear and measurable learning objectives, particularly focusing on vocabulary and basic sentence structures relevant to fifth-grade students. The development of these materials was aimed at enhancing students' motivation and comprehension of the subject matter. With a focus on presenting the content through animated AR-based media, the materials were expected to not only increase students' motivation to learn but also facilitate a deeper understanding of Arabic. These objectives served as a guiding framework throughout the development process, ensuring that both the instructional materials and the media elements were aligned with the intended learning outcomes.

Following that, content selection was identified as a critical aspect of the planning stage. The chosen theme must be relevant to the current curriculum and engaging for students. In this case, the theme "Al-Hayawānāt" (Animals) was selected as the focus of instruction. This theme not only offers a familiar context for students but also allows them to practice Arabic in scenarios they commonly encounter in everyday life.

During the design phase, the researcher also prepared initial design drafts in the form of storyboards and interface sketches to illustrate how the Arabic materials would be presented through 3D Assemblerword media. These drafts included the sequence of animated content, integration of interactive features, and alignment with the targeted vocabulary and sentence structures. To ensure the feasibility of the design, feasibility questionnaires were distributed to expert validators in both content and media. These instruments were used to assess the appropriateness and consistency of the instructional content and media formats, ensuring that they met the required pedagogical and technological standards before proceeding to the development stage.

Material Expert Validation Analysis

The material expert validation was conducted to evaluate the appropriateness and relevance of the developed Arabic language learning materials using 3D Assemblerword-based Augmented Reality technology. The expert assessed various aspects of the content, including the accuracy of the material, alignment with the curriculum, clarity of instructional objectives, and suitability for the learners' level.

Based on the assessment conducted by expert 1, the instructional material obtained a total score of 75 out of a maximum of 85, resulting in a percentage of 89.41%. According to the established criteria, this score falls into the "highly feasible" category. This indicates that the content was considered very appropriate and ready for implementation with minimal revisions.

The expert also provided qualitative feedback, noting that the integration of vocabulary and visual elements was well-aligned with students' learning needs and that the chosen theme (Al-Hayawānāt) was contextually appropriate for elementary learners. This feedback served as the basis for refining the initial design, ensuring that the revised media better met pedagogical standards and students' characteristics. As a result, the improved version of the media was finalized and prepared for use in the Implementation phase with the target group of students.

Table 1. Material Expert Validation

Expert	Score Obtained	Maximum Score	Percentage	Category
RB	75	85	89.41%	Highly Feasible

Media Expert Validation Analysis

The media expert validation was conducted to assess the quality of the instructional media developed using 3D Assemblerword-based Augmented Reality. The validation process took place to evaluate various aspects of the media, including its design, usability, technical quality, and alignment with instructional goals.

Based on the results presented in Table 2.2, the media expert assigned a total score of 56 out of a maximum of 60, resulting in a 93% achievement rate. According to the predetermined criteria, this score falls within the "Very Appropriate" category.

Table 2. Media Expert Validation

Expert	Score Obtained	Maximum Score	Percentage	Category
ZY	56	60	93%	Very Appropriate

The expert noted that the media fulfilled high standards in terms of interface design, visual appeal, and interactivity. Recommendations for minor improvements included optimizing font readability on smaller screens and enhancing user navigation within the AR application. These suggestions were considered in the media revision process to ensure maximum functionality and effectiveness. The results of this validation indicate that the Arabic language learning media developed is both technically feasible and pedagogically effective, supporting its broader implementation in primary school classrooms.

Development

This study focuses on the development of instructional media through the application of Augmented Reality (AR) technology in designing Arabic language learning materials using 3D Assemblerword-based media. The media was specifically developed to support Arabic language instruction for Grade V students at MIN 1 Gorontalo Regency. In line with the rapid advancement of information technology, the integration of digital media into the classroom has become increasingly relevant, particularly in creating interactive and engaging learning experiences for students.

The process began with the Analysis phase, in which the researcher identified key challenges faced by students in understanding Arabic learning materials. Surveys and interviews with teachers and students were conducted to gather insights into learners' preferences, classroom conditions, and common learning difficulties. The results of this stage provided a strong foundation for designing content that was relevant, responsive to students' needs, and aligned with instructional objectives.

