International Journal Software Engineering and Computer Science (IJSECS)
4 (1), 2024, 81-90
Published Online April 2024 in IJSECS (http://www.journal.lembagakita.org/index.php/ijsecs)
P-ISSN : 2776-4869, E-ISSN : 2776-3242. DOI: https://doi.org/10.35870/ijsecs.v4i1.2179.

RESEARCH ARTICLE Open Access

Implementation of Augmented Reality to Enhance Alphabet Letter Understanding at Paud Bintang Jonggol

Sri Lestari
Informatics Engineering Study Program, Faculty of Computer Technology, Sekolah Tinggi Ilmu Komputer Cipta Karya Informatika, East Jakarta City, Special Capital Region of Jakarta, Indonesia.
Email: sri.lestari1203@gmail.com.

Ratih Eldina *
Informatics Engineering Study Program, Faculty of Computer Technology, Sekolah Tinggi Ilmu Komputer Cipta Karya Informatika, East Jakarta City, Special Capital Region of Jakarta, Indonesia.
Corresponding Email: ratiheldina1234@gmail.com.

Divaretta K. Sumartha
Informatics Engineering Study Program, Faculty of Computer Technology, Sekolah Tinggi Ilmu Komputer Cipta Karya Informatika, East Jakarta City, Special Capital Region of Jakarta, Indonesia.
Email: divarettaa@gmail.com.

Nida Apipah
Informatics Engineering Study Program, Faculty of Computer Technology, Sekolah Tinggi Ilmu Komputer Cipta Karya Informatika, East Jakarta City, Special Capital Region of Jakarta, Indonesia.
Email: nina.apipah@idn.sch.id.

Received: January 29, 2024; Accepted: March 10, 2024; Published: April 1, 2024.

Abstract: Implementing Augmented Reality (AR) in Early Childhood Education (PAUD) promises children an interactive and immersive learning experience. In this study, we evaluate the potential of AR in improving the quality of early childhood education. AR can help PAUD educators create a more engaging learning environment where children can learn through games that support the development of motor skills and conceptual understanding. However, challenges such as access to technology, adequate teacher training, and appropriate curriculum planning need to be addressed. Policy support, comprehensive teacher training, and selecting the proper AR application are critical factors in implementing AR in PAUD. This technology has great potential to change how children learn and better prepare them for the future.

Keywords: Augmented Reality (AR); Early Childhood Education (ECE); Interactive; Learning Experience; Childhood Education.

1. Introduction

Early Childhood Education (PAUD) marks a vital preschool phase in a child's development before entering formal education at the elementary school level. In the age range from 0 to 6 years, children experience significant physical, mental, and emotional development. Therefore, early childhood education focuses on developing motor skills, emotional intelligence, intellectual intelligence, as well as language and communication skills. At an early age, children learn through play. However, it is essential to provide games that are not only entertaining but also educational value. Therefore, the use of interactive learning media is a necessity. One technology that promises to create exciting learning experiences is Augmented Reality (AR). By using AR, learning can be presented in a more exciting and interactive format because this technology allows visual objects to be displayed in a natural environment, both in 3D and 2D. This not only enhances children's imagination and creativity but also deepens their understanding of various concepts. The results of an interview with the head of the Bintang playgroup in Jonggol, Bogor, show that the process of learning letters in early childhood still uses conventional techniques with printed books. However, this is often ineffective because some children become disinterested and lose concentration. Therefore, the idea emerged of integrating AR technology into learning alphabet letters so that children could learn while playing.

The implementation of AR in early childhood education has been proven to improve learning outcomes, student motivation, and understanding of educational concepts. By integrating AR into the curriculum at PAUD Bintang Jonggol, educators can create a dynamic and interactive learning environment that meets the needs of young children. In addition, the development of AR-based learning media such as AR letter cards has proven effective in increasing children's understanding of various concepts. Implementing Augmented Reality (AR) can be a valuable tool for improving knowledge of the alphabet in Early Childhood Education at Bintang Jonggol. AR has been successfully used in educational settings to enhance learning outcomes, engagement, and motivation [1]. By incorporating AR technology, children can interact with digital content embedded in their natural environment, making the learning experience more immersive and engaging. In addition, the use of interactive media such as letter cards and visual aids has been proven to be effective in improving early reading skills in children [2]. This visual tool can help strengthen letter recognition and phonemic awareness, essential skills for understanding letters.

