Development of Augmented Reality-Based Learning Media in Early Childhood Learning

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***Abstract*— The purpose of this research is: (1) to describe the characteristics of Augmented Reality-based learning media in early childhood learning in PAUD Kendari City institutions, (2) to find out the validity of Augmented Reality-based learning media to be used in early childhood learning in PAUD institutions in Kendari City, (3) how to effectively learn by using augmented reality-based learning media in PAUD institutions in Kendari City. This research is a research development or Research and Development (R & D) with a design model developed by Lee & Owens (2004) consisting of four stages assessment/analysis, design, development and implementation, evaluation. The results of this study showed that (1) media characteristics developed are (a) using Augmented Reality technology, (b) independent learning resources for children during the covid-19 pandemic, (c) have flashcards, (d) learning media developed are contextual; (2) The development of Augmented Reality-based learning media in early childhood learning has been valid after going through a little revision so that this media product is feasible to be used in learning in PAUD institutions in Kendari City. This is indicated by a validator rating average of 3.57 with a very valid category; (3) Development of Augmented Reality-based learning media is effective for use in the learning of children of age in PAUD institutions in Kendari City. This is shown by (a) the average percentage of child development of 87.62 is in the excellent category, (b) 85.71% of kindergarten teachers respond positively to augmented reality-based learning media, (c) there is an increase in aspects of child development after using Augmented Reality-based learning media. This is indicated by the significance value of the paired t-test being less than α = 0.05.**

Keywords: **augmented reality, flashcard, *PAUD Learning***

I. INTRODUCTION

Early age is a golden age that only happens once during the life of a human being. Therefore, serious, systematic, and sustainable efforts are needed to awaken and strengthen the potential, awareness, and confidence of students. This is in line with the results of Osakwe's (2009) shows that students who have attended preschool education perform better in aspects of cognitive, psychomotor, and social skills than students who do not follow their preschool education.

Early childhood learning has the following characteristics: 1) children learn through play; 2) children learn by building their knowledge; 3) children learn scientifically; 4) children learn best if what they learn considers the overall aspects of development, meaningful, interest, and functional (Wiyani, 2012). According to Suyadi (2010) suggested that early childhood learning is done through play, children learn by building their knowledge, children learn scientifically, children learn best if what they learn considers all aspects of development, meaningful, interest, and functional that are prepared by educators by preparing materials

and learning processes. Early childhood-oriented learning that is adjusted to the child's age level means that learning must be in demand, expected abilities can be achieved, and learning activities can challenge learners to do according to the age of the child (Wiyani, 2012). So far, there are still many teachers who use teacher center-centered learning strategies. Murdiono (2012) revealed that the role of teachers in the classroom is still very dominant and student involvement in the learning process is still limited so that learning is still one-way. As a result, the interaction between the teacher and the student or the student is rare. The learning activities emphasize the results more than the learning process.

Covid-19 cases in Kendari City also increased with 152 confirmed positive cases dated August 11, 2020, and increased to 518 dated September 26, 2020, with all areas of Kendari City sub-district, included in the red zone. During the Covid-19 pandemic in Kendari City, local stakeholders' policies towards the implementation of education, especially students from PAUD to SMA/SMK levels, were still available to study at home independently and online. The learning conditions that occurred during this time at PAUD institutions in Kendari City, Southeast Sulawesi Province showed that learning in early childhood is a learning that is often considered as boring, monotonous, just playing and singing, less fun, and others. PAUD learning is more oriented towards the dominance of teachers without trying to pay attention to children's activity patterns and children's learning development. Judging from the use of learning media, teachers still use media that is monotonous, less interesting and does not involve children to be active in learning. Teachers also have not used ICT-based learning media even though curriculum 2013 strongly recommends the use of ICT-based learning media. This condition, of course, cannot be maintained as one of the strategies that PAUD teachers will use to carry out learning during the current Covid-19 pandemic.

