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User experience measurement on augmented reality mobile application for learning to read using a phonics-based approach

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***Abstract*— Reading skills in early childhood provide the foundation for acquiring and mastering other lessons that are useful for their lives. The use of fun interactive learning media is one technique to boost interest in reading for early childhood. The advantage of the phonics-based method that emphasizes word learning through the listening of letter sounds makes it easier for children to improve their reading skills. Augmented reality (AR) development is beneficial because it helps students pay more attention and raise passion by including them in the learning process. This study aimed to create an AR-based multimedia application for learning to read by utilizing the phonics-based method, which is beneficial for the first step in advancing the reading skills of the Indonesian language. At the final stage of the study, a user experience measurement was conducted to investigate the level of acceptance of the developed application. The application that has been developed has been experimentally confirmed to have a high level of user acceptability.**

Keywords—augmented reality, phonics, learning to read, Indonesian language, user experience measurement

I. INTRODUCTION

Technically, reading lessons can be taught sequentially, i.e., reading per word fragment. This teaching method is accomplished by concentrating on the alphabet by familiarizing each letter, sound, and word one by one. The phonic method focuses on an essential part of the language learning process for beginners, namely, learning the alphabet system, including letter-sound correspondence and spelling patterns. That method demonstrated that students who use the phonics method could read and recognize words considerably faster[1].

The phonics technique encourages kids to learn the sounds of letters before reading a whole word because if students are taught to recognize words first, they are more likely to memorize them. As a result, kids will have trouble learning new words due to the many words to memorize and the various letter sequences.

With the rapid development of information technology, various learning media through mobile devices have been widely developed. Small, intelligent, portable, multimedia-rich, user-friendly, and highly flexible learning activities are just a few of the benefits of this device. In addition, learning activities using multimedia applications on mobile devices provide students with numerous chances to actively and independently gain knowledge to supplement the teacher's instruction.

I Dewa Gede et al. suggested that Augmented Reality has a deeper function in presenting the information. They introduced the development of an Augmented Reality Magic Book Application for Animal Recognition for Kindergarten Students. The application can display 3-dimensional animals objects and their sounds [2]. Furthermore, Budi Arifitama develops educational material using Augmented Reality to introduce the milky way solar system. This study concludes that Augmented Reality can attract students' interest in studying the solar system[3].

Radhea Wicaksono Putra et al. conducted another study that used Augmented Reality technology. They created games apps to promote children's learning about animals, allowing them to learn about animals without going to a real zoo. [4]. The result showed that Augmented Reality game applications could make children learn with fun.

Elsa Patricia Senduk et al. were also successful in applying AR technology into mobile learning applications for building good character in children. [5]. Another study entitled "Learning Media Of Mathematical Operations In Early Childhood Based Augmented Reality" conducted by Ahmad Ihsan et al. shows that a child can learn mathematics visually more effectively and interactively while using Augmented Reality [6]. Overall, the research above shows that AR technology has proven to be an alternative learning supplement for students since it can increase understanding and increase student motivation.

The study aims to develop an application for learning to read using the AR-based phonics method. This mobile application is specially designed for children who want to learn to read Indonesian. Furthermore, the study will also evaluate how attractive the application has succeeded in helping the learning process and increasing children's enthusiasm to read.

The following is how the rest of the manuscript is organized. The problem's background is described in the first section, which is followed by a literature review in Section 2. The experimental results and system design will be given in Section 3 of the article. We continue the discussion and evaluation of the proposed system in Section 4. Finally, we will come to some conclusions in the last section.

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II. LITERATURE REVIEW

A. Phonics-based method

The term phonics is derived from the word phoneme, which refers to the smallest unit of speech. There are three phonemes in the word "and," for example: /d/, /a/, /, and /n/. In our study, the phonics method was defined as a method for teaching kids to read and write. It teaches kids how to recognize, hear, and employ distinct sounds that distinguish one word from another. The skills obtained with this method are mastery of the alphabetic code. In more detail, the reader is only asked to read letter by letter, recognize phonemes, and combine phonemes into syllables or words. In previous studies, phonics was implemented in English [7]. It could even be applied to people with intellectual disabilities [8], but in our study, we used Indonesian phonics, which was more relevant for our target users, who were Indonesian school children.