Additionally, the implementation of gamification techniques, such as those used in the Kahoot platform, has been proven to increase student engagement, motivation, and learning outcomes [3]. By incorporating game elements into the learning process, educators can make letter learning more fun and interactive for young children, which will ultimately improve retention and understanding of letter names and their sounds. Furthermore, collaborative learning models such as the Student Teams-Achievement Divisions (STAD) approach have been successful in improving conceptual knowledge in educational settings [4]. By encouraging collaboration among students, this model can promote a deeper understanding of letter concepts and their practical applications.

Early childhood education (PAUD) is an essential stage in a child's growth and development, and it helps them gain a solid initial understanding of various concepts, including the letters of the alphabet. In the era of information technology that continues to develop, technology is the key to increasing learning effectiveness. One promising technology to be applied in this context is Augmented Reality (AR). AR allows the integration of the natural world with digital elements, creating a more interactive and engaging learning experience for children [5]. Previous research shows that the application of AR in educational environments can increase the level of engagement, motivation, and understanding of learning concepts [6]. Using AR technology, alphabet learning at PAUD Bintang Jonggol can be presented in a more exciting and interactive format.

Furthermore, the development of AR-based learning media, such as AR flashcards, has proven effective in increasing young children's understanding of various concepts [7]. Therefore, this research explores the potential of applying AR to improve alphabet knowledge at PAUD Bintang Jonggol. Through AR technology, it is hoped that alphabet learning can be presented as more enjoyable, interactive, and effective for young children. Through this innovative approach, it is expected that a learning environment can be created that motivates and strengthens young children's understanding of the alphabet. By integrating AR technology, interactive media, gamification techniques, and collaborative learning models into the curriculum at PAUD Bintang Jonggol, educators can create a dynamic and engaging learning environment that facilitates a thorough understanding of the letters of the alphabet among young children. This approach is hoped to improve the quality of early childhood education and prepare them well to enter formal education at the next level.

2. Research Method

The development of interactive learning media that is engaging and enjoyable using Augmented Reality (AR) technology by leveraging the camera feature on smartphones is a promising approach to enhance educational experiences. This study adopts the Multimedia Development Life Cycle (MDLC) methodology, consisting of six stages: concept, design, material collection, assembly, testing, and distribution, based on the version proposed by Luther and Sutopo. The educational objectives, target audience, and content structure for the AR learning media are defined in the concept stage. Subsequently, in the design phase, the visual and interactive elements of the AR application are planned and created to ensure alignment with the educational goals. Material collection involves gathering relevant content, such as alphabet letters, interactive games, and audio-visual aids, to be integrated into the AR learning experience. During the assembly stage, the collected materials are combined to develop the interactive AR learning application. This phase entails programming and integrating the AR features with the smartphone camera functionality to create an immersive learning environment. Subsequently, the testing phase is crucial for evaluating the AR application's functionality, usability, and effectiveness in enhancing alphabet understanding among young learners. The distribution stage focuses on deploying the AR learning media to the target audience, in this case, the students at PAUD Bintang Jonggol. This stage involves ensuring accessibility and usability of the AR application on smartphones, providing necessary instructions for educators and students, and monitoring the implementation and impact of the AR learning media on alphabet understanding.

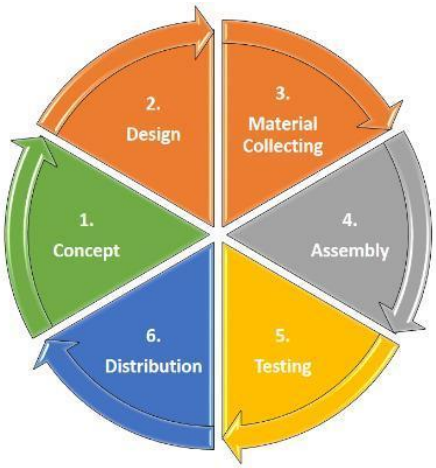

Figure 1. Multimedia Development Life Cycle (MDLC)

The Multimedia Development Life Cycle (MDLC) is a systematic approach to developing multimedia projects, encompassing various stages from conceptualization to distribution. This methodology provides a structured framework for creating interactive and engaging multimedia content. The MDLC typically comprises six key stages: concept, design, material gathering, assembly, testing, and distribution. This MDLC method is very suitable for the application system the author is researching because it includes the development of media applications which combine image, sound, video, animation, and other media. The explanation is as follows.

