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This letter is to confirm that the following manuscript:

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Augmented Reality as a Pedagogical Tool: Flashcards for English Vocabulary in Early Childhood

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ABSTRACT

This study is motivated by challenges in early childhood English vocabulary acquisition, where conventional pedagogical tools remain prevalent, often resulting in inefficient learning. Problem analysis reveals that limited media diversity and minimal integration of digital technology contribute to low learner engagement. A needs assessment further underscores the demand for visual, interactive learning media aligned with early childhood developmental characteristics. Market analysis indicates a scarcity of Augmented Reality (AR)-based flashcard media designed for English vocabulary introduction in early childhood education. Consequently, this research aims to develop and evaluate the feasibility of AR-based flashcard learning media for this purpose. Employing a Research and Development (R&D) methodology structured around the ADDIE model, the study involved 16 children from Group TK B at PAUD Hidayatullah Nagan Raya. Evaluation results demonstrated high feasibility, with validation scores from media experts (97.5%) and material experts (100%) exceeding the positive response rates from children (91.7%–100%); all metrics fell within the "very feasible" category. Implementation challenges included unstable internet connectivity, extended AR scanning durations, and a shortage of supporting devices. Despite these limitations, the findings conclude that Augmented Reality-based flashcards represent a highly viable and effective medium for introducing English vocabulary to young learners.

Keywords: Augmented Reality, Flashcard, English Vocabulary, Early Childhood

1. Introduction

Language serves a fundamental role in human life, functioning as an essential tool for thought, communication, and the expression of emotions and ideas (Ningrum et al., 2024). Within education, language extends beyond being a subject of study to become a vital instrument for developing students' social, emotional, and cognitive capacities (Mazidah et al., 2025). English occupies a particularly strategic position in this global context. As the predominant international language, it is extensively utilized in worldwide developments in science, technology, and communication (Lubis et al., 2024). Consequently, proficiency in English represents a critical competency that must be cultivated from an early age.

The introduction of English in early childhood is particularly appropriate, as this period represents an optimal stage for language development. Children aged 0 to 6 years are within the "golden age" a critical phase marked by the brain's rapid capacity for absorbing information (Angelica, 2023). During this window, children are naturally predisposed to acquire the sounds, vocabulary, and meanings of language through direct experience. Supported by language acquisition theory, learning occurs most effectively through interaction, repetition, and meaningful context rather than through rote memorization (Pransiska, 2020). Consequently, introducing English vocabulary from an

early age can help children establish a more intuitive and sustainable foundation for second-language proficiency.

Introducing vocabulary to children helps them speak and communicate with each other (Chaniago et al., 2021). All aspects of language skills are interrelated and are very important for the ability to send and receive information during the communication process (Harianto, 2020). Children can learn and use language skills if they have mastered the language. When young children acquire good language skills, they will more easily understand the intentions and messages of others (Dini Hari et al., 2021)

However, the effectiveness of English vocabulary learning in young children is heavily influenced by the media and teaching strategies employed. Young children learn through play, are easily bored, and respond well to engaging visuals (Losi & Ferusgel, 2021). Therefore, selecting appropriate learning media is crucial for creating effective learning experiences. Learning media are tools or means used to convey educational messages, aiming to increase students' attention, interest, and understanding (Ani Daniyati et al., 2023). They also assist teachers in delivering content and making abstract concepts more tangible (Hasan et al., 2021).

Various media can support young children in learning English, including picture cards, educational games, and visual and audio materials (Aulia & Putro, 2024). Choosing the right media is expected to foster an enjoyable learning environment and enhance children's active participation in English lessons. Media that prioritize visual elements are particularly suitable, as they capture children's attention and aid vocabulary retention (Shabrina et al., 2025).

One widely used visual medium for teaching English vocabulary to young children is flashcards. Flashcards are picture cards that contain text, symbols, or illustrations, helping children remember and understand vocabulary through visual association (Warda & Kumalasari, 2023). This medium is considered practical because it is simple, easy to use, and aligns with the visual learning characteristics of early childhood. However, conventional flashcards have limitations, particularly in creating interactive and immersive learning experiences. This gap calls for innovative learning media that are more engaging and in tune with technological developments.

The evolution of learning media has been propelled by digital technology, including Augmented Reality (AR) (Dini Hari et al., 2021). AR technology integrates two-dimensional or three-dimensional virtual objects into the real world in real time, allowing users to interact with these objects as if they were physically present (Ismayani, 2020). AR can enhance early childhood education by offering more concrete, engaging, and immersive learning experiences, thereby increasing children's attention and motivation to learn (Rondi & Amrullah, 2025). The use of AR-based flashcards as an innovative pedagogical tool bridges the gap between traditional methods and interactive, enjoyable learning.