The phonic technique focuses on word recognition through listening to letter sounds. Children are first asked to distinguish letter sounds before synthesizing them into syllables and words. Since the phonics approach we utilize has been tailored to the Indonesian language, the letters and words we use are Indonesian phrases. The letter "A" for example, is presented by connecting it with a picture of a chicken where the word "Chicken" in Indonesian is "Ayam". While the letter "B" is connected to a duck image (*duck = bebek in Indonesian language), and so on. In the phonics method, children are taught the sounds of the alphabet letters and groups of letters used in words. With a focus on word phonemes, children can acquire ways to interpret new words. Knowing each sound in a word will help students understand the meaning of the words [9].

The following are the four stages of learning to read using the phonics method [9]:

a. Word habituation phase
   This phase is designed to familiarize youngsters with the structure of written words as well as to raise and build awareness of the differences between them.
b. The phase of word recognition
   This phase seeks to teach youngsters which written word corresponds to (which is the symbol for) the spoken word and the item to which it refers.
c. The phase of phrase and sentence understanding
   This phase teaches toddlers how to recognize which written phrases and sentences correspond to spoken phrases or sentences.

B. Augmented Reality

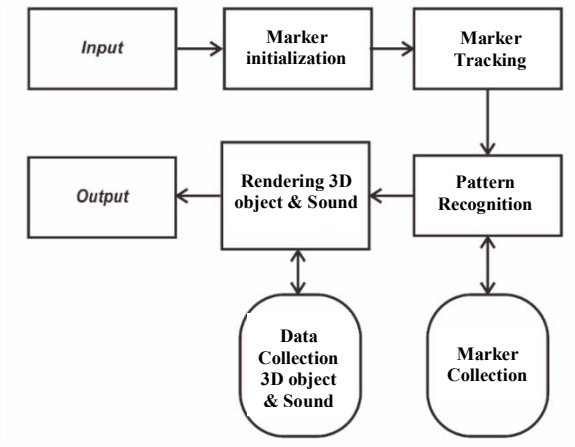


Fig. 1. Block diagram of the AR system

The idea of effective teaching is that it should be fun for the user. Furthermore, this is in line with the child's natural growth, in which he enjoys playing and becomes bored quickly. As a result, teaching reading to the children should be delivered with fun. AR technology makes a teaching media application more interesting since it allows users to see a mix of real and virtual objects in a real-time environment. AR technology generates virtual objects that will be displayed following the markers that have been created so that they look real in real-time.

Previous AR studies have confirmed that AR technology may improve the user experience while using applications software; hence the usage of AR technology in this study can be concluded as the relevant research path[10]–[12]. The design of our AR system is shown in Fig. 1. First, our AR system will initialize the marker image. In the application that we made, there are 26 marker images, namely images of the letters A-Z. After the initialization process, the system will perform tracking or pattern detection on the marker image. Next, Vuforia is in charge of the process of identifying and recognizing marker patterns. Vuforia uses the previously registered marker image database to perform pattern matching in the next stage. The success of this pattern matching procedure has a significant impact on the next step, rendering. A three-dimensional object will appear if the system recognizes the marking. The 3D item will not appear if the marker is not recognized.

C. User Experience Measurement

User Experience Measurement is an evaluation method to determine the perspective and aspects that affect user experience while using the application. The surveys are required to understand better user perceptions and human attention to software applications [13][14].

The indicators used as a reference in measuring User Experience Measurement can be seen in Table I.

TABLE I. INDICATOR OF USER EXPERIENCE SURVEY[14]

Indicator		Description	Psychological Component
1	*Role Engagement*	*Captivated and enclosed into the role and place provided by the story*	*Perception-social cognition*
2	*Attention*	*Time distortion focus on the game world instead of the real world*	*Attention*
3	*Interest*	*The game was interesting, exciting as well as lively*	*Motivation-emotion*
4	*Importance*	*The meaning of the game, the game was relevant, close, personal and sensitive*	*Motivation-cognition*
5	*Interaction*	*Speed, range, mapping, exploration, predictability of own actions*	*Perception-cognition*
6	*Arousal*	*Active, stimulated vs. passive, unaroused*	*Emotion*
7	*Valence*	*Positive valence, happy, not bored or anxious*	*Emotion*
8	*Impressed*	*Amazed and impressed by the game-world, the game elicited real feelings*	*Feeling*
9	*Competence*	*Skilled, competent, enjoying using the skills, clear goals*	*Cognition - past experience*
10	*Enjoy*	*Playing was pleasant, enjoying and exciting, I'll recomend it to my friends*	*Feeling*