Description of children's learning conditions, how to teach teachers, positive cases of Covid-19, and education policies in the Kendari City area, it is necessary to make maximum efforts to design learning at PAUD level so that learning continues during the Covid-19 pandemic, namely optimizing the use of ICT-based media in early childhood learning. Daryanto (2010) revealed that learning media is everything that can be used to channel messages (learning materials), so as to stimulate children's attention, interests, thoughts, and feelings in learning activities to achieve learning goals. Azhar (2011) revealed that learning media could overcome the limitations of senses, space, and time.

ICT-based learning media is a component of learning resources containing instructional materials in the student environment in information and communication technology (Rusman, 2012). However, learning students with ICT depends on the teacher's ability, attitude, and perception of the teacher towards ICT is an essential factor in the class using ICT (Mai, 2015). Most teachers admit that ICT has a significant impact on students' learning (Mwalongo, 2011). Utilization of ICT-based media will make learning activities provide examples of more concrete reality, history learning is not only nostalgic away from students (Sutiyah, 2013). The utilization of ICT in the process of information delivery is overgrowing. Today, the latest technology used in information delivery is Augmented Reality technology.

Augmented Reality has the advantage of being interactive and real-time so that it can be implemented in various fields. Augmented Reality is used as a medium to introduce historical objects that are a cultural heritage (Haryani,& Triyono, 2017).

Augmented Reality can be used in a variety of activities, such as presentations, estimating an object, performance stimulant equipment, simulating a tool's performance, and others (Raajan, 2014). Augmented Reality is two types of interactive technology and is listed in 3D and combines real and virtual objects (Furh, 2011). Augmented Reality allows children to interact with virtual objects through the exploration of an object as if interacting with a real object. Degeng (2013) explained that using this mock model allows the use of combined media. Billinghurst (2002) suggested that the Augmented Reality app basically uses a facial interface in the form of allusions to physical objects manipulated into imaginative virtual information. Dünser (2012) explained that a very important feature of Augmented Reality is allowing users to interact with virtual content.

Augmented Reality is a merging of real and virtual objects in real environments, runs interactively in real-time and there is integration and virtual is possible with appropriate display technology, interactivity is possible through certain input devices, and good integration requires effective explanation (Azuma, 2014). Augmented Reality allows users to see two-dimensional or three-dimensional virtual objects projected towards the real world (Haller et.al, 2010). Augmented Reality has three characteristics that are interactive (improving user interaction and perception with the real world), real-time, and 3-dimensional (Sanna, & Manuri, 2016). The use of Augmented Reality technology in the creation of 3-dimensional animation (3D) aims to look more real-time and attractive. The animation is built using Blender as well as the augmented reality development process using Qualcomm Augmented Reality (QCAR), which is displayed using a smartphone that uses the Android operating system (Prime, Fitrisia, & Putra 2012). Introduction to objects (images) is used to display various information about the object in the form of 3D images and sounds in accordance with the character of the image object (Saurina, 2016). Augmented Reality application, the end result consists of two forms, namely in physical form (printed media in the form of printouts) containing markers and mobile-based Augmented Reality applications (Adami, & Budihartanti, 2016).

Augmented Reality also requires video streaming with a camera used as an image input source, then tracking and detecting markers. After the marker is detected, a 3D model of an item will appear. This 3D model was created using software for 3D design, e.g., 3DS Max, Blender, and others (Mahendra, 2016). One of the other applications for Augmented Reality development in Unity 3D and Vuforia SDK. Unity 3D is a software or computer program that is currently popular among game developers. The interesting thing about 3D unity is its ability to support a wide range of technology devices. Vuforia is an SDK developed by Qualcomm used to assist developers in creating applications that have Augmented Reality technology. Vuforia SDK will facilitate and accelerate the developer in creating applications that have Augmented Reality technology because the library and its core functions have been created by Qualcomm. Vuforia has various interesting features such as scanning objects,

scanning text, recognizing marker frames, virtual buttons, identifying object surfaces, recognizing cylindrical object targets, and recognizing designated target objects (Manuputty, 2017).

