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LexiAR Quest: An Augmented Reality Flashcard in Teaching English Vocabulary

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Abstract

This study aims to develop and evaluate LexiAR Quest, an Augmented Reality (AR)-based 3D flashcard for thematic vocabulary learning using the ADDIE model. The study employed a Research and Development (R&D) design involving eleventh-grade students at a senior high school in Bandung Regency, West Java. Data were collected through expert validation sheets, student questionnaires, and classroom observations used to identify implementation challenges. The findings revealed that the developed media was categorized as very feasible, obtaining an expert validation result of 91.53. The limited try-out and field test results further indicated that the media was practical and positively received by students, particularly in terms of usability, visual attractiveness, and vocabulary comprehension. Furthermore, the implementation process revealed several challenges, particularly in terms of audio clarity, internet stability, and technical accessibility. Some students experienced difficulties when accessing AR features, while occasional system errors affected the smoothness of classroom activities. For future research, it is recommended to develop AR-based learning media with more flexible accessibility and lower dependence on internet connectivity to improve its applicability across different educational settings.

Keywords: Augmented Reality; Vocabulary Learning; 3D Flashcards; ADDIE Model; EFL

INTRODUCTION

Vocabulary mastery is a fundamental component of language learning because it supports learners' ability to communicate effectively through listening, speaking, reading, and writing. Without sufficient vocabulary knowledge, students may struggle to understand texts, express ideas, and participate actively in language-learning activities. Therefore, vocabulary instruction plays a crucial role in English Language Teaching (ELT), particularly in English as a Foreign Language (EFL) contexts where learners have limited exposure to English outside the classroom. Despite its importance, many students still experience difficulties in acquiring and retaining new vocabulary. Traditional teaching methods often rely on memorization and textbook-based activities, which may not provide meaningful learning experiences or sufficient contextual support for vocabulary retention. As a result, students frequently forget newly learned words and have difficulty applying them in authentic communication situations.

To address these challenges, various technology-enhanced learning media have been introduced to support vocabulary instruction. One of them is Augmented Reality (AR), which integrates virtual objects into the real-world environment and provides interactive learning experiences. In language learning, AR has been widely used to enhance students' motivation, engagement, and vocabulary acquisition through 3D visualization and multimodal learning experiences (Belda-medina et al., 2023; Hersulastuti et al., 2025; Majid et al., 2023). The use of AR is supported by Dual Coding Theory (Paivio, 1990) and the Cognitive Theory of Multimedia

Learning (Mayer, 2005), which suggest that combining verbal and visual information can improve cognitive processing and long-term memory retention. Recent studies have demonstrated the effectiveness of AR in improving vocabulary retention and learning performance across different educational contexts, including higher education (Ahmed & Mohamed, 2026), secondary EFL classrooms (Siregar & Syahputri, 2025), and learners with special educational needs (Al-khresheh et al., 2024). In Indonesia, AR and Virtual Reality (VR) technologies have also shown positive impacts on students' vocabulary achievement and learning engagement (Arifin et al., 2025).

Although research on Augmented Reality (AR) in language learning has been increasingly developed, most studies remain focused on learning outcomes and effectiveness, while aspects such as media development, validation, and classroom implementation challenges have received less attention (Akbar et al., 2023; Umar et al., 2025). Limited attention has been given to the systematic development process, expert validation, and feasibility of AR-based vocabulary learning media. Furthermore, relatively few studies have examined how such media function in actual classroom settings, particularly regarding usability and implementation challenges (Ahmed & Mohamed, 2026; Arifin et al., 2025). Preliminary observations conducted at a senior high school in Bandung Regency revealed that students experienced difficulties in understanding and retaining vocabulary due to the limited availability of engaging learning media and visual learning support. These findings indicate a gap between the potential of AR technology and its practical implementation in classroom-based vocabulary instruction.

By focusing on media development, student responses, and implementation challenges, this study contributes to bridging the gap between theoretical potential and classroom applicability of AR-based vocabulary media. Specifically, it develops LexiAR Quest, an AR-based 3D flashcard using Assemblr EDU with the thematic focus on Adventure and Outdoor Activities to support vocabulary learning for eleventh-grade students. Accordingly, the study investigates

1. How Is LexiAR Quest Developed Through the ADDIE Model?
2. How Feasible Is LexiAR Quest in Vocabulary Learning?
3. What Challenges Are Encountered During the Implementation of LexiAR Quest?