In the Design stage, the researcher developed learning scenarios that leveraged the key features of Assemblerword media, such as the creation of animations and interactive videos. The instructional content was designed to emphasize not only on linguistic components but also on cultural and social contexts relevant to Arabic language acquisition. In the Development stage, the researcher produced the animated visuals and videos utilizing Augmented Reality. At this stage, Arabic language teachers were involved as partners to provide feedback and ensure that the product aligned with the curriculum and addressed the learners' needs. Thus, while the researcher was responsible for the design and production of the media, the teachers contributed as validators and end-users to enhance the product's pedagogical and practical relevance in classroom settings.

Finally, the Implementation and Evaluation phase aimed to assess the effectiveness of the developed media in improving students' speaking skills and learning motivation. A field trial was conducted in Grade V at MIN 1 Gorontalo Regency, where students engaged with the Arabic learning content through the Assemblerword platform. The evaluation included pre- and post-tests to measure speaking performance as well as questionnaires and observations to assess

changes in student motivation. The results provided empirical evidence of the media's effectiveness in supporting both skill development and student engagement in Arabic language learning.

The following figure illustrates the stages in creating animated visuals using the Assemblerword platform.

Figure 1. Initial Interface of the Assemblerword 3D Application

This figure illustrates the starting interface displayed when launching the Assemblerword 3D application, which serves as the main platform for designing Arabic language instructional media based on Augmented Reality technology.

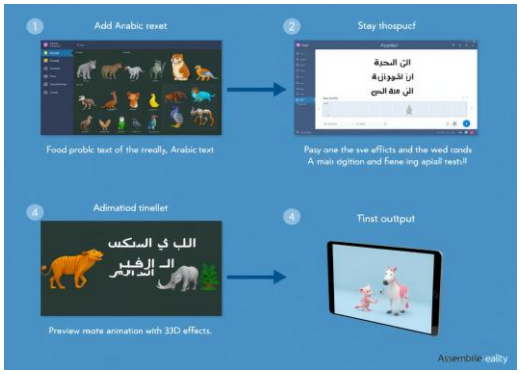

Figure 2. Development Stages of Arabic Language Teaching Materials on the Theme "Al-Hayawanat" for Grade V

This figure shows the sequential stages in developing Arabic teaching materials with the theme Al-Hayawanat (Animals), integrating animated visual elements into the Grade V curriculum using Assemblerword 3D media.

Implementation

This stage aims to determine the feasibility of implementing the developed instructional media using the Assemblerword platform in Arabic language learning. The trial was conducted with Grade V students at MIN 1 Gorontalo Regency. The following table presents the results of the teacher's response to the implementation of the media:

Table 3. Teacher's Respons

No	Indicator/Aspect Validated	Score				
		1	2	3	4	5
1	The content presented through the Assemblerword application					√
2	The developed media is easy to use				√	
3	The media design encourages student motivation to learn					√
4	Students become more enthusiastic in the learning process					√
5	The use of media is flexible and user-friendly				√	
6	The features in the media are easy for students to operate					√
					8	20
Total Score = 28 Maximum Score = 30 Percentage = (28 ÷ 30) × 100 = 93.33% Category = Very Appropriate						

The results showed that the teacher rated the media highly across all aspects. Most indicators received a score of 5 (very good), while two aspects received a score of 4 (good), resulting in a total score of 28 out of a maximum of 30. This yields a percentage of 93.33%, which falls under the "Very Appropriate" category. These results indicate that the media is highly feasible for use in Arabic language instruction, supporting both student motivation and active participation in the learning process.

Table 4. Learner's Respons

Respondent	Score Obtained	Maximum Score	Percentage	Category
A	76	80	95 %	Appropriate
B	65	80	81.25 %	Appropriate
C	73	80	91.25 %	Appropriate
D	69	80	86.25 %	Appropriate
E	65	80	81.25 %	Appropriate
F	70	80	87.5 %	Appropriate
G	78	80	97.5 %	Appropriate
H	78	80	97.5 %	Appropriate
I	80	80	100 %	Appropriate
J	76	80	95 %	Appropriate

Based on the data collected from ten respondents regarding the feasibility of using the developed Arabic language learning media based on Assemblerword 3D, the results indicate a highly positive response across all indicators. The scores obtained by the respondents ranged from 65 to 80 out of a maximum score of 80, with percentage values between 81.25% and 100%. These results fall into the "appropriate" category, indicating the overall acceptance and effectiveness of the media used in the classroom.