Research related to the use of augmented reality in early childhood learning was also carried out by Mubaraq, Kurniawan, & Saleh (2018) with the results showing that the use of augmented reality attracts children's learning interest, and gets a different learning experience than before regarding the introduction of fruit. The results of research conducted by Sugara, Mahmudi, & Wahyudi (2017) show that learning applications about various professions using augmented reality really helps children in understanding the introduction of professional concepts and can be a source of independent learning for children. The results of other studies were also conducted by Saurina (2016) that children are more interested in using augmented reality media in recognizing animal characteristics than using educational props. The results of this research have differences with this study in terms of the object of augmented reality material and the measurement of aspects of child development. In this study, the object of augmented reality material used is animals and transportation, which so far have only introduced the material using image media. Aspects of measuring child development in this study include all aspects of child development: cognitive, language, physical motor, moral and religious, social-emotional, and art.

The objectives in this study are: (1) to describe the characteristics of Augmented Reality-based learning media in early childhood learning in Kendari City PAUD institutions, (2) to find out the validity of Augmented Reality-based learning media to be used in early childhood learning in PAUD institutions in Kendari City, (3) how to effectively learn by using Augmented Reality-based learning media in PAUD institutions in Kendari City.

II. METHODS

This research is a research development or Research and Development (R & D) to produce learning media products based on Augmented Reality and test the effectiveness of Augmented Reality-based learning media in early childhood learning. The research model of augmented reality-based learning media development using a model developed by Lee & Owens (2004) consisting of four stages, namely assessment/analysis, design, development and implementation, evaluation.

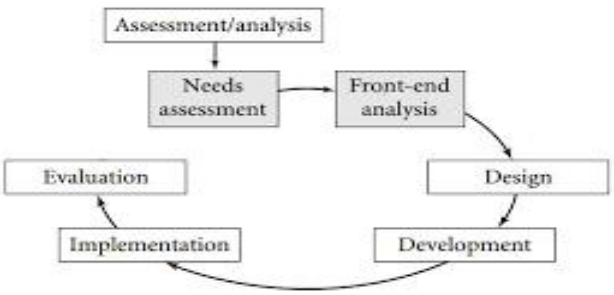

Figure 1 Lee & Owens development model steps

This research was conducted in Kendari City, Southeast Sulawesi Province at the time of implementation of this research following the design stages of the Lee & Owens model R & D which was carried out from September 14, 2020, to November 21, 2020. Respondents to the limited trial related to the use of Augmented Reality-based learning media in this study were kindergarten teachers and group B children in Kendari City. Samples in the study were conducted with purposive sampling techniques, namely selecting test respondents in kindergartens with school locations have a low risk of Covid-19 transmission and local government policies related to learning patterns during the Covid-19 pandemic so that in this study it takes 2 kindergarten institutions with details of 1 kindergarten institution for children learning from home (BDR) and 1 kindergarten institution for children learning from school (BDS). The teachers involved in this limited trial were teachers in both kindergartens who sampled as many as 7 people and 25 students who were involved with details of 12 students in the BDR school and 13 students in the BDS school. For limited trials, the use of Augmented Reality-based learning media to kindergarten children was conducted as many as 7 learning meetings including pre-test before the trial and post-test at the end of the implementation of learning.

Data collection instruments used in this research are validation sheets, observation sheets for children's learning, teacher questionnaires. Data analysis techniques in this study use descriptive analysis and inferential analysis. Descriptive analysis is used to describe the characteristics of early childhood learning media based on Augmented Reality and the validity of early childhood learning media based on Augmented Reality. Meanwhile, to measure the effectiveness of early childhood learning media based on Augmented Reality, descriptive and inferential analysis is used.

Augmented Reality-based learning media is said to be valid if the average minimum validator assessment has been in the valid to the very valid category that is at an interval of $2.5 < Va \leq 4.00$. Augmented Reality-based learning media is said to be effective at supporting early childhood learning if: (1) the average percentage of child development has been in the minimum category either; (2) 75% or more kindergarten teachers responded positively to augmented reality-based learning media: (3) there was an increase in aspects of children's development after using Augmented Reality-based learning media.