2.1 Concept

The concept stage involves defining the project's goals, objectives, target audience, and overall scope. The educational needs and requirements are identified during this phase, and the content structure and interactivity elements are outlined. At this stage, the author conducted research at the Bintang Playgroup about the obstacles experienced. It isn't easy to organize students to understand and learn alphabet letters using a conventional system of printed books. After the problem was studied, the author created a planning concept regarding problem-solving related to this matter by creating a 3D animation application for alphabet letters using Augmented Reality media to make learning more enjoyable so that students are more motivated to learn.

2.2 Design

In the design phase, the visual and interactive components of the multimedia project are planned and created. This stage focuses on the project's layout, user interface, navigation, and overall aesthetics to ensure alignment with the defined concept and educational objectives. The design stage is creating a storyboard in

the form of a description of each scene that visually explains the program that will be created and serves as a reference when the system is developed. The design is as follows.

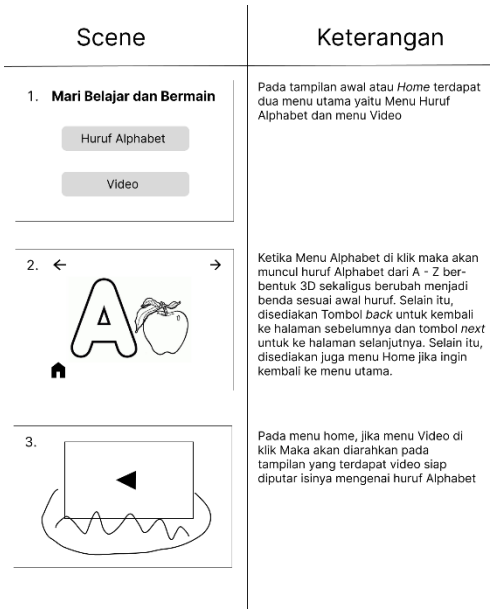

Figure 2. Background Image Assets

2.3 Material Gathering

The material-gathering stage involves collecting and preparing the necessary content for the multimedia project. This may include text, images, videos, audio files, animations, and interactive elements that will be integrated into the final product. The teaching materials for learning were obtained from books about the Alphabet letters; apart from the material about Augmented Reality, the author received the material by asking more expert people, reference books, and the internet. Apart from collecting material in the form of theory, at this stage, assets or components are collected to create the required applications, such as text, images, animation, etc. The picture is below.

Figure 3. Collection of Background Image Assets

Figure 4. Assets Menu Collection

Figure 5. Letters Alphabet Assets

2.4 Assembly

During the assembly stage, the amalgamation of collected materials occurs, culminating in the creation of the multimedia project. This phase is characterized by the technical implementation of design elements, encompassing the meticulous programming of interactive features and ensuring the seamless integration of multimedia components. Here, painstaking attention is paid to detail to ensure that the envisioned interactive learning experience is accurately brought to fruition.

2.5 Testing

The testing phase assumes paramount importance in the development process, serving as a critical evaluation mechanism for the multimedia project. Rigorous testing procedures are employed to assess the functionality, usability, and overall effectiveness of the project. This phase aims to identify and rectify any technical glitches, user interface complexities, or content incongruities before the final deployment. By subjecting the project to comprehensive testing protocols, potential impediments to a seamless user experience are mitigated, thereby enhancing the project's quality and reliability.

2.6 Distribution

The distribution stage constitutes the final frontier in the development lifecycle, focusing on the widespread dissemination of the completed multimedia project to its intended audience. This phase involves ensuring accessibility across diverse platforms and devices, accompanied by the provision of user instructions or tutorials for seamless navigation. Moreover, meticulous monitoring mechanisms are instituted to track the project's utilization and gauge its impact on the target audience. By facilitating broad access and providing comprehensive guidance, the distribution stage aims to maximize the project's reach and efficacy within the educational landscape.