Indicator		Description	Psychological Component
11	*Playfulness*	*Ease of doing, creative, live and vivid, not unimaginative*	*Feeling*
12	*Control*	*Feeling of being in control and independent*	*Feeling*

Measurements of user opinion are performed to obtain positive or negative feedback on applications that have been developed. The 12 measurement indicators described in Table-I are used to gauge user opinion. The advantage of the Likert scale is that it does not require respondents to provide simple yes/no answers but rather allows for a wide range of responses, including no response at all [15]. As a result, quantitative data is acquired, suggesting that the data may be evaluated more easily.

The respondent's perception is assumed to be linear from strongly agree to disagree on the Likert scale strongly. The range of values on the Likert scale that we employed in this investigation is shown in Table II.

TABLE II. RESPONDENTS OPTIONS ON THE LIKERT SCALE[13]

Statement	Positive	Negative
Strongly agree	5	1
Agree	4	2
Undecided	3	3
Disagree	2	4
Strongly disagree	1	5

The following formula is used to determine the results of each question chosen by the respondent:

$$T \; x \; P_n \tag{1}$$

where,

T = The number of each question selected by the respondent

P_n = Likert scale for each column.

The percentage value of each analysis indicator will be calculated after the data from all survey indicators has been obtained.

$$Y = (\text{highest Likert score}) \times (\text{number of respondents}) \tag{2}$$

After obtaining the total score, the perceived value can be calculated and used to evaluate the user's overall interpretation.

$$Interval = \frac{100}{\text{number of Likert}} \tag{3}$$

$$Percentage\ of\ result\ = \frac{Total\ of\ each\ question}{Y} X\ 100\% \tag{4}$$

III. DESIGN SYSTEM AND EXPERIMENTAL RESULTS

A. Design System

Our system combines Augmented Reality technology with the phonics approach to help you learn to read. The usage of augmented reality (AR) is designed to display things whose first letters serve as letter introductions. This augmented reality software will only work if the user's smartphone has a camera and a specified marker. This application is intended for the children who can use mobile devices, i.e. smartphones with low or moderate levels, are not visually and hearing impaired, and are accompanied by teachers or parents as guides.

Using the Blender software (https://www.blender.org/), we designed a 3D object model. Among these are objects whose first letters are used to identify them. Table III shows the 3D object for each letter. The markers were created using the GIMP software (https://www.gimp.org/).

Fig. 2. Marker design for the AR system

As many as 26 markers were made, namely A-Z letter markers that have different designs.

The marker in Fig. 2 is then uploaded to the Vuforia Developer website (http://developer.vuforia.com) to obtain a license key, which can then be used in our application. Vuforia is an Augmented Reality Software Development Kit (SDK) for mobile devices that allows developers to create Augmented Reality apps that use Computer Vision to recognize and track the actual marker picture.

TABLE III. 3D OBJECT DESIGN FOR EACH LETTER

Letter	Developed 3D-Object	Read in Indonesian Phonemes
A	Apple, Chicken, Dog	Apel, Ayam, Anjing
B	Duck, Ball, Pillow, Earth	Bebek, Bola, Bantal, Bumi
C	Cherry, Cup, Ring, Dragonfly	Ceri, Cangkir, Cincin, Capung
D	Lamb, Donut, Tie, Dice	Domba, Donat, Dasi, Dadu
E	Bucket, Eagle	Ember, Elang
F	Ferry	Feri
G	Elephant, Dipper, Gallon	Gajah, Gayung, Galon
H	Tiger, Shark	Harimau, Hiu
I	Fish, Iguanas	Ikan, Iguana
J	Orange, Giraffe, Mushroom	Jeruk, Jerapa, Jamur
K	Horse, Cat, Ax	Kuda, Kucing, Kapak
L	Pumpkin, Cupboard, Laptop	Labu, Lemari, Laptop
M	Car, Melon, Table, Bowl	Mobil, Melon, Meja, Mangkuk
N	Pineapple	Nanas
O	Medicine, Screwdriver	Obat, Obeng
P	Banana, Boat, Hammer	Pisang, Perahu, Palu
Q	Qur'an	Qur'an
R	Deer, Bread, House, Racket	Rusa, Roti, Rumah, Raket
S	Cow, Watermelon, Shoes	Sapi, Semangka, Sepatu
T	Tomato, Bag, Egg	Tomat, Tas, Telur
U	Money, Camel, Snake	Uang, Unta, Ular
V	Vase	Vas
W	Carrots, Frying Pan	Wortel, Wajan
X	Xylophone	Xilofon
Y	Yoyo	Yoyo
Z	Zebra	Zebra