AR flashcards enable children to see objects in three-dimensional form and hear vocabulary pronunciation, allowing them to not only see but also hear and understand

words in context (Padwika et al., 2023). This medium aligns with multisensory learning theory, which posits that learning is more effective when it engages multiple senses. Observations at Hidayatullah Preschool (PAUD) indicate that English vocabulary instruction still relies on conventional media such as whiteboards, posters, and simple songs. The school has not yet fully utilized digital learning media, resulting in monotonous and uninteresting lessons. Children quickly lose interest, and their English vocabulary remains limited. This situation underscores the need for innovative learning media to boost children's engagement and comprehension in English instruction.

Numerous previous studies have demonstrated that Augmented Reality-based learning media are effective, valid, and practical for early childhood education. Research by Elvina et al. (2024) shows that AR-based thematic flashcards are valid and effective in enhancing the learning experience of children aged 5-6 years. Aisyah and Wiranti (2024) also proved that using AR flashcards significantly improves student learning outcomes. Additionally, Utami et al. (2021) reported that AR-based flashcard media effectively increase attention and focus in early childhood learning.

In line with these studies, this research also develops innovative AR flashcard media for learning. However, it differs in its focus on developing media specifically to introduce English vocabulary to young children using the ADDIE model. This study emphasizes feasibility testing by verifying the media with material experts, media experts, and teacher practitioners. Furthermore, the developed media includes three-dimensional audio and visual vocabulary pronunciations tailored to children's characteristics and learning experiences. Thus, this research not only confirms the feasibility of AR media but also contributes to developing appropriate and suitable learning tools for early childhood.

Based on this background, it is essential to develop Augmented Reality-based flashcard learning media for teaching English vocabulary to young children. It is hoped that this media will not only help children learn English vocabulary in an enjoyable way but also assist educators in creating a learning environment that is innovative, interactive, and aligned with the demands of the digital era. This research aims to contribute to the development of English language learning theory and practice in early childhood education.

2. Method

This research uses development research, also known as Research and Development (R&D). The ADDIE model used in this study includes analysis, design, development, implementation, and evaluation (Waruwu, 2024).



Figure 1. ADDIE Model Product Development Stages

This study involved 16 children from Kindergarten Group B at Hidayatullah Early Childhood Education (PAUD) Nagan Raya as research subjects who participated in a media trial during the odd semester of the 2025/2026 academic year. The trial was conducted on a medium scale due to the number of students involved (Jailani, 2023).

The data collection techniques in this study used observation and feasibility testing. The instruments used to collect data were an observation sheet and a feasibility testing questionnaire. The observation sheet was used to analyze needs. Then, a questionnaire was used to evaluate the feasibility of the developed AR flashcard for teaching English vocabulary to early childhood. Product feasibility was assessed using a percentage score; a higher score indicates a more feasible product (Dewi, 2020). The usability of this AR flashcard learning media was evaluated through assessments from material and media experts, and the media's feasibility was also tested in the field by teachers. The material expert validator was a lecturer from the Early Childhood Islamic Education Study Program, the media expert validator was a lecturer from the Information Technology Education Study Program, and the media and material validator were a teacher practitioner at Hidayatullah Early Childhood Education School to measure the feasibility of the AR flashcard learning media.

The data analysis technique used was product feasibility analysis. The steps for analyzing the product's feasibility criteria being developed included calculating the feasibility percentage using a Likert Scale (Sugiyono 2016, cited in Mahardika, et al, 2022)

The formula used is as follows:

$$NP = \frac{R}{SM} \times 100\%$$

Sugiyono 2016, cited in (Happynis et al., 2025)

Description:

- NP : Percentage value sought
- R : Score from the respondent's answer
- SM : Maximum score from the test used

Table 1 presents a classification of learning media feasibility criteria based on the percentage of assessment scores. These criteria serve as a basis for assessing the feasibility of the developed product, enabling evaluation results to be categorized systematically and quantitatively.

Table 1. Feasibility Criteria

Percentage	Criteria
82%-100%	Highly feasible
63%-81%	Feasible
44%-62%	Less feasible
25%-43%	Not feasible

Sugiyono 2017, cited in (Utami et al., 2021)

Table 2 presents the assessment instruments used by media experts to evaluate the quality of AR-based flashcard media. The assessment covers aspects of visual appearance, material safety, size, colour compatibility, and ease of use in supporting early childhood learning.