3. Result and Discussion

3.1 Results

The initial stage of this research begins with the concept stage, where the learning objectives, target audience, and content structure for Augmented Reality (AR) learning media in learning alphabet letters are identified. In this stage, information is collected about the educational needs of early childhood and the problems faced in learning the alphabet. Next, in the design phase, the visual and interactive elements of the AR application are planned and created to ensure compliance with the stated learning objectives. The main focus at this stage is designing learning experiences that are interesting and appropriate to the developmental characteristics of early childhood. After establishing the concept and design, the material collection stage is carried out. Learning materials, including images of alphabet letters, interactive games, and audio-visual aids, are collected from various sources to be integrated into the AR learning experience. At this stage, the materials are analyzed to ensure they suit young children's learning objectives and needs. Next, the assembly stage is the point where all the collected materials are combined to develop an interactive AR learning application. This process involves programming and integrating AR features with smartphone camera functionality to create an immersive and engaging learning environment for children. At this stage, extra attention is paid to technical details to ensure compliance with the previously planned design. Thus, from the concept stage to assembly, the research involved identifying needs, designing, planning, collecting materials, and developing a suitable AR application. These stages ensure that the resulting AR learning experience meets young children's learning objectives and needs.

Furthermore, the evaluation and distribution process will focus on measuring the effectiveness and impact of AR learning media in improving understanding of the alphabet among young children. The testing stage is carried out to test whether all material combinations in the assembly process are functioning correctly (malfunction). For this reason, the author carried out testing using the black box technique, and the following test results:

Table 1. Black Box Testing Results

Menu	Scenario	Testing	Info
Main menu	Select alphabet menu	BlackBox	Ok
	Select Video menu	BlackBox	Ok
Alphabet letter menu page	3d letters change shape	BlackBox	Ok
	letter sounds	BlackBox	Ok
	Back Button	BlackBox	Ok

	Next Button	BlackBox	Ok
	Home Button	BlackBox	Ok
Menu videos	Videos can be played	BlackBox	Ok
	Home Button	BlackBox	Ok

In this stage, after it has been tested and is declared to be the purpose of creation, the Augmented Reality Alphabet letter application will be distributed to teachers and students at PAUD Bintang Jonggol so that it can be used as an interactive learning medium in teaching and learning activities. The distribution stage is an essential phase in this research series, which is focused on disseminating Augmented Reality (AR) learning media to the target audience, namely students at PAUD Bintang Jonggol. This distribution process involves several crucial steps. It is, first, to ensure that AR applications can be easily accessed and used effectively via smartphones. This consists in testing the app on various devices to ensure optimal compatibility. The next step is to provide clear and easy-to-understand instructions for educators and students on using AR applications to learn the alphabet. These instructions are essential to ensure users can properly utilize all available features. Additionally, the distribution stage also involves careful monitoring of the implementation of AR applications in the learning environment. This was done to measure its impact on understanding of the alphabet among students, as well as to identify areas where the application could be improved or perfected.

Table 2. Impact Analysis Matrix

No	Organizational Needs	IT Implication
1	Business Needs	
	a) Business Needs (Influence to the Field) b) Make it easier for teachers to provide interactive media learning using AR (Augmented Reality) to students. c) Students are more motivated to participate in learning. d) d) With the AR application for alphabet letters, teachers and students can increase technological literacy regarding interactive learning media using AR (Augmented Reality).	
2	Data Requirements	
	Alphabet letter data is directly stored in assembler so that it can be accessed when the marker is detected	With this AR application, it makes it easier for teachers to access it anytime and anywhere to directly teach their students
3	Technology Requirements	
	This AR application can be accessed using a marker which will be detected by the webcam camera or Android	To access the AR application for Alphabet letters, apart from using a marker, the teacher can also directly open the link provided and set it to open the application

Table 3. Functional Specification

No	Function/Module Name	Information
1	Interactive media learning uses AR (Augmented Reality) technology for alphabet letters	As a tool to assist teachers in carrying out teaching and learning activities (KBM) to improve understanding of the alphabet.