By applying a Research and Development (R&D) approach with the ADDIE framework (Sugiyono, 2016), this study is expected to produce a learning medium that is valid, practical, and pedagogically relevant for vocabulary instruction in EFL classrooms.

METHOD

This study employed a Research and Development (R&D) design to develop and evaluate LexiAR Quest, an Augmented Reality (AR)-based 3D flashcard for vocabulary learning. The study adopted the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation as presented in Figure 1. The model was selected because it provides a systematic framework for developing educational media and allows continuous revision throughout the development process.

The study was conducted at one of the senior high schools in Bandung Regency, West Java. The participants were eleventh-grade students selected through purposive sampling based on their relevance to the research objectives. The implementation phase consisted of a limited try-out involving five students and a field test involving thirty-four students.

Three instruments were used in this study, namely expert validation sheets, student questionnaires, and observation sheets. The expert validation sheet was employed to assess the feasibility of the developed media in terms of media, content, and language with pedagogical aspects. The questionnaire was administered during limited trials and field testing to obtain data related to the feasibility and practicality of LexiAR Quest from the students' perspective. In addition, the observation sheet was used during the implementation phase to identify challenges when using LexiAR Quest in classroom activities.

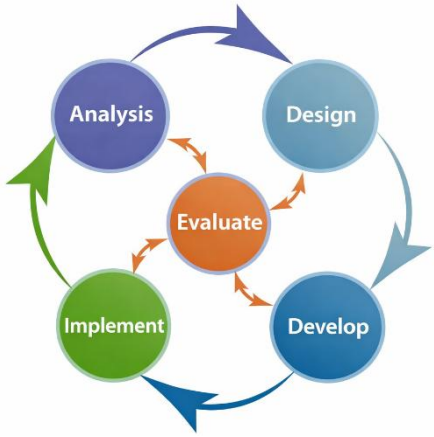


Figure 1. ADDIE Model Used in This Research (Sukma & Amurdawati, 2020)

The research procedure followed the ADDIE model. The first stage was Analysis, which aimed to identify students' learning needs, vocabulary learning difficulties, curriculum requirements, and learner characteristics through preliminary observation and curriculum review. The second stage was Design, during which the learning objectives, vocabulary content, media specifications, and instructional materials were planned. The third stage was Development, where the AR-based flashcards were developed using the Assemblr EDU platform and revised based on expert feedback and validation results. The fourth stage was Implementation, which involved conducting a limited try-out and a field test to examine students' responses and the use of the media in classroom settings. The fifth stage was Evaluation, where feedback from experts, observations, and students' responses was analyzed to assess the strengths and weaknesses of the media and support further revisions.

Table 1. Category of Feasibility Criteria of Validation Results

Percantage Range	Category
85.01 – 100.00	Very Feasible
70.01 – 85.00	Feasible
50.01 – 70.00	Fair
≤ 50.00	Not Feasible

Adapted from (Parapat & Sagala, 2022)

Table 2. Category of Practicality Criteria Student Responses

Percantage Range	Category
86.00 – 100.00	Very Practical
76.00 – 85.00	Practical
60.00 – 75.00	Fairly Practical
55.00 – 59.00	Less Practical

Adapted from Purwanto in (Syafitri et al., 2023)

RESULTS AND DISCUSSION

Results

1. The Development of LexiAR Quest

The findings showed that LexiAR Quest was developed systematically through the ADDIE model, which consists of Analysis, Design, Development, Implementation, and Evaluation stages. During the Analysis stage, preliminary observations and curriculum reviews revealed that many students experienced difficulties in understanding and retaining English vocabulary. The observations also indicated that vocabulary learning was still dominated by conventional methods and provided limited visual support. In addition, students showed greater interest in interactive and technology-based learning activities. These findings highlighted the need for a learning medium that could provide more meaningful visual experiences and support vocabulary learning through interactive technology.