Table 2. Media Expert Validation Rubric

Aspects assessed	Assessment Indicators
Cover	The Augmented Reality Flashcard display is appropriate and engaging for children
Material	The safety level of the materials used is appropriate and safe for children.
Size	The size of the Augmented Reality Flashcard is appropriate and safe for children
Colour	The colours on the Augmented Reality Flashcard are appropriate and engaging for children.
Use of Flashcard (AR) media	The use of Augmented Reality Flashcards in learning is appropriate for children

(Fitriani et al., 2021)

Table 3 explains the assessment indicators used to assess the suitability of the material presented in the Augmented Reality flashcard media. The evaluation was conducted by considering the material's suitability to the learning objectives, the English vocabulary introduction theme, the developmental level of the early childhood, and the clarity of the presentation.

Table 3. Material Experts Validation Rubric

Assessment Indicators
The material presented in the Augmented Reality Flashcards is tailored to the desired learning objectives.
The material presented in the Augmented Reality Flashcards aligns with the learning theme, namely introducing English vocabulary for early childhood, and is presented in an engaging way.
The material in the Augmented Reality Flashcards is tailored to the child's developmental age.
The material presented is clear and aligns with the title of the Flashcard.
The material presented in the Augmented Reality Flashcards is tailored to the desired learning objectives.

(Fitriani et al., 2021)

Table 4 presents the indicators used to measure children's responses to AR-based flashcard media. These indicators include children's ability to understand vocabulary, remember information, and improve their listening and pronunciation skills in English.

Table 4. Rubric for Children's Response

Assessment Indicators
Children are able to understand and recognize the vocabulary contained on the Flashcards
Children are able to remember and repeat the information on the flashcards well.
Children are able to improve their listening and pronouncing skills on the vocabulary contained in the Flashcards.

(Fitria Anggriani et al., 2024)

3. Results and Discussion

This research produces a product, which is a Flashcard learning media, converted into an Augmented Reality (AR) Flashcard, namely a flashcard that displays 3D images when scanned by a cell phone (Anggreani & Satrio, 2021). This media was developed to introduce English vocabulary to young learners at Hidayatullah PAUD, Nagan Raya. To measure the media's feasibility, validation tests were conducted by material experts, media experts, and ECE teacher practitioners, as well as trials with children aged from five to six years old of a Kindergarten at Nagan Raya Regency.

In the analysis phase, researchers conducted a field needs analysis of the use of English vocabulary learning media at Hidayatullah Early Childhood Education (PAUD). The analysis results showed that the learning process is still dominated by conventional media, such as whiteboards, songs, and posters. Based on initial observations, schools have not yet utilized digital-based learning media, so vocabulary learning tends to be less varied and has the potential to reduce children's interest in learning. This condition indicates a need for more innovative and engaging learning media for early childhood. Furthermore, market analysis results indicate that Augmented Reality (AR)-based

Flashcard media for introducing English vocabulary to early childhood learners is not yet widely available. These findings indicate the need for innovative AR Flashcard media that is appropriate to the developmental characteristics of early childhood (Rifqy & Wahyudi, 2025).