The results display of this program display the application from the user's side or what is usually called the User Interface. Below is the display design (User Interface) created in Augmented Reality for the Alphabet letters in PAUD Bintang. The Alphabet letter menu has an Augmented Reality of the letters A - Z. For example, the author shows the letters A & Z.

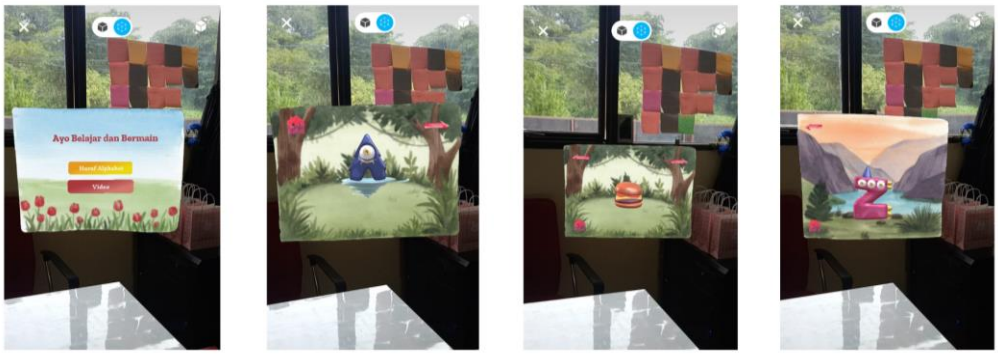

Figure 6. AR letter display menu from the user's side

Apart from the letters of the alphabet, in this application the author provides a video display that can be played, namely a song to memorize the letters of the alphabet.

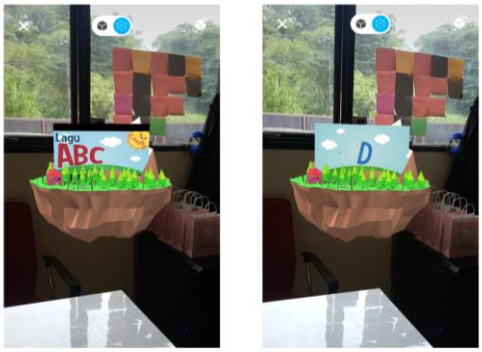

Figure 7. Video menu display font.

3.2 Discussion

This research underwent a series of in-depth and structured processes from the concept stage to assembly. The initial stage begins with identifying needs in learning the alphabet, where learning objectives, target audience, and content structure for Augmented Reality (AR) learning media are determined. The AR design is then carefully prepared, ensuring suitability to early childhood learning objectives and developmental characteristics. Material collection involves a thorough analysis of the learning materials collected, ensuring their relevance to the learning objectives and needs of young children. Next, at the assembly stage, all the collected materials are combined to develop an interactive AR learning application. This process involves programming and integrating AR features with smartphone camera functionality to create an immersive and engaging learning environment for children. Extra attention is paid to technical details to ensure compliance with the pre-planned design. These stages ensure that the resulting AR learning experience meets young children's learning objectives and needs. The evaluation and distribution process will be the next focus, where careful testing will be carried out to measure the effectiveness of the AR application in improving understanding of the alphabet among young children. Thus, this research not only produces a product that meets educational needs and objectives, but also provides a strong foundation for further development in the use of AR technology in learning the alphabet.

4. Related Work

The research journey from the concept stage to assembly in this study involved a series of in-depth and structured processes. Beginning with identifying needs in alphabet learning, the research established learning objectives, target audiences, and content structures for Augmented Reality (AR) learning media. The AR design was meticulously prepared to ensure alignment with learning objectives and the developmental characteristics of young children. The material gathering involved a comprehensive analysis of collected learning materials to ensure their relevance to learning objectives and the needs of young children. Moving on to the assembly stage, all collected materials were combined to develop an interactive AR learning application. This process

involved programming and integrating AR features with smartphone camera functionality to create a deep and engaging learning environment for children. Attention to technical details was paramount to ensure alignment with the pre-planned design [6]. These stages ensure that the AR learning experience produced is aligned with learning objectives and meets the needs of young children [7]. The evaluation and distribution processes will be the next focus, where careful testing will be conducted to measure the effectiveness of the AR application in enhancing alphabet understanding among young children. Thus, this research yields a product that meets educational needs and objectives and provides a strong foundation for further development in using AR technology for alphabet learning.