III. RESULTS AND DISCUSSION

The implementation of this research activity follows the design of development research or Research and Development (R & D) used that is using a model developed by Lee & Owens (2004) consisting of four stages, namely assessment/analysis, design, development & implementation, and evaluation for achieve the objectives of this research.

1. Assessment/Analysis

At this stage of development, a preliminary study is carried out to find out the current situation in the field. The results of the initial study, through observations and interviews,

showed that during the covid-19 pandemic, children learn independently at home, teachers only provide learning tasks that must be completed by the child to the child's parents through WhatsApp without the support of adequate learning supplements. Periodically, parents of children report the results of their children's learning activities in the form of photos or videos to teachers through WhatsApp. This condition certainly makes the burden of parents heavier because of the lack of knowledge of parents related to the tasks given by teachers and parents have difficulty accessing learning resources for children's needs in learning.

Learning activities applied by teachers are considered boring, monotonous, just more routine activities, less fun. Especially during the covid-19 pandemic, teachers need to be more creative and innovative in developing children's learning activities at home. Judging from the use of learning media, teachers still use media that is monotonous, less interesting, two-dimensional, and does not involve children to be interactive in learning. Teachers also have not used ICT-based learning media even though during the covid-19 pandemic strongly recommend the use of ICT-based learning media. This condition, of course, cannot be maintained as one of the strategies that PAUD teachers will use to carry out learning during the current Covid-19 pandemic. This condition certainly needs to be overcome to provide assistance to children in learning at home so it is necessary to develop Augmented Reality (AR)-based learning media. The choice of AR to help children study at home independently because AR has the ability to display 3D objects in virtual form into a real environment, so that children do not need to leave the house with the aim of child safety from the dangers of Covid-19. This media can also be run easily through gadgets by children so it is very practical in terms of use and safety in its use.

The selection of 3D objects is selected based on the real conditions experienced by children in their daily lives, objects are also selected based on the suitability of the ongoing curriculum so that they are in accordance with the competencies achieved by the child. An object that is contextual in nature is needed so that the object is familiar with what children experience in their daily lives. This is supported by the results of research by Watini (2019) showing that contextual learning will make children's learning experiences more meaningful because they are directly related to children's daily lives. Likewise, the results of research by Sita, Shaifuddin, & Palupi (2014) that contextual-based learning greatly affects children's cognitive development in recognizing objects related to their daily lives.

AR can be explored into 3D media freely and in real-time, can be combined as a child's learning supplement, helps children's imagination and is more practical for children to access at any time, does not require too much space. The selection of AR media is very suitable with the theme that children will learn because it is contextual. The learning theme chosen in this study is in accordance with the ongoing curriculum, namely the theme of animals and vehicles. The selection of 3D objects on the types of animals and types of vehicles is adjusted to the environmental conditions around the child. The selected 3D objects are presented in the form of colorful flash cards with the aim of attracting children's interest in the early use of media. The cards presented are used to place 3D objects as markers to support augmented reality technology when running. This is in line with the results of

research by Perwitasari (2018) that markers are indispensable in augmented reality because they make it easier for users to see observed objects clearly, attract users' attention, and get a different learning experience than before.

2. Design

At this stage, the determination of 3D models will be displayed in Augmented Reality-based learning media, flashcard display design, image selection and styling, text size, and QR-Code design. The design flow of Augmented Reality media products. At this stage also created a design of interaction between users, augmented reality applications, and Augmented Reality flashcards.