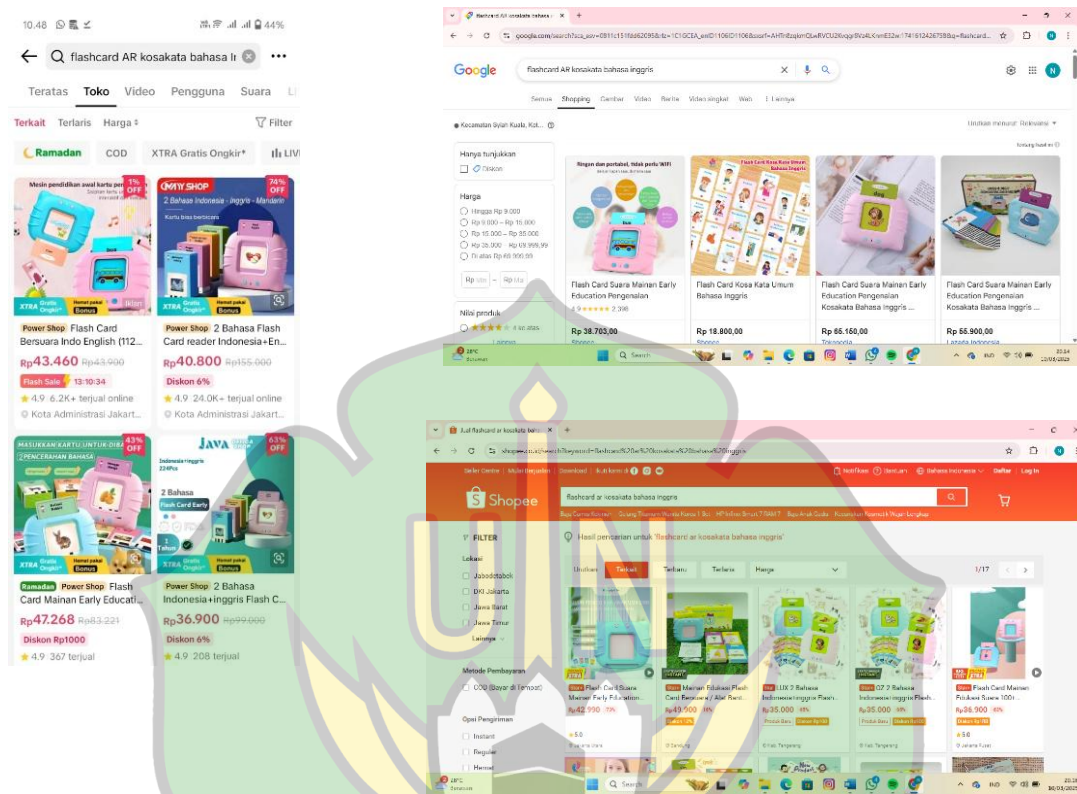


Figure 2. Market Analysis (TikTok Shop, Google, and Shopee)

In the design stage, researchers adapted the Augmented Reality (AR)-based Flashcard media to the learning needs and characteristics of early childhood. This included determining English vocabulary content, creating visual illustrations for the Flashcards, and planning the use of Augmented Reality technology to support learning. Furthermore, the media usage flow was designed in a way that was easy for both teachers and children to understand (Sukmawan et al., 2024). At this stage, a Flashcard media design plan based on Augmented Reality (AR) was developed, which became a reference for the next development stage.

In the development phase, the Flashcard media has been adapted to Augmented Reality (AR)-based development. Flashcard visuals were developed using the Canva app, and AR technology was integrated through the Assemblr EDU app. This media displays interactive visual objects and includes audio pronunciations of English vocabulary that correspond to those objects (Karina Firstiary, 2025)

**Before Revision
Cover and Box**



**After Revision
Cover and Box**

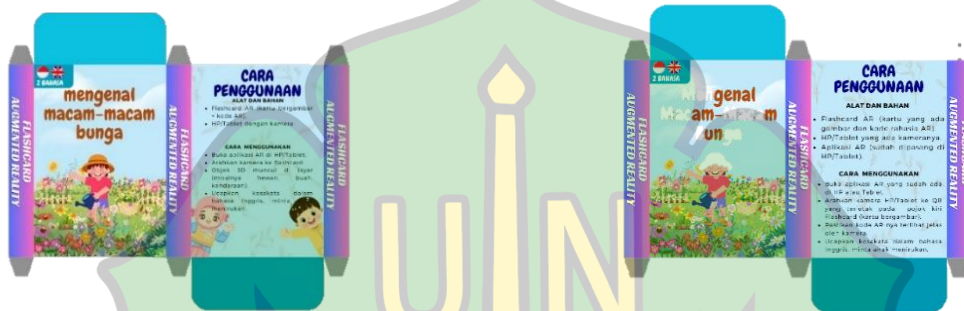


Figure 3. Cover and box before and after revision

**Before Revision
Front and Back Views**



daisy
bunga daisy



MARKER QR



MARKER QR



Daisy
Bunga Aster

Bunga Aster (Si Matahari Kecil)

Anak-anak, coba perhatikan bunga ini. Ini adalah bunga aster.
 • Bunga aster memiliki batang yang tegak dan berwarna hijau.
 • Daunnya kecil, memanjang, dan bergergi di pinggirnya.
 Sekarang lihat bunganya.
 • Bunga aster berbentuk bulat seperti matahari kecil. Di tengah bunga ada bagian bulat berwarna kuning. Di sekelilingnya ada kelopak-kelopak kecil yang panjang.
 • Kelopak bunga aster bisa berwarna ungu, merah muda, putih, atau biru. Bunga aster tumbuh berkelompok, jadi sering terlihat banyak bunga bersama-sama. Bunganya ringan dan lembut saat dilihat. Bunga aster membuat taman terlihat cerah dan indah.

