

Developing and Evaluating the Le-Zoo Board: An Augmented Reality-Based Medium for English Vocabulary Reading among Students with Autism

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Article Info	Abstract
Received: 2026-05-09 Revised: 2026-05-30 Accepted: 2026-06-05 Keywords: <i>Augmented Reality; Autism; English Vocabulary; Learning Media; Reading Skills</i> DOI: 10.24256/ideas.v14i1.10762 Corresponding Author: Testiana Deni Wijayatiningsih testiana@unimus.ac.id	<i>Students with autism may benefit from structured, visually clear, and multisensory English learning materials. This study developed and preliminarily evaluated the Le-Zoo Board, an interactive learning medium integrating a board game, sensory audio, and augmented reality cards for English animal-vocabulary reading. The study employed a research-and-development approach based on the ADDIE model. Participants were 11 students with mild autism from a special school in Yogyakarta, selected through purposive sampling. Data were collected through material- and media-expert validation, a one-group pre-test-post-test, and a student-response questionnaire. Material-expert validation reached 97.6%, and media-expert validation reached 97%, both categorized as very valid. The paired-samples analysis showed a significant pre-post difference (mean difference = -44.545, SD = 9.342, $t(10) = -15.815$, $p < .001$). The student-response score was 480 of 550, or 87.27% of the maximum possible score, indicating a positive practicality response. These findings provide preliminary evidence that the Le-Zoo Board is valid, positively received, and associated with short-term improvement in English animal-vocabulary reading. Because the study involved a small one-group sample, causal and comparative interpretations should be made cautiously.</i>

1. Introduction

English vocabulary reading is an important foundation for communication and second-language development. For students with autism, learning to recognize written word forms, connect them with meanings, and produce understandable pronunciation may require more explicit, structured, and individualized support

than is typically available in conventional classrooms. Previous research has reported challenges in English vocabulary learning among students with autism, including limited attention, differences in communication and social interaction, and difficulty connecting written forms with meanings and pronunciation (Brahim, 2022; Hashim et al., 2022; Hidayati & Amalia, 2025). These differences do not imply a uniform learning profile; rather, they highlight the need for flexible instructional media that can be adjusted to individual strengths and support needs.

Technology-supported and multisensory media offer one possible response to these needs. Augmented reality can connect printed markers with three-dimensional visualizations and audio, thereby making vocabulary referents more concrete and allowing repeated exposure to word forms and pronunciation (Jalaluddin et al., 2020). Multisensory learning that coordinates visual, auditory, and hands-on activity may also support attention and participation when it is carefully designed and not overstimulating (Nurjanah et al., 2024). In English language education, technology is most useful when it serves a clear pedagogical purpose rather than functioning as an isolated novelty (Masruddin, 2014). Development studies in other subject areas likewise show that mobile and Android-based media can be designed through systematic development models and evaluated through expert validation and learner responses (Bani & Masruddin, 2021).

Game-based formats provide an additional structure for repeated vocabulary practice. Research in Indonesian EFL contexts has shown that vocabulary activities organized through brainstorming, treasure-hunt games, and web-based games can support active participation and vocabulary learning (Annisa et al., 2022; Masruddin & Munawir, 2022; Nurpita et al., 2025). Studies of games and children also indicate that game design should be educationally purposeful, age-appropriate, and sensitive to the language and behavior that games may encourage (Munawir, 2019). Traditional games can also be integrated into learning when their rules and features are aligned with instructional competencies (Rustan & Munawir, 2020). These studies support the use of play as an instructional framework, but they do not directly address the specific needs of students with autism learning English animal vocabulary.

A closely related study developed Animal UNO (ANIMO), an augmented reality-assisted card medium for teaching animal-name vocabulary to a student with autism. That study reported improvement across classroom-action cycles and emphasized the value of visual, auditory, and hands-on support (Istiqomah & Mahabbati, 2019). However, the reviewed literature provides limited evidence on a single medium that combines an interactive board game, direct audio pronunciation, augmented reality cards, and English vocabulary-reading practice for students with mild autism. The present study addresses this practical gap through the development of the Le-Zoo Board. Its novelty lies in the integration of these features within one classroom learning medium, rather than in a claim that

no comparable work exists internationally.

The design was informed by a simple conceptual relationship: printed vocabulary and animal images provide visual cues; audio provides a pronunciation model; augmented reality provides an additional three-dimensional representation; and the board-game sequence organizes repeated practice in a predictable activity. Together, these components were expected to support word recognition, pronunciation practice, engagement, and recall. Social interaction was considered a possible affordance of the board-game format, but it was not measured as an outcome in this study.