Respondents I, G, and H gave the highest evaluations with scores of 100% and 97.5%, suggesting that they found the media to be highly effective, engaging, and beneficial for learning. Meanwhile, the lowest score (81.25%) was given by respondents B and E, with the "appropriate" category. This suggests that while the media is effective, there may still be minor areas for improvement, particularly in terms of user experience or content clarity.

Overall, the average score across all respondents was 73 out of 80, or 91.25%, which strongly supports the conclusion that the Assemblerword 3D-based Arabic learning media is suitable and well-received by students. Moreover, the media has demonstrably enhanced students' motivation and enthusiasm during Arabic language learning, making it a valuable tool for educational settings.

Evaluation

The results of the study on the development of Arabic language learning media using Assemblerword with augmented reality technology for fifth-grade students at MIN 1 Gorontalo Regency demonstrate positive outcomes. The instructional media was developed through a Research and Development (R&D) process, which included the stages of needs analysis, design, development, implementation, and evaluation. The resulting media met the criteria for validity, as confirmed by expert validation, receiving an assessment in the "highly valid" category. Furthermore, the suggestions provided by validators were incorporated to enhance the quality of the learning media.

In terms of its impact on students, the implementation of this media had a positive influence on improving students' learning motivation. Observations during the learning process and analysis of questionnaire responses indicated that students were more active, enthusiastic, and motivated in engaging with Arabic lessons. Statistical data supported these findings, showing a significant increase in students' motivation scores before and after the use of the media. A summary of the pre-test and post-test results is presented in the following table.

Table 5. t-Test: Paired Two Sample for Means

	Pre-test Score	Post-test Score
Mean	61.25	79.96666667
Variance	44.29237288	23.18531073
Observations	60	60
Pearson Correlation	0.933251544	
Hypothesized Mean Difference	0	
df	59	
t Stat	-52.36882882	
P(T<=t) one-tail	1.82075E-51	
t Critical one-tail	1.671093032	
P(T<=t) two-tail	3.6415E-51	
t Critical two-tail	2.000995378	

The statistical analysis from the pre-test and post-test provides compelling empirical evidence of the effectiveness of the augmented reality-based learning media using Assemblerword 3D. The mean score of students increased significantly from 61.25 in the pre-test to 79.97 in the post-test, showing an average gain of approximately 18.72 points. This improvement indicates a notable enhancement in students' learning outcomes and motivation after the intervention. Furthermore, the variance decreased from 44.29 in the pre-test to 23.19 in the post-test. These results confirm that the developed learning media had a significant effect on improving students' speaking skills and learning motivation in Arabic language learning. Collectively, these results confirm that the developed learning media had a significant positive effect on improving both speaking skills and learning motivation in Arabic language instruction.

The Pearson correlation coefficient of 0.933 reflects a very strong positive relationship between the two sets of scores, indicating that students who initially performed better continued to achieve higher results after the treatment. This consistency strengthens the claim that the intervention had a systematic and reliable impact. Most importantly, the paired-sample t-test results confirm the statistical significance of the improvement. The t-statistic of -52.37 far exceeds the critical t-value of 2.00 (two-tailed), and the p-value of 3.64×10^{-51} is substantially below the conventional alpha level of 0.05. These values provide robust evidence that the observed gains were not due to chance, but rather a direct effect of the implementation of Assemblerword 3D.

Taken together, these findings strongly support the conclusion that the use of augmented reality-based learning media significantly enhances students' motivation and learning outcomes. Beyond the immediate statistical improvements, the results have broader implications for the integration of educational technology in Arabic language pedagogy. The use of Assemblerword 3D demonstrates how immersive technologies can transform abstract linguistic concepts into interactive and visual experiences, thereby fostering deeper engagement and more meaningful learning processes. Such innovations align with contemporary approaches in digital pedagogy that emphasize student-centered, experiential, and constructivist learning models.

Nevertheless, the implementation of augmented reality in classroom practice is not without challenges. Constraints such as limited technological infrastructure, varying levels of digital literacy among teachers, and potential resistance to adopting new pedagogical tools may hinder the scalability of this approach. Moreover, the cost of devices and the need for continuous technical support could create barriers, particularly in schools with limited resources. Addressing these constraints require collaborative efforts between educators, institutions, and policymakers to ensure equitable access and sustainable integration.