3. Development and Implementation

At this stage, it has several steps. The first marker development is using a marker in the form of QR-Code. QR-Code selection because it has a contrastive color and a high augmentable rate. QR-Code was redesigned by providing a picture in the middle to make it easier for users to recognize markers. For example, an image of the aircraft is added in the middle of the QR-Code to indicate that the marker can bring up the plane's 3D model. The marker is then uploaded on the target manager database provider page. Second, the development of 3D models, namely the number of models and various models that will be developed based on existing learning themes and children's needs for 3D models, namely animals and vehicles. Activities in this step include modeling and designing objects. Third, ar application implementation is an application implementation activity that will be assessed sufficiently by validators to obtain the validity of AR media developed. A validator that will provide assessment and input related to AR products made. Validator used as many as three people. Likert-scale validation instruments are used to collect assessment and suggestion data from validators. Statements in instruments are based on the principles of Augmented Reality, visual design, and learning media. Validation results derived from validators used to improve AR products are presented in Table 1.

Table 1 AR-Based Media Validation Results

No	Validator	Average Assessment Aspects			Average Total	Category
		Flash Card AR	Marker	3D Objects		
1	Expert I	3,60	3,67	3,44	3,57	Very Valid
2	Expert II	3,50	3,50	3,56	3,52	Very Valid
3	Expert III	3,60	3,67	3,67	3,64	Very Valid
		Average			**3,57**	**Very Valid**

Validator assessment of AR-based learning media shows the average score of the three validators is 3.57. The value indicates that the developed AR learning media is well structured and can be used with little revision. Input suggestions from all three validators on

AR-based learning media followed up by revising AR-based learning media. The result of this revision becomes the final product of the improvement of AR-based learning media. An explanation of the revision to AR-based learning media is presented in Table 2.

Table 2 Revision of AR-Based Learning Media from Validator Input

No	Input Validator	Follow-up
1	Flashcards presented need additional ornament images to show the characteristics of media used in early childhood	The flashcard has been redesigned by adding image ornaments that reflect typical learning for early childhood
2	The layout on the flashcard needs to be adjusted to the marker image	Letter size and layout have proportional placement
3	The color on the flashcard is sought to attract attention when the child sees it.	There is a combination of colors contained in the flashcard with a bright color selection so that the child can be distracted.

In the implementation stage, there is a change in the design of AR-based learning media products based on input advice from validators with the aim that AR-based learning media products are feasible to be used and ready to be mandated in early childhood education level learning.

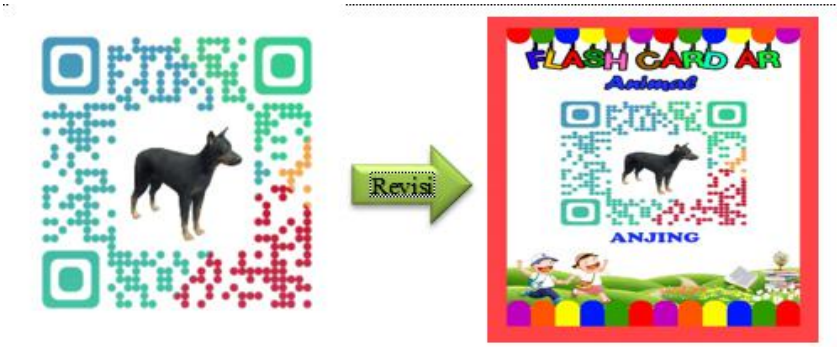

Figure 2 Products Before and After Repair

At first, the flashcard is presented only in the form of markers and object 3D only. But based on the advice of the validator, the flashcard is designed further to make it easier to attract attention when the child sees the flashcard first before the child uses it.

4. Evaluation

The evaluation phase on the development of Augmented Reality (AR) based media products aims to assess the effectiveness of AR products. AR-based learning media products will be

tested on children to see their effectiveness in early childhood learning and their effective results are used as a reflection of ar product improvement so that it can be used widely.

The learning activities begin with praying together, conducting discussions about the learning subtheme material provided, teachers/parents/companions tell stories according to the theme of learning both directly and through other media. Core activities include observing Flash Cards introduced by teachers/parents/escorts, choosing Flash Cards according to sub-themes, listening to teacher/parent/companion explanations about Flash Card media, observing how to use augmented reality apps, using augmented reality apps with Flash Cards, giving children the opportunity to ask/express opinions about Flash Card media, teachers/parents/escorts doing Q& A with children, performing activities/movements according to teacher/parent/companion instructions. Recalling activities include tidying up the media and tools that have been used to learn, discussions about children's feelings during play activities if there is inappropriate behavior, teachers/parents/escorts straighten, tell and show their work. The closing activities include: asking the children how they feel today, discussing what activities they have played today, what toys they like the most, short stories that contain messages, praying after activities.