Accordingly, this study aimed to develop and preliminarily evaluate the Le-Zoo Board as a learning medium for English animal-vocabulary reading among students with mild autism. The study addressed three questions: (1) How valid is the Le-Zoo Board according to material and media experts? (2) Is there a statistically significant difference between students' pre-test and post-test scores after using the medium? and (3) How do students respond to the practicality and learning experience provided by the medium?

2. Method

This study used a research-and-development approach guided by the ADDIE model: analysis, design, development, implementation, and evaluation (Branch, 2009). ADDIE provides a systematic sequence for identifying learning needs, designing and producing a learning medium, implementing it with intended users, and evaluating the resulting product. The development process was accompanied by an embedded one-group pre-test–post-test product trial. Expert validation and student responses were used to assess product validity and practicality, while the paired pre-test and post-test scores were used to examine short-term change after implementation. This design does not include a comparison group and therefore does not establish causal superiority over conventional instruction.

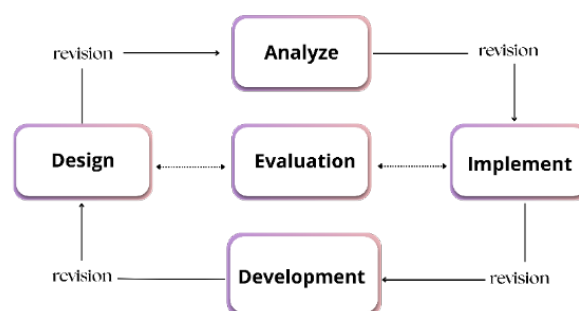


Figure 1. ADDIE model adapted from Branch (2009)

The study was conducted at a special school serving students with autism in Yogyakarta. The population consisted of students classified by the school as having mild autism. Eleven students participated in the product trial. Purposive

sampling was used because the selected group was accessible, was beginning to develop English vocabulary-reading skills, and had learning needs relevant to the use of interactive media.

The product developed in this study was the Le-Zoo Board, an interactive medium combining a board-game format, sensory audio, and augmented reality cards accessed through a mobile device. The content focused on English animal vocabulary. The board and cards presented pictures, written animal names, brief information about animal characteristics, and audio pronunciation. The augmented reality component was created using Assemblr Studio, while the printed board and card layouts were designed using Canva.

During the analysis stage, classroom observation and discussions with special education teachers were used to identify learning problems, material needs, and relevant competencies. The observations indicated that English instruction relied mainly on paper-based pictures and that teachers needed more interactive support for vocabulary reading. Animal vocabulary was selected after consultation with the accompanying teachers.

The product was evaluated by one material expert and one media expert. The material-expert instrument covered material, language, and presentation. The media validation results were reported for design, learning, and usability. Each expert provided quantitative scores, and the media expert also provided a qualitative suggestion concerning the color of the card lettering.

Table 1. Material-expert validation instrument

No.	Aspect	Indicator
1	Material	Completeness of the material
		Alignment with learning objectives
		Alignment with learning outcomes
2	Language	Appropriate use of language conventions
3	Presentation	Engaging presentation of the material
		Alignment between material and illustrations

A pre-test and post-test were administered to examine students' English vocabulary-reading performance before and after using the Le-Zoo Board. The test focused on English animal-name vocabulary corresponding to the product content. The same participants completed both measurements, making the data paired.

A ten-item student-response questionnaire was used to assess practicality and the learning experience. The questionnaire used a five-point Likert scale: strongly agree (5), agree (4), neutral (3), disagree (2), and strongly disagree (1). The accompanying teacher assisted students in completing the questionnaire. The indicators covered learning interest, ease of use, and perceived learning benefits.

Table 2. Student-response questionnaire indicators

No.	Aspect	Indicator
1	Learning interest	Appeal of the medium
		Enjoyment during learning
2	Ease of use	Ease of playing the board game
		Ease of using the augmented reality features
		Clarity of the audio
3	Learning benefits	Support for vocabulary reading
		Support for vocabulary recall
		Motivation to relearn the vocabulary

The product trial involved the 11 participating students and was supported by school teachers. Students listened to and observed the English animal words activated by the audio features, viewed the printed or augmented reality representations, and repeated the pronunciation. The board-game sequence was used to organize the learning activity. Pre-test and post-test scores were collected before and after implementation, and the questionnaire was completed during the evaluation stage.

Expert-validation scores were converted to percentages by dividing the score obtained by the maximum possible score and multiplying by 100. The original interpretation ranges were corrected so that each category had a clear and nonoverlapping interval.

Table 3. Percentage interpretation criteria

No.	Percentage	Interpretation
1	81%–100%	Very good / very valid
2	61%–80%	Good / valid
3	41%–60%	Fair
4	21%–40%	Poor
5	0%–20%	Very poor

The pre-test and post-test results were analyzed using a paired-samples t-test because the two scores came from the same participants. Statistical significance was evaluated at the .05 level. The submitted manuscript also stated that a normality test was used, but the normality result was not reported. The student-response percentage was calculated by dividing the total obtained score by the maximum possible score and multiplying by 100. A score of at least 70% was interpreted as practical (Cahya et al., 2020).