The design of the navigation flow used in the application can be seen in Fig. 3.

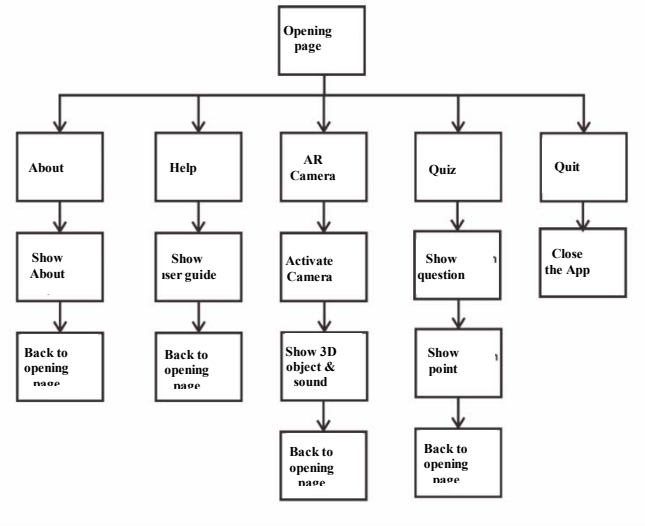


Fig. 3. System diagram of in-app navigation flow

B. Experimental results

Our main purpose is to make reading guides more appealing to children. The implementation of augmented reality technology is expected to provide them with a new experience. The basic concept of the AR system is to display 3D objects in the real world so that users may interact with them. As described in Fig. 3, the system will display 3D objects and play the relevant sound on the AR Camera page. Vuforia is in charge of the pattern recognition procedure. Vuforia will use the database of previously registered marker images. Vuforia system then will try to detect the marker and display the appropriate 3D object if the detected marker is similar to the marker in the database; however, if the marker is not recognized, the 3D object will not appear.

Fig. 4 shows the application's main menu, which includes several option buttons. AR Camera (pink color) to start Augmented Reality, Quiz (purple color) to answer some questions after playing Augmented Reality, Guide (blue color) to learn how to use the application, and About (brown color) to learn what AR is, are some of the buttons that can be described. Finally, the Exit button (red colour) to close the application.

Fig. 4. Main menu display

Fig. 5 shows some examples of markers along with the appearance of 3D objects that appear on the application system.

Fig. 5. 3D object sample for the specific marker

We created two questions for each of the 12 predetermined indicators, one question is positive, and the other is negative. Our target respondents are students and teachers/ parents. A positive statement is a statement of the attitude expected by the developer, while a negative statement is the opposite. The list of statements that students and teachers/ parents must choose is in Table IV.