From the research conducted, several previous studies are relevant to developing interactive learning media using the Multimedia Development Life Cycle (MDLC) and Augmented Reality (AR) methods in the educational context. One of them is research by Nur *et al*. (2023), who developed AR-based mathematics learning media using MDLC. This research shows that the MDLC method can effectively create interactive learning media [8]. Apart from that, research by Hasanah (2022) also used MDLC in designing video tutorials for keyboard learning. This research shows that the MDLC application can produce learning products that suit educational needs and goals [9]. Research by Solehatin *et al*. (2023) also highlighted the development of AR applications using the MDLC method in learning media, showing that MDLC can be widely used to develop innovative learning media. This research's findings align with previous research, which shows that the use of MDLC in creating interactive learning media, especially AR-based ones, can increase learning effectiveness and provide a more exciting learning experience for students. This research is essential in developing innovative and technology-oriented learning methods to improve young children's understanding of alphabet letters [10].

Nafiah *et al*. (2022) developed alphabet maze media for children's early reading skills with research by Syam *et al*. (2022), which explores the role of alphabet books in improving early childhood letter recognition [11][12]. These two studies focus on developing learning media for alphabets and reading skills in early childhood. Apart from that, research by Rachmayanti and Alatas Rachmayanti & Alatas (2020), which discusses learning Arabic letters for students with special needs in elementary schools, can be compared with research by Maliki and Yasin Maliki & Yasin (2017), which applies multisensory in letter identification skills for education students special. These two studies highlight learning approaches tailored to specific student needs in understanding letters and letter identification skills [13][14]. Additionally, research by Sadouk (2020) discussing handwritten Phoenician character recognition and its use to improve handwritten alphabet recognition with a lack of annotated data can be compared with research by Ziafat *et al*. (2021), which focuses on detecting the correct pronunciation of the Arabic alphabet using deep learning. These two studies demonstrate technological approaches to improve the understanding and recognition of letters in different contexts. Highlights AR application development using MDLC [15][16]. MDLC can be widely used to develop innovative learning media. These findings align with previous research, which shows that the use of MDLC in creating interactive learning media, especially AR-based, can increase learning effectiveness and provide a more exciting learning experience for students.

5. Conclusion

Based on the research results and discussions that have been carried out, the development of interactive learning media using Augmented Reality (AR) technology is a practical step in improving understanding of the alphabet in early childhood. Through the application of the Multimedia Development Method (MDLC) in the stages of concept, design, material collection, assembly, testing, and distribution, an AR learning application has been created that aligns with educational objectives and meets the needs of early childhood. This process produces products that meet academic standards and provides a strong foundation for further development in using AR technology to learn alphabet letters. This research also highlights previous findings that show the effectiveness of MDLC in developing interactive learning media, especially AR-based, in increasing learning effectiveness and providing a more exciting learning experience for students. In the context of early childhood education, the use of AR technology, together with gamification techniques and collaborative learning models, can enrich children's learning experiences, motivate them to actively participate in the learning process, and improve their understanding of the concept of letters of the alphabet. Furthermore, this research contributes to developing innovative and technology-oriented learning methods to increase alphabet literacy among young children. Thus, by integrating AR technology in the PAUD curriculum, educators can create a dynamic, interactive, and engaging learning environment, which will help prepare children well to enter formal education at the next level.

References

[1] Nainggolan, E. R., Asymar, H. H., Nalendra, A. R. A., Sulaeman, F., & Radiyah, U. (2018, August). The implementation of augmented reality as learning media in introducing animals for early childhood education. In *2018 6th International Conference on Cyber and IT Service Management (CITSM)* (pp. 1-6). IEEE. https://doi.org/10.1109/CITSM.2018.8674350

[2] Hawali, R. F., Amseke, F. V., Radja, P. L., & Lobo, R. (2022). Penggunaan media gambar dan kartu huruf dalam meningkatkan kemampuan membaca anak usia dini. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini, 6*(6), 6723-6731. https://doi.org/10.31004/obsesi.v6i6.2532