During the Design stage, the researchers determined the learning objectives, selected the thematic vocabulary content, and planned the overall structure of the media. The theme Adventure and Outdoor Activities was chosen to provide contextual vocabulary learning experiences for eleventh-grade students. The product was named LexiAR Quest, combining the words Lexi (vocabulary), AR (Augmented Reality), and Quest (exploration or adventure). The name was intended to reflect the concept of learning vocabulary through interactive exploration supported by AR technology. At this stage, the researchers also designed the flashcard layout, vocabulary content, pronunciation guides, QR codes, and supporting guidebooks for both students and teachers.

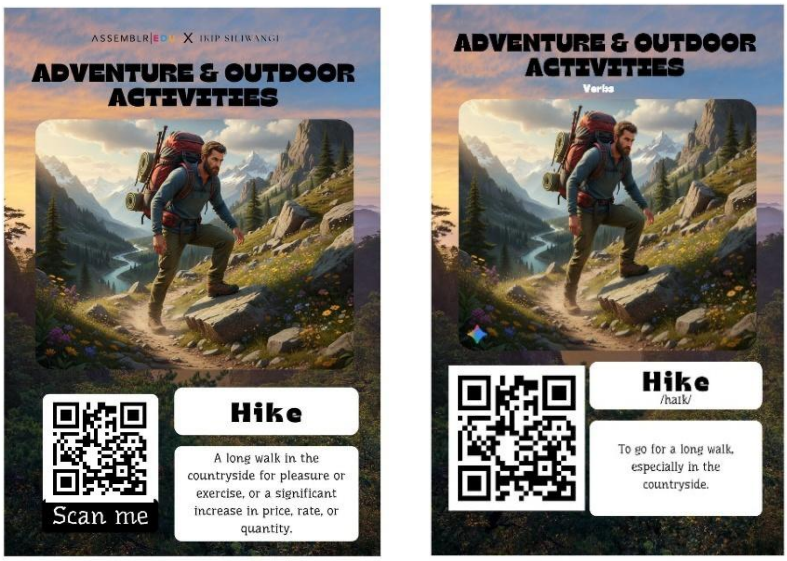
During the Development stage, the product underwent several revisions based on expert feedback and evaluation results. The first revision focused on the product packaging and cover design. In Prototype 1, the cover displayed limited product information and included only a small number of sample cards. Following expert suggestions, several improvements were made in Prototype 2, including the addition of the number of flashcards, a revised packaging structure, and a more proportional layout to improve readability and product presentation.

Prototype 1 Prototype 2

Figure 2. Product Cover Revision from Prototype 1 to Prototype 2

The second revision focused on the flashcard design. In Prototype 1, the flashcards contained vocabulary items, definitions, pronunciation guides, QR codes, and vocabulary classifications. However, expert validation suggested several improvements related to vocabulary definitions, visual consistency, and product identity. As a result, the flashcards were revised and finalized

under the title LexiAR Quest. Vocabulary definitions were refined, visual objects were redesigned to achieve greater consistency, and vocabulary classifications were standardized across all flashcards. These revisions aimed to improve both instructional quality and user experience.



Prototype 1 Prototype 2

Figure 3. Flashcard Revision from Prototype 1 to Prototype 2

The third revision involved the supporting guidebook. Prototype 1 only provided a simple user guide written in Bahasa Indonesia and offered limited instructional guidance. Based on expert feedback, the guidebook was expanded into two separate versions consisting of a User Guide and a Teacher Guide. In addition, the guidebook was redesigned in a bilingual format using Bahasa Indonesia and English. The Teacher Guide also included several suggested classroom activities, such as Look–Listen–Repeat, Guessing Meaning, Say and Use, Repetition, and pair-work activities, to support classroom implementation.

Prototype 1 Prototype 2

Figure 4. Guidebook Revision from Prototype 1 to Prototype 2

The Implementation stage consisted of a limited try-out and a field test conducted to examine the use of the media in actual classroom settings. Throughout these activities, observations were conducted to identify potential areas for improvement and to collect feedback from users. The Evaluation stage was carried out continuously throughout the development process. Feedback obtained from expert validation, classroom observations, and student responses was used to refine and improve the product. Through a series of revisions and evaluations, LexiAR Quest

evolved from an initial prototype into a more comprehensive AR-based vocabulary learning medium designed to support vocabulary instruction in EFL classrooms.