TABLE IV. LIST OF STATEMENTS QUESTIONNAIRE FOR THE STUDENT AND THE TEACHER/PARENT

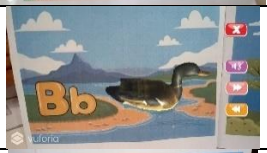
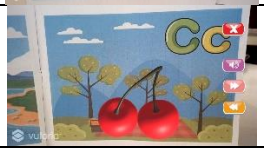
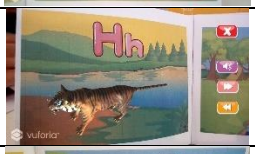
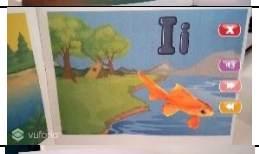
No	Indicator	Statement for the student	Statement for the teachers/parents
1	*Role Engagement* (Positive)	I've used AR applications	I've used AR applications
2	*Role Engagement* (Negative)	I've never used an AR applications	I've never used an AR applications
3	Attention (Positive)	I prefer to learn phonics using AR applications rather than learning phonics the conventional way	I prefer to accompany children to learn phonics using the AR application rather than learning phonics in a conventional way
4	*Attention* (Negative)	I don't like learning phonics using AR apps	I don't like it when children learn phonics using AR apps
5	*Interest* (Positive)	The AR application is attractive and easy to understand	AR applications are more practical and interesting if they are used to teach phonics to children
6	*Interest* (Negative)	AR app is not interesting	I prefer to teach phonics to children without using the AR application
7	*Importance* (Positive)	I didn't realize that I was learning phonics when using the AR app	It helps me a lot to teach phonics to children when using the AR application
8	*Importance* (Negative)	I prefer to learn phonics without using AR apps	AR applications make it more difficult for me to teach phonics to children
9	*Interaction* (Positive)	AR application has a fast response	AR application has a fast response
10	*Interaction* (Negative)	AR applications have a fairly slow response	AR applications have a fairly slow response
11	*Arousal* (Positive)	I'm more excited to learn phonics if I use the AR application	I will be more passionate about teaching phonics to children when using the AR application
12	*Arousal* (Negative)	I feel bored learning Phonics using the AR app	I feel bored teaching Phonics to children using the AR application
13	*Valence* (Positive)	All features in the AR application are working properly	All features in the AR application are working properly
14	*Valence* (Negative)	There are some features in the AR application that are not working	There are some features in the AR application that are not working

No	Indicator	Statement for the student	Statement for the teachers/parents
15	*Impressed* (Positive)	I like the 3D Objects contained in the AR application	I am impressed with the 3D Objects contained in the AR application
16	*Impressed* (Negative)	3D objects in AR applications are not attractive	3D objects in AR applications are not attractive
17	*Competence* (Positive)	I memorize the sound of letters faster when using the AR application	AR application is suitable with the concept of Phonics
18	*Competence* (Negative)	I feel more and more confused when learning to use the AR application	AR applications are not suitable with the concept of Phonics
19	*Enjoy* (Positive)	I want to continue learning phonics using the AR app	I want to continue teaching phonics to children using the AR app
20	*Enjoy* (Negative)	I no longer want to learn phonics using the AR app	I no longer want to teach phonics to children using the AR app
21	*Playfulness* (Positive)	3D objects in the AR app look like real	3D objects in the AR app look like real
22	*Playfulness* (Negative)	3D objects in AR apps don't look real	3D objects in AR apps don't look real
23	*Control* (Positive)	I don't find it difficult to operate the AR application because there are clear guidelines	I don't find it difficult to operate the AR application because there are clear guidelines
24	*Control* (Negative)	The AR application usage guide is not clear. I have difficulty operating it	The AR application usage guide is not clear. I have difficulty operating it

IV. Evaluation And Discussion

Application testing and evaluation refer to the process of determining whether or not a completed application can be performed on a specific device. The test's purpose is to identify any application flaws or defects so that the developer may address them. Testing also aims to adjust the system with the expected goals to be ready to be implemented on research subjects. We test our application in two ways, namely functionality test, and user experience test. Testing of the augmented reality feature in this application has been successfully carried out. Details of the results can be seen in Table V.

TABLE V. The Sample of AR Feature Functionality Test Results

No	*Object Test*	*Result*
1	Showing object for the marker A	
2	Showing object for the marker B	
3	Showing object for the marker C	
4	Showing object for the marker D	
5	Showing object for the marker E	
6	Showing object for the marker F	
7	Showing object for the marker G	
8	Showing object for the marker H	
9	Showing object for the marker I	
10	Showing object for the marker J	

The following information is derived from the experimental results of the Augmented Reality Feature Functionality test performed on smartphones:

a. Illumination of the marker must be adequate.
b. The camera application on the smartphone used must be active.
c. The response speed of 3D objects on the marker depends on the quality level of the camera and the marker image.