Future research should explore the long-term impact of augmented reality on language acquisition, particularly in developing higher-order language skills such as writing and critical thinking in Arabic. Comparative studies across educational levels, contexts, and regions would also provide valuable insights into the generalizability of the findings. Additionally, investigating the role of teacher training and pedagogical design in optimizing the use of AR technology could further strengthen the effectiveness of this innovative approach in Arabic language education.

Discussion

The findings of this study, which demonstrated significant improvements in students' motivation and speaking skills, are consistent with the principles of dual-coding theory proposed by Allan Paivio.[16] The integration of 3D visuals and audio pronunciation in AR-based media allowed students to process information through both verbal and visual channels simultaneously, thereby reinforcing vocabulary retention and supporting oral practice. This explains why students not only demonstrated higher enthusiasm during learning but also showed measurable progress in their speaking performance. These results also align with previous studies (e.g., Sidik et al.; Lai & Chang) that highlight the potential of AR to foster engagement and improve language learning outcomes.

Furthermore, the effectiveness of AR can be analyzed through the lens of Sweller's cognitive load theory.[17] Traditional learning often imposes a high cognitive load due to minimal visual representation and weak learning context.[18] AR has the potential to reduce this load by presenting material more concretely, thus aiding students in grasping abstract concepts such as grammar and vocabulary meaning.[19] By providing direct visual representations linked to

[16] Rustam Shadiev and Qiwei Liang, "A Review of Research on AR-Supported Language Learning," *Innovation in Language Learning and Teaching* 18, no. 1 (2024): 78–100, https://doi.org/10.1080/17501229.2023.2229804; Johan @ Eddy Luaran et al., "Immersive Learning Environment: Investigating Student Engagement, Retention and Learning Outcomes in Using Virtual Reality (VR) and Augemented Reality (AR) in Teaching and Learning," *International Journal of Research and Innovation in Social Science* IX, no. IV (2025): 3119–25, https://doi.org/10.47772/IJRISS.2025.90400231; Allan Paivio and Wallace Lambert, "Dual Coding and Bilingual Memory," *Journal of Verbal Learning and Verbal Behavior* 20, no. 5 (1981): 532–39, https://doi.org/10.1016/S0022-5371(81)90156-0.

[17] John Sweller and Paul Chandler, "Evidence for Cognitive Load Theory," *Cognition and Instruction* 8, no. 4 (1991): 351–62, https://doi.org/10.1207/s1532690xci0804_5; Yuko Suzuki et al., "Measuring Cognitive Load in Augmented Reality with Physiological Methods: A Systematic Review," *Journal of Computer Assisted Learning* 40, no. 2 (2024): 375–93, https://doi.org/10.1111/jcal.12882.

[18] John Sweller et al., "Cognitive Architecture and Instructional Design: 20 Years Later," *Educational Psychology Review* 31, no. 2 (2019): 261–92, https://doi.org/10.1007/s10648-019-09465-5.

[19] Josef Buchner et al., "The Impact of Augmented Reality on Cognitive Load and Performance: A Systematic Review," *Journal of Computer Assisted Learning* 38, no. 1 (2022): 285–303, https://doi.org/10.1111/jcal.12617; Nasser Mansour et al., "Embodied Learning of Science Concepts through Augmented Reality Technology," *Education and Information Technologies* 30, no. 6 (2025): 8245–75, https://doi.org/10.1007/s10639-024-13120-0.

relevant objects or contexts, AR accelerates information processing in working memory and facilitates the transfer of knowledge to long-term memory.[20] This is particularly crucial in Arabic learning, where understanding vocabulary meaning often requires cultural and situational context.

From an affective perspective, AR has been shown to positively influence student motivation and engagement. John Keller's ARCS Motivation Model emphasizes four key components that drive learning motivation: Attention, Relevance, Confidence, and Satisfaction. AR naturally captures students' attention through engaging visuals and high interactivity. The relevance of content increases as students relate material to real-world experiences. User-controlled interaction boosts student confidence, while successful task completion through AR fosters satisfaction with both the learning process and outcomes. In this way, AR supports not only cognitive development but also provides a joyful, personalized, and meaningful learning experience.