Figure 3. Front and back view before and after revision

The results of this development stage after revision are: 1) The cover was simplified by removing one tree element. 2) The animated image of a child on the box was removed. 3) The front of the flashcard features a flower illustration, a photo of a real flower, and an AR barcode. 4) The back contains a brief description of the flower. 5) The media is equipped with an audio pronunciation of the flower name.

Table 5. Media Expert Validator Results

Aspect	Category	Quantity
Lecturer Media	Total Score	20
	Maximum Score	20
Teacher Media	Total Score	19
	Maximum Score	20
	Percentage Results	97,5% Highly feasible

The results of the validation by media experts from lecturers and teacher practitioners in Table 4 show that flashcards (AR) are very suitable for teaching English vocabulary to early childhood.

Table 6. Results of the Validator of Material Experts

Aspect	Category	Quantity
Lecturer Material	Total Score	16
	Maximum Score	16
Teacher Material	Total Score	16
	Maximum Score	16
	Percentage Results	100% Highly feasible

Table 5 shows that the expert validation results indicate that the material presented in the Augmented Reality flashcard media aligns with the learning objectives, the English vocabulary introduction theme, and the developmental characteristics of early childhood. The assessment percentage obtained is in the very appropriate category; thus, the material is deemed appropriate and can be used in the learning process.

Based on the validation results from media and material experts presented in Tables 5 and 6, the Augmented Reality (AR)-based flashcard media achieved a very suitable percentage. These results indicate that the developed media meet the criteria for visual appearance, material suitability, and ease of use in learning activities. The interactive, engaging AR-based flashcard design can increase young children's attention and help them understand and master English vocabulary (Saputra et al., 2025). Thus, AR Flashcards can be used as a viable alternative learning medium for introducing English vocabulary to young children. After this development, the AR Flashcards were created, ready for use in the learning process and tested in the next stage.

In the implementation phase, Augmented Reality (AR)-based flashcards media was applied in English vocabulary learning activities at Hidayatullah Early Childhood Education (PAUD). Educators used the media, directly involving 16 students in the learning process (Saputra et al., 2025). During the lesson, students demonstrated high enthusiasm and active engagement when the teacher introduced and explained how to use AR flashcards. The students appeared captivated by the three-dimensional visuals and

animations that emerged from the flashcards, which focused their attention on the material being presented (Novita Resti, Ridwan, Riska Trian Palupy, Ridwan, 2024).

Furthermore, students followed the instructions well, such as observing the displayed AR objects and naming English vocabulary according to the images. This active engagement demonstrates that the AR flashcard media can create a fun, interactive learning atmosphere aligned with the developmental characteristics of early childhood. This supports the understanding of English vocabulary and increases students' motivation during learning. The implementation phase showed that the AR flashcard media can be used appropriately as a supporting medium for early childhood English learning.

Table 7. Percentage Details of Child Trial Results

Respondents	P1-P3 Statements			Total Score	Maximum Total	Percentage
	P1	P2	P3			
CAJ	4	4	4	12	12	100%
ANO	4	4	4	12	12	100%
ENP	4	4	4	12	12	100%
NH	4	4	4	12	12	100%
KA	4	4	4	12	12	100%
AF	4	4	4	12	12	100%
AA	4	4	4	12	12	100%
AKM	4	4	4	12	12	100%
KH	4	3	4	11	12	91,7%
MG	4	4	4	12	12	100%
AR	4	4	4	12	12	100%
ASA	4	4	4	12	12	100%
ANR	4	4	3	11	12	91,7%
ANH	4	4	4	12	12	100%
NSR	4	4	4	12	12	100%
ER	4	4	3	11	12	91,7%