3. Result

The needs analysis identified three areas: student characteristics and learning problems, material needs, and competency needs. Classroom observations indicated that English learning relied largely on conventional paper

pictures and provided limited interactive support. Teachers expressed a need for a medium that could support English vocabulary reading while maintaining students' interest. Following discussion with the accompanying teachers, simple animal vocabulary was selected as the content focus. These findings informed the development of a structured board game integrating visual, auditory, and augmented reality features.

The design stage included development of the board layout, the cards, the augmented reality content, and the learning activity sequence. The board and cards were designed in Canva, while Assemblr Studio was used to create the augmented reality objects and audio. The board used a simple blue-and-white layout. Based on discussion with the accompanying teacher, the design used ladders without descending snakes to reduce the possibility of frustration when students were required to move backward.



Figure 2. Le-Zoo Board design

The board contained ten animals: lion, snake, giraffe, deer, butterfly, dolphin, leopard, elephant, tiger, and monkey. Animated and realistic animal images were combined to retain visual appeal while also presenting recognizable representations. When a student's game piece reached a relevant square, the audio feature produced the English pronunciation of the animal name. The design therefore allowed repeated exposure to the printed word and its pronunciation.



Figure 3. Le-Zoo card design

Each card corresponded to one of the ten animals. The cards included the English vocabulary item, an animated animal image, brief information about the animal, and an augmented reality marker. When scanned through Assemblr Studio, the marker displayed a three-dimensional animal visualization and audio pronunciation. These features were intended to support vocabulary recognition and pronunciation practice through coordinated visual and auditory input.

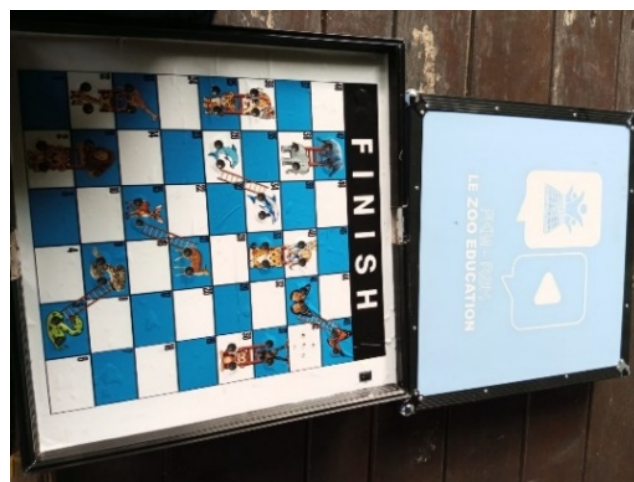


Figure 4. Developed Le-Zoo Board medium

After the prototype was produced, it was reviewed by a material expert and a media expert. The material expert evaluated material, language, and presentation, while the media expert evaluated design, learning, and usability.

Table 4. Material-expert validation results

No.	Aspect	Average result	Criteria
1	Material	93%	Very valid
2	Language	100%	Very valid
3	Presentation	100%	Very valid
	Overall average	97.6%	Very valid

The overall material-validation score was 97.6%, categorized as very valid. The material aspect received 93%, while language and presentation each received 100%. No qualitative revision was reported by the material expert.

Table 5. Media-expert validation results

No.	Aspect	Average result	Criteria
1	Design	91%	Very valid
2	Learning	100%	Very valid
3	Usability	100%	Very valid
	Overall average	97%	Very valid

The overall media-validation score was 97%, categorized as very valid. Design received 91%, while learning and usability each received 100%. The media expert recommended changing the card lettering from black to a brighter color, such as green or yellow. The card was revised by changing the lettering to bright green.

Table 6. Media revision based on expert feedback

No.	Before revision	After revision
1	 Black lettering	 Bright green lettering

The Le-Zoo Board was implemented with 11 students with mild autism, with assistance from school teachers. During the activity, students listened to the vocabulary pronunciation generated by the audio feature, observed the visual representations, and repeated the words. A paired-samples t-test was used to compare the pre-test and post-test results.

Table 7. Paired-samples *t*-test for pre-test and post-test scores

Mean difference (pre-post)	SD of difference	SE	95% CI	t	df	p
-44.545	9.342	2.817	[-50.821, -38.269]	-15.815	10	< .001

The mean pre-test minus post-test difference was -44.545, indicating that the post-test scores were higher by an average of 44.545 points. The difference was statistically significant, $t(10) = -15.815$, $p < .001$, with a 95% confidence interval from -50.821 to -38.269. This result indicates a significant short-term pre-post improvement after implementation of the Le-Zoo Board. Because the study did not include a comparison group, the result should not be interpreted as proof that the medium was superior to conventional instruction.