2. The Feasibility of LexiAR Quest in Learning English Vocabulary

The feasibility of LexiAR Quest was evaluated through expert validation involving four experts in the areas of media, language, material, and pedagogy. The validation results indicated that the developed media achieved a Very Feasible category. All experts provided consistently positive evaluations across the assessed aspects, suggesting that the media met the required standards in terms of instructional content, language appropriateness, visual design, and pedagogical relevance. These findings indicate that the development process successfully produced a learning medium that was suitable for vocabulary instruction in EFL classrooms.

Table 3. Results of Expert Validation

Expert	Media	Language	Material	Total	Category
Expert 1	91.67	87.50	90	89.72	Very Feasible
Expert 2	91.67	93.75	90	91.81	Very Feasible
Expert 3	91.67	87.50	90	89.72	Very Feasible
Expert 4	95.83	93.75	95	94.86	Very Feasible
Average	92.71	90.63	91.25	91.53	Very Feasible

The positive validation results also reflected the effectiveness of the revision process conducted throughout the development stage. Feedback provided by the experts contributed to improvements in the flashcard design, vocabulary presentation, visual consistency, and supporting guidebooks. As a result, the final version of LexiAR Quest was considered appropriate for classroom implementation and further testing with students.

Students' responses were examined through a limited try-out and a field test to determine the practicality of the media in actual learning situations. The findings revealed that most indicators were categorized as Very Practical, particularly those related to ease of use, visual attractiveness, vocabulary comprehension, and learning enjoyment. Students generally perceived the AR-based flashcards as engaging and helpful in supporting vocabulary learning. The integration of three-dimensional objects, pronunciation features, and visual representations appeared to facilitate students' understanding of vocabulary in a more interactive manner.

Table 4. Limited Test and Field Test

No.	Statement	Limited Try-Out	Field Test	Average	Category
1	The media is easy to use on my smartphone	85	85.29	85.15	Very Practical
2	The AR 3D objects help me understand new vocabulary	90	83.82	86.91	Very Practical
3	The 3D objects match the vocabulary being learned	95	83.09	89.05	Very Practical
4	The pronunciation audio is clear and easy to follow	80	78.68	79.34	Practical

No.	Statement	Limited Try-Out	Field Test	Average	Category
5	The media makes vocabulary learning more enjoyable	95	87.50	91.25	Very Practical
6	The media helps me remember vocabulary more easily	95	76.47	85.74	Very Practical
7	I would like this media to be used in future learning	85	78.68	81.84	Practical
8	The visual appearance of the media is attractive	95	86.76	90.88	Very Practical
9	The language used in the media is easy to understand	95	85.29	90.15	Very Practical
10	The media helps me be more active in learning	90	77.21	83.61	Practical

Although the overall results remained within the practical category, several indicators showed slightly lower results during the field test compared to the limited try-out stage. This difference may be attributed to the larger number of participants involved in the field test, which introduced more diverse learning conditions, device capabilities, and user experiences. Variations in smartphone performance, internet connectivity, and classroom dynamics may also have influenced students' perceptions of the media. Nevertheless, the overall findings continued to demonstrate positive responses toward the use of LexiAR Quest in vocabulary learning activities.

Based on the expert validation and student response results, LexiAR Quest was considered both feasible and practical for vocabulary learning. The findings suggest that the integration of Augmented Reality technology can provide meaningful visual support, increase student engagement, and create more interactive vocabulary learning experiences. Therefore, the developed media has the potential to serve as an innovative instructional tool for EFL vocabulary learning in secondary school contexts.

3. The Challenges During Implementation of LexiAR Quest

The findings revealed several challenges in vocabulary learning activities. The most frequently observed challenges were related to audio clarity, internet connectivity, and minor technical issues when scanning several flashcards. Although these problems did not prevent students from completing the learning activities, they occasionally disrupted the learning process and affected the overall user experience. In addition, differences in smartphone specifications influenced the performance of the AR features, resulting in varying levels of responsiveness and visualization quality among students. Some students also required additional guidance when accessing the application and operating the AR components, particularly during their first experience using the media.

During the implementation phase, several challenges were identified, including unclear pronunciation audio, unstable internet connections, and minor technical errors when scanning some flashcards. These challenges occasionally disrupted classroom activities and affected students' access to several AR features. Therefore, in audio quality, system performance, and user guidance are needed to support smoother implementation in future classroom use.