More broadly, the integration of AR in Arabic language instruction aligns with constructivist learning approaches, where learners are not passive recipients of information but active constructors of knowledge through interaction with their learning environment. AR technology encourages students to explore, manipulate, and reflect on learning objects or situations, leading to deeper understanding. In this context, AR is not simply an innovative strategy, but a theoretically grounded approach supported by cognitive, affective, and constructivist frameworks. Mohamad et al, conducted a systematic review on AR integration with cognitive constructivist theory and found that AR promotes experiential learning, active learner engagement, and deeper conceptual understanding across various educational domains.[21] Similarly, foundational research by Santos et al, considered AR as situated multimedia that overlays meaningful labels onto real-world objects, facilitating situated vocabulary learning aligned with constructivist and situated cognition theories; this approach resulted in improved word retention and student attention compared to non-AR methods.[22] Further evidence in EFL contexts comes from Chang et al. who reported that AR-based vocabulary lessons produced significantly higher post-test gains—an average score of 92.6 vs. 84.9—and a 23.1 percent improvement compared with traditional multimedia instruction

[20] Paula Srdanović et al., "Neurocognitive Foundations of Memory Retention in AR and VR Cultural Heritage Experiences," *Electronics* 14, no. 15 (2025): 2920, https://doi.org/10.3390/electronics14152920.

[21] Shahrul Amri Mohamad et al., "Integrating Augmented Reality with Cognitive Constructivist Theory: A Systematic Review of Enhancing Learning in Education," *Journal of Contemporary Social Science and Education Studies (JOCSSES)* 4, no. 3 (Special Issue) (2024), https://www.jocss.com/index.php/multidiscipline/article/view/243.

[22] Marc Ericson C. Santos et al., "Augmented Reality as Multimedia: The Case for Situated Vocabulary Learning," *Research and Practice in Technology Enhanced Learning* 11, no. 1 (2016): 4, https://doi.org/10.1186/s41039-016-0028-2.

($p < .001$).[23] These findings offer solid theoretical support for the current research: AR-mediated instruction does not simply introduce new technology, but operates as a constructivist tool that encourages learners to explore, interact with, and internalize language in situated contexts, thereby supporting motivation, deeper engagement, and more meaningful learning.

Building upon this theoretical foundation, the present study applies these principles within the specific context of Arabic language instruction using AR tools tailored to young learners. By integrating AR through platforms such as Assemblerword 3D, the research not only aligns with constructivist theory but also operationalizes it in a classroom setting, providing tangible evidence of how interactive, visual learning environments can enhance linguistic competence. This application bridges the gap between theory and practice, demonstrating how abstract pedagogical concepts can be translated into effective instructional strategies using modern technology.

This study strengthens the evidence that the use of AR technology—particularly through Assemblerword 3D—is an effective approach in Arabic language instruction. These findings are consistent with prior research and are grounded in strong theoretical foundations in visual learning psychology. They also highlight the significant potential of AR for advancing technology-based language learning in the future. The practical implications encourage educators and curriculum developers to systematically explore the integration of AR media into instructional processes to create more interactive, engaging, and learner-centered environments that meet the needs of 21st-century students.

Conclusion

The study shows that the use of Augmented Reality (AR) technology through Assemblerword 3D has a significant positive impact on students' comprehension in learning Arabic. The paired t-test results confirm a significant difference between pre-test and post-test scores, with a higher mean score in the post-test. The substantially high t-statistic value and very small p-value provide strong evidence of this improvement. These findings indicate that AR-based media can enhance both students' understanding and motivation by creating interactive and engaging learning experiences. However, successful implementation requires adequate teacher training and supportive technological infrastructure. Future research should focus on developing more varied AR content aligned with curriculum standards and examining its effects across different language skills, grade levels, and educational contexts to maximize its pedagogical impact and ensure broader applicability.

[23] Chin-Huang Daniel Liao et al., "The Learning Outcome of Using Augmented Reality Instruction to Enhance Students' English Vocabulary Learning in the EFL Elementary School," *English Language Teaching Methodology* 3, no. 1 (2023): 143–52, https://doi.org/10.56983/eltm.v3i1.921.

Author Contribution Statement

MZP conceived the research idea, designed the study framework, and supervised the overall project. MA contributed to data collection, analysis, and drafting the manuscript. SS assisted in the development of learning media, validated the research instruments, and contributed to manuscript revision. All authors reviewed and approved the final version of the manuscript.

Declaration of Competing Interest

The authors state that there are no financial, professional, or personal conflicts of interest that could have influenced the research and findings presented in this study.

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