User experience assessment is conducted on two groups of respondents: students and teachers/parents who are familiar with phonics. Respondents were instructed to test out the applications that came with the markers. Two results were obtained based on the survey data: the conclusion of a value with a Likert scale and each score for each user experience indicator.

In Fig. 6, the Arousal Indicator has the highest score of 95%, so it can be concluded that Robbaniyyin's TKIT students

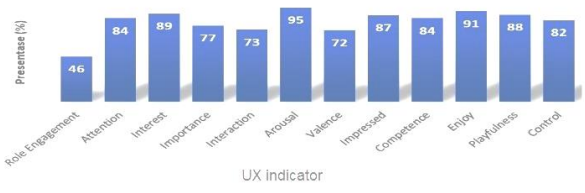


Fig. 6. User experience indicator graph for students

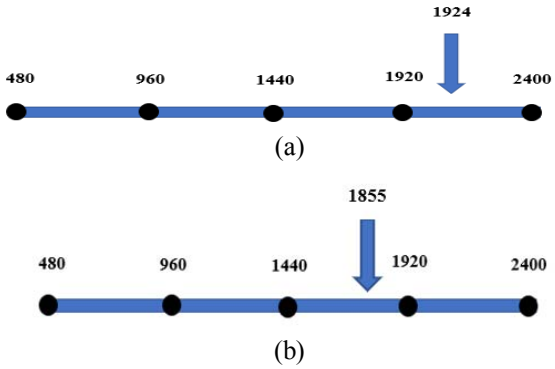


Fig. 7. Likert score for (a) students (b) teacher and parents answer score

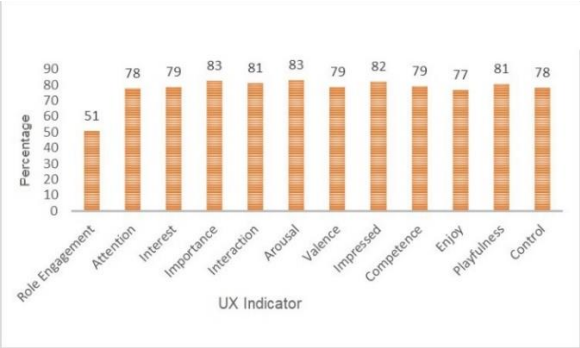


Fig. 8. User Experience indicator graph for the teachers and parents

are interested in the AR-Phonics application and are more enthusiastic about learning. The total Likert score obtained from 20 students of TKIT Robbaniyyin Bangkalan is 1924 so that the Likert scale is obtained as shown in Fig. 7(a). As shown in Fig. 7(b), the total Likert score based on survey data for teachers and parents consisting of 20 respondents (9 TKIT Robbaniyyin Bangkalan teachers, 9 TKIT Ulil Albab Kamal teachers, and 2 parents who understand the concept of phonics) is 1855 better than student answer.

In Fig. 8, Importance and Arousal indicators have the highest value of 83%, so it can be concluded that teachers and parents feel interested and helped in teaching a student with this application.

V. Conclusions

The following conclusions can be drawn from our studies conducted at TKIT Robbaniyyin Bangkalan and TKIT Ulil Albab Kamal, along with parents who understand the concepts of phonics:

1. Our AR-Phonics application can run well on mobile devices with the Android operating system.
2. Our AR-Phonics application can increase children's interest and enthusiasm for learning. It could be seen in the results of the User Experience test with an average percentage of 80%.
3. Our AR-Phonics application can help the learning process. Results of the User Experience test with an average percentage of 77% proved that the application enough helping the user learning to read.

References

[1] V. Connelly, R. Johnston, and G. B. Thompson, "The effect of phonics instruction on the reading comprehension of beginning readers," *Read. Writ.*, vol. 14, no. 5, pp. 423–457, 2001, doi: 10.1023/A:1011114724881.

[2] I. D. Gede, W. Dhiyatmika, I. K. Gede, D. Putra, N. Made, and I. Marini, "Aplikasi Augmented Reality Magic Book Pengenalan Binatang Untuk Siswa TK," *Apl. Augment. Real. Magic B. Pengenalan Binatang Untuk Siswa Tk*, vol. 6, no. 2, pp. 120–127, 2015, doi: 10.24843/LKJITI.6.2.16708.