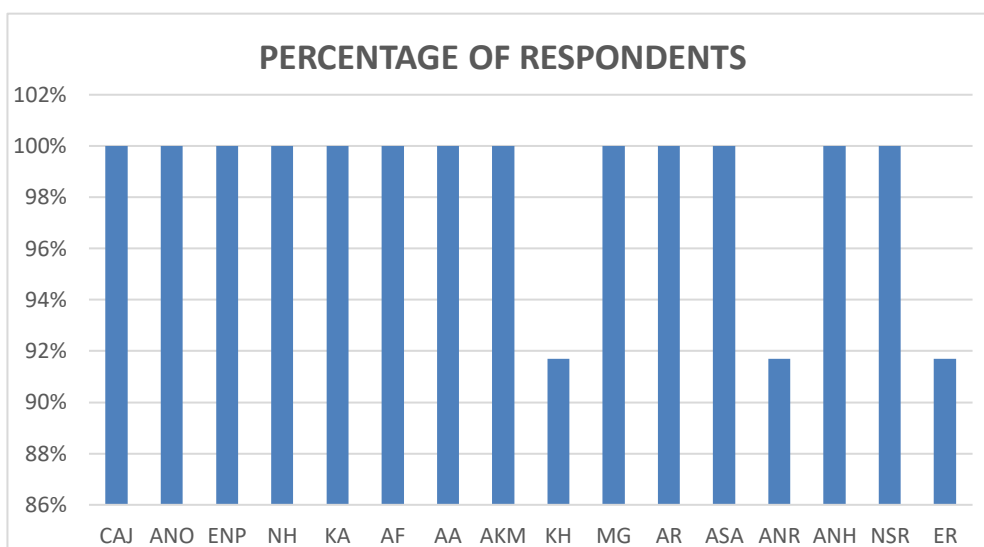


Figure 4. Percentage of Respondents

The evaluation phase examined the use of Augmented Reality (AR) Flashcard media during learning activities, including technical constraints and student responses. Based on the observation results, several obstacles were identified during media implementation, including an unstable internet connection, which caused the AR barcode-scanning process to experience a relatively long loading time. In addition, when children waited for their turn to scan, some appeared a little noisy and less orderly. There were also instances in which children gathered to watch the scanning process simultaneously, which disrupted the lighting and affected the appearance of the AR object on the cell phone screen. Nevertheless, when the scanning process succeeded and the Augmented Reality object appeared, the children showed great enthusiasm. This was shown through expressions of amazement and spontaneous comments such as "Miss, how come it can appear on the cell phone but not on the card," "Miss has a voice," and "Great, Miss, it can appear like that, cool."

These responses show that AR Flashcard media is able to attract attention, arouse curiosity, and provide meaningful learning experiences for early childhood (Dhea Meichika, 2025). Despite technical constraints during implementation, Augmented Reality-based Flashcard media is still considered feasible and effective in creating interactive and enjoyable English vocabulary learning (Saputra, et. al., 2025). Thus, children's responses and behaviour during the use of AR Flashcard media reflect the important roles of the learning environment and concrete stimuli, and it is relevant to analyze them based on theories of language acquisition and children's cognitive development.

Behaviourist theory emphasizes the importance of the external environment for children's language acquisition. Consistent with the theory that children acquire language from their surroundings, young children find it easier to remember concrete English vocabulary related to their experiences (& Warmadewi, 2021). Based on Jean Piaget's cognitive theory, which holds that early childhood is in the pre-operational stage and that children need concrete objects to acquire knowledge and understanding of language,

Augmented Reality (AR) - based Flashcards help children learn English by providing visual and audio stimulation (Khotimah & Agustini, 2023).

Children's language acquisition is influenced by innate abilities, as well as environmental factors. Noam Chomsky's theory holds that children have language abilities from birth, which develop only with the right stimulation from their environment (Dash, 2023). Thus, AR Flashcards are the right media because they can optimize children's innate potential by supporting a concrete, interactive, and developmentally appropriate learning environment.

The results of the development process in this study indicate that Augmented Reality (AR)-based Flashcard media is highly suitable for teaching English vocabulary to young children. By integrating three-dimensional visuals and audio vocabulary pronunciation, this media has the ability to produce a concrete, interactive, and engaging learning experience. These findings indicate that AR Flashcards not only support young children's learning but also align with language acquisition theories that emphasize the roles of the environment, multisensory stimuli, and concrete objects in helping children better understand and remember English vocabulary.

4. Conclusion

The research results show that the Augmented Reality (AR) flashcard learning media developed using the ADDIE model is highly suitable for introducing English vocabulary to young children. The integration of audio pronunciation and three-dimensional visuals makes learning more concrete, interactive, and engaging. Validation results from material experts yielded a 97.5% score and from media experts a 100% score, indicating that the media meets the requirements for visual appearance, material suitability, and ease of use.

Trial results with young children showed a very positive response, with scores of 91.7%–100%, indicating that children are able to understand, remember, and pronounce English vocabulary well. However, its implementation still faces several challenges, including limited access to free, fully accessible AR images, teachers' readiness to use technology-based media, unstable internet connections, and limited learning time. Therefore, further development is needed to optimize the use of the media.

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