During evaluation, the final expert-recommended revision was incorporated, and student responses were analyzed. The questionnaire contained ten items scored from 1 to 5. The accompanying teacher assisted students in completing the questionnaire.

Table 8. Student-response questionnaire result

Score obtained	Maximum possible score	Percentage
480	550	87.27%

The total student-response score was 480 of a possible 550, equivalent to 87.27%. This value exceeded the 70% practicality criterion and therefore indicated a positive response to the medium. The percentage represents the proportion of the maximum possible questionnaire score; it should not be interpreted as the percentage of individual students who responded positively. The responses indicated that the medium was engaging, understandable, and useful for vocabulary practice.

4. Discussion

The study produced an English vocabulary-learning medium that integrated a board game, audio pronunciation, and augmented reality cards. The expert-validation results indicate that the submitted product was judged highly appropriate in terms of material, language, presentation, design, learning support, and usability. These results support the feasibility of continuing the product beyond prototype development. They should nevertheless be interpreted as expert judgments rather than direct evidence of long-term learning effectiveness.

The design of the Le-Zoo Board is consistent with the pedagogical rationale for multisensory and technology-supported learning. Written vocabulary and animal images provide visual anchors, audio supplies a repeatable pronunciation model, and augmented reality adds a concrete three-dimensional representation. Such coordination can help learners connect word forms with referents and sounds. This interpretation is compatible with research emphasizing visual and auditory

support for students with autism (Hashim et al., 2022; Nisrina et al., 2025) and with studies reporting the practicality of mobile augmented reality for vocabulary learning (Jalaluddin et al., 2020). The present study extends this line of work by placing these features within a predictable board-game sequence.

The game-based format may also have supported repeated practice and participation. Research in Indonesian EFL settings has reported benefits from structured vocabulary games and collaborative vocabulary activities (Annisa et al., 2022; Masruddin & Munawir, 2022). More recent development work has similarly shown that web-based games can be designed to increase motivation in vocabulary learning (Nurpita et al., 2025). The current medium differs from these studies in its target learners and its integration of physical and augmented reality components. However, the findings do not demonstrate that all game features were equally influential, and the study did not directly measure engagement behavior or social interaction.

The statistically significant pre-post difference indicates that the participants performed better after the learning activity. The magnitude of the reported mean difference is substantial within this sample, but the one-group design leaves several alternative explanations, including repeated testing, teacher support, familiarity with the vocabulary, and novelty effects. Consequently, the result provides preliminary evidence of short-term improvement associated with the intervention rather than definitive causal evidence. A comparison group, longer implementation, and delayed retention test would be needed to evaluate relative effectiveness and sustained learning.

The student-response score of 87.27% indicates that the product was positively received and met the study's practicality threshold. Positive responses are educationally relevant because a medium for students with autism must be usable and sufficiently comfortable to sustain participation. Nonetheless, teacher assistance during questionnaire completion may have influenced the responses, and the manuscript did not report questionnaire reliability. Future evaluation should include structured observation, teacher ratings, and, where appropriate, accessible learner-response procedures that reduce response bias.

The study has practical value for special education and English language teachers seeking a structured medium for limited sets of concrete vocabulary. The product may be particularly suitable for guided practice in which teachers control sensory load, model the activity, and adjust the pace to individual learners. Its use should not be generalized to all students with autism without individual assessment. The findings are also limited by the small sample, one school, one-group design, unspecified intervention duration, focus on ten animal words, absence of a delayed test, and incomplete reporting of instrument validation and ethical procedures. Social interaction was not measured and should therefore be treated as a potential design affordance rather than a demonstrated outcome.

5. Conclusion

This study developed and preliminarily evaluated the Le-Zoo Board, an English animal-vocabulary learning medium combining a board game, sensory audio, and augmented reality cards for students with mild autism. The development followed the ADDIE stages of analysis, design, development, implementation, and evaluation. Material-expert validation reached 97.6%, and media-expert validation reached 97%, with both results categorized as very valid. The paired-samples test showed a significant pre-post difference, $t(10) = -15.815$, $p < .001$, and the student-response score reached 87.27% of the maximum possible score.

These findings indicate that the product was judged valid, was positively received, and was associated with short-term improvement in the English animal-vocabulary reading performance measured in this sample. The findings do not establish superiority over conventional instruction or effectiveness for broader English reading skills. The contribution of the study lies in the integration of physical game play, audio pronunciation, and augmented reality within one structured medium designed for a specific special-education context.

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