[3] B. Arifitama, "Pengembangan Alat Peraga Pengenalan Tata Surya Bima Sakti Menggunakan Augmented Reality di PAUD," *Sisfo*, vol. 5, no. 4, 2015, doi: 10.24089/j.sisfo.2015.09.006.

[4] R. W. Putra, D. Herumurti, and I. Kuswardayan, "Permainan Augmented Reality dalam Mendukung Pembelajaran Anak tentang Binatang pada Perangkat iOS," *J. Tek. ITS*, vol. 5, no. 2, pp. 542–546, 2016, doi: 10.12962/j23373539.v5i2.18607.

[5] E. P. Senduk, A. Sinsuw, and S. Karouw, "M-Learning Pendidikan Karakter untuk Anak Usia Dini Berbasis Augmented Reality," *J. Tek. Inform.*, vol. 9, no. 1, pp. 1–5, 2016, doi: 10.35793/jti.9.1.2016.14929.

[6] A. Ihsan, M. Munawir, and F. Amir, "Learning Media Of Mathematical Operations In Early Childhood Based Augmented Reality," *Int. Conf. Sci. Technol. Mod. Soc.*, vol. 1, no. 1, pp. 19–22, 2017, [Online]. Available: https://ejurnalunsam.id/index.php/icstms/article/view/498

[7] I. Chen, "The Application of Augmented Reality in English Phonics Learning Performance of ESL Young Learners," 2018, doi: 10.1109/IC3.2018.000-7.

[8] R. S. Dessemontet, A. De Chambrier, C. Martinet, N. Meuli, and A. Linder, "Research in Developmental Disabilities Effects of a phonics-based intervention on the reading skills of students with intellectual disability," vol. 111, no. January, 2021.

[9] Haryati, "Pengembangan Kemampuan Membaca Permulaan Melalui Metode Fonik Pada Taman Kanak-Kanak Bhayangkari," *Cahaya PAUD*, vol. 2, pp. 36–46, 2015.

[10] J. Ma, Q. Liu, S. Yu, M. Liu, J. Liu, and L. Wu, "Chinese K-12 Teachers' Acceptance of Augmented Reality based on Technology Acceptance Model," in *2021 International Symposium on Educational Technology (ISET)*, 2021, pp. 243–246. doi: 10.1109/ISET52350.2021.00058.

[11] A. Kusumaningsih, C. V. Angkoso, and A. Ubaidillah, "Augmented Reality-Marker Detection Measurement on Heroes of Surabaya Mobile Games," *J. Phys. Conf. Ser.*, vol. 1569, no. 2, 2020, doi: 10.1088/1742-6596/1569/2/022066.

[12] P. Reisinho, C. Silva, M. Vairinhos, A. P. Oliveira, and N. Zagalo, "Tangible Interfaces and Augmented Reality in a Nutrition Serious Game for Kids," in *2021 IEEE 9th International Conference on Serious Games and Applications for Health(SeGAH)*, 2021, pp. 1–8. doi: 10.1109/SEGAH52098.2021.9551852.

[13] A. Kusumaningsih, A. Kurniawati, C. V. Angkoso, E. M. Yuniarno, and M. Hariadi, "User experience measurement on virtual dressing room of Madura batik clothes," *Proc. - 2017 Int. Conf. Sustain. Inf. Eng. Technol. SIET 2017*, pp. 203–208, 2018, doi: 10.1109/SIET.2017.8304135.

[14] J. Takatalo, J. Häkkinen, J. Kaistinen, and G. Nyman, "Measuring user experience in digital gaming: theoretical and methodological issues," *Image Qual. Syst. Perform. IV*, vol. 6494, no. May 2014, p. 649402, 2007, doi: 10.1117/12.698486.

[15] I. A. Astuti, L. D. Farida, and T. Hidayat, "Measuring the UX of Mobile Application Attendance Lectures Feature Using Short-User Experience Questions (UEQ-S)," *3rd 2021 East Indones. Conf. Comput. Inf. Technol. EIConCIT 2021*, pp. 286–291, 2021, doi: 10.1109/EIConCIT50028.2021.9431891.