Table 5. Number of Students Based Early Mathematical Ability

PAM	Experiments	Control
High	11	12
Medium	53	44
Low	9	10
Total	73	66

Discussion

LexiAR Quest as a Tool for Learning English Vocabulary

The findings demonstrated that the development of LexiAR Quest through the ADDIE model not only resulted in a feasible learning medium but also highlighted that developing instructional media requires a systematic and continuous process. Based on the researcher's experience throughout the study, the media, which was initially considered to have met the learning needs, still required several improvements after undergoing expert validation and classroom implementation. This finding suggests that the quality of instructional media cannot be judged solely from the developer's perspective but should be confirmed through evaluation involving both experts and users. Therefore, the ADDIE model served not only as a development framework but also as a guideline that enabled each stage of the development process to be evaluated before the media was implemented on a wider scale. This finding is consistent with Branch, (2009), who emphasizes that the ADDIE model provides a systematic instructional design framework that supports continuous evaluation throughout the development process. It is further supported by (Febriansyah et al., 2025), who found that applying the ADDIE model contributes to the development of instructional media that better meets users' needs through iterative validation, revision, and evaluation.

Expert validation results and positive student responses indicate that LexiAR Quest is not only feasible as a learning medium but also capable of addressing students' vocabulary learning needs in the classroom. According to the researcher, these findings reflect not only the quality of the developed product but also demonstrate that the systematic development process contributed to creating a learning medium that is aligned with students' characteristics and instructional needs. Although several aspects received slightly lower scores during the field test compared to the limited try-out, this does not necessarily indicate that the media became less feasible. Instead, it reflects the diversity of real classroom conditions, including differences in device specifications, internet connectivity, and students' experience with Augmented Reality-based technology. This finding suggests that the quality of instructional media should not be determined solely by expert validation during the development stage but also by its ability to support learning effectively when implemented in authentic classroom settings. The findings are consistent with (Zhang et al., 2025), who reported that the effectiveness of Augmented Reality-based learning media is influenced by the quality of instructional design and its alignment with learners' needs. Similar findings were also reported by (Akbar et al., 2023), who found that the use of Augmented Reality-based flashcards can enhance student engagement and provide a more meaningful vocabulary learning experience. Therefore, LexiAR Quest can be viewed not only as a feasible instructional medium but also as a learning tool with the potential to support more interactive vocabulary learning in EFL classrooms.

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Using LexiAR Quest in the EFL Classroom

During the implementation process, this study found that technical challenges are unavoidable in the use of Augmented Reality-based learning media. These challenges did not indicate that the developed media is unsuitable; rather, they form an important part of the evaluation process aimed at improving product quality. Based on the implementation experience, several aspects need improvement to ensure more optimal use in future learning activities. Audio quality, for instance, should be tested across different devices and involving potential users prior to wider implementation to ensure clarity and ease of understanding. Since AR-based media also depends on internet connectivity, teachers need to ensure network readiness before instruction and adjust learning strategies according to school conditions. Additionally, compatibility testing across various device specifications is necessary to ensure optimal performance on students' devices. These points highlight that, as also noted by (Hakami et al., 2026; Koumpouros, 2024; Majid et al., 2023), the effectiveness of learning media is not only determined by technological innovation but also by infrastructure readiness and thorough pre-implementation testing.

CONCLUSION

This study developed and evaluated LexiAR Quest, an Augmented Reality (AR)-based vocabulary learning medium, using the ADDIE model. The findings demonstrated that LexiAR Quest was systematically developed through the ADDIE stages and was considered highly feasible based on expert validation, limited try-out, and field test results. The positive responses from students also suggest that LexiAR Quest has the potential to support more interactive and engaging vocabulary learning in EFL classrooms. This study focused on the development and feasibility evaluation of LexiAR Quest. Therefore, its effectiveness in improving students' vocabulary achievement was beyond the scope of this study. In addition, the implementation was conducted in one senior high school, which may limit the transferability of the findings to other educational. Future studies are encouraged to investigate the effectiveness of LexiAR Quest in improving students' vocabulary achievement through an experimental design involving a larger and more diverse sample.

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