[3] Kedah, Z. (2023). Inovasi penerapan teknik gamifikasi terhadap pembelajaran kampus merdeka. *Jurnal MENTARI: Manajemen, Pendidikan Dan Teknologi Informasi, 1*(2), 133-143. https://doi.org/10.34306/mentari.v1i2.259

[4] Trihantoyo, S. (2017). Implementasi tipe student teams–achievement divisions (stad) sebagai model pembelajaran kooperatif untuk meningkatkan pemahaman konsep manajemen paud. *Jurnal Dinamika Manajemen Pendidikan, 1*(1), 15. https://doi.org/10.26740/jdmp.v1n1.p15-23

[5] Mohajerani, A. A. (2021). Algoritma fcd dan nft pada sistem pencernaan berbasis ar menggunakan single marker. *JATISI (Jurnal Teknik Informatika Dan Sistem Informasi), 8*(3), 1049-1061. https://doi.org/10.35957/jatisi.v8i3.1043

[6] Pangestu, D. A., Fauziah, F., & Hayati, N. (2020). Augmented reality sebagai media edukasi mengenai lapisan atmosfer menggunakan algoritma fast corner. *JIPI (Jurnal Ilmiah Penelitian Dan Pembelajaran Informatika), 5*(2), 67. https://doi.org/10.29100/jipi.v5i2.1759

[7] Anggreani, C., & Satrio, A. (2021). Pengembangan flashcard berbasis augmented reality untuk anak usia dini. *Edukatif : Jurnal Ilmu Pendidikan, 3*(6), 5126-5135. https://doi.org/10.31004/edukatif.v3i6.1639

[8] Nur, M. A., Wirawan, R., & Inayah, A. (2023). Media pembelajaran matematika materi pokok bagun datar berbasis augmented reality. *Justek : Jurnal Sains Dan Teknologi, 6*(1), 30. https://doi.org/10.31764/justek.v6i1.12683

[9] Hasanah, N. (2022). Perancangan video tutorial untuk pembelajaran keyboard bagi pemula menggunakan metode mdlc. *Telcomatics, 6*(2), 67. https://doi.org/10.37253/telcomatics.v6i2.6357

[10] Solehatin, S., Aslamiyah, N. S., Pertiwi, D. A. A., & Santosa, K. (2023). Augmented reality development using multimedia development life cycle (mdlc) method in learning media. *Journal of Soft Computing Exploration, 4*(1). https://doi.org/10.52465/joscex.v4i1.118

[11] Nafiah, I. N., Wijayanti, A., & Sukmono, N. D. (2022). Development of alphabet maze media for beginning reading skills for children. *Al-Athfaal: Jurnal Ilmiah Pendidikan Anak Usia Dini, 5*(1), 48-62. https://doi.org/10.24042/ajipaud.v5i1.11678

[12] Syam, N., Afiif, A., & Damayanti, E. (2022). The role of alphabet book in improving preschool children's letter recognition. *Journal of Early Childhood Care and Education, 5*(1), 59-72. https://doi.org/10.26555/jecce.v5i1.3991

[13] Rachmayanti, I., & Alatas, M. A. (2020). The learning of arabic alphabets for special needs students in elementary school. *Izdihar : Journal of Arabic Language Teaching, Linguistics, and Literature, 3*(2), 79-94. https://doi.org/10.22219/jiz.v3i2.11931

[14] Maliki, N. S. B. M., & Yasin, M. H. M. (2017). Application of multisensory in learning alphabets identification skills for special education students. *Journal of ICSAR, 1*(2), 150-154. https://doi.org/10.17977/um005v1i22017p150

[15] Sadouk, L. (2020). Handwritten phoenician character recognition and its use to improve recognition of handwritten alphabets with lack of annotated data. *International Journal of Advanced Trends in Computer Science and Engineering, 9*(1), 171-181. https://doi.org/10.30534/ijatcse/2020/26912020

[16] Ziafat, N., Ahmad, H. F., Fatima, I., Muhammad, Z., Alhumam, A., & Rajpoot, K. (2021). Correct pronunciation detection of the arabic alphabet using deep learning. *Applied Sciences, 11*(6), 2508. https://doi.org/10.3390/app11062508.