The results of children's development after being treated using AR-based learning media are presented in table 3 below.

Table 3 Percentage Results of Child Development

No	Group	Average Percentage	Category
1	Work from home	88,78%	Excellent
2	Work from school	86,46%	Excellent
Rata-Rata		**87,62%**	**Excellent**

The results in Table 3 showed that the average development of children both from home and who learned from school has exceeded the specified limit of good minimum categories. This indicates that AR-based learning media can develop all aspects of a child's development ranging from cognitive, language, motor physical, moral and religious, social and emotional, and artistic. The results of this study are also in line with the results of research conducted by Azuma, Billinghurst, & Klinker (2015) that Augmented Reality can be used to help visualize abstract concepts for the recognition and understanding of an object. Other studies also reveal Augmented Reality which is applied in the world of education as a learning medium (Sahertian, & Muladi, 2013).

The results of teacher response to AR-based learning media showed that 85.71% of kindergarten teachers responded positively to AR-based learning media. This indicates that ar-based learning media developed is suitable for use in early childhood learning. This is in line with the results of research by Saputro & Saputra (2015) in their research showing that the application of Augmented Reality is able to realize the virtual world into the real world,

can display these 2D image objects into 3D objects, so that learning is not monotonous and students are motivated to find out more.

Furthermore, the effectiveness analysis is to find out whether there is an increase in aspects of child development after using AR-based learning media both for students who study from home and students who study at school with the results presented in Table 4.

Table 4 Results of Pre Data Analysis and Post Child Development Data

No	Measure	WFH		WFS	
		Data Pre	Data Post	Data Pre	Data Post
1	Average	61,92	92,33	62,31	89,92
2	Test Normality	*Sig* = 0,890	*Sig* = 0,228	*Sig* = 0,120	*Sig* = 0,720
3	Homogeneity Test	*Sig* = 0,440		*Sig* = 0,654	
4	Paired *t-test*	*Sig* = 0,000		*Sig* = 0,000	

The results in Table 4 showed that the average child's development in both children who learned from home (WFH) and learned from school (WFS) after using AR-based learning media increased results compared to the previous child's development. Similarly, the test results of normality and homogeneity of data as a prerequisite of paired t-test show that the data group has normal data both pre and post data in BDR and BDS data groups. This is indicated from the value of sig greater than $\alpha = 0.05$. For the pre-data group and post pad data group, BDR and BDS have homogeneous data indicated with a sig value greater than $\alpha = 0.05$. The increase in aspects of child development in this study is also in line with the results of research by Mauludin, Sukamto, & Muhardi (2017) which obtained the results that learning media using Augmented Reality technology can easily improve student understanding, student involvement in learning becomes interactive, provides feedback to students so that students get comfortable in using the media.

To find out which is better in the use of Augmented Reality (AR)-based learning media by children who study from home (BDR) and study from school (BDS) it can be seen in the average development of children obtained from the two groups. Table 4 shows that in total the average development of children with BDR is higher than the average development of children with BDS. This indicates that AR-based learning media is quite helpful for children in learning from home. This is in line with research by Ulfadhilah (2021) with results showing that during the elimination of learning from school to study at home due to the Covid-19 pandemic, the implementation of learning runs quite effectively by applying blended learning-based learning. For children with BDR, the average cognitive, physical, motor, and artistic development is better than children with BDS. With the provision of AR-based media, BDR children have wider learning opportunities, children's learning difficulties

can be anticipated, children are easier to ask questions / interact directly with educators (parents / companions) so that children's learning services from home are very good which has an impact on the achievement of aspects of child development. However, the results of this study also found that in other aspects, children who learn from school have a slight advantage over children who learn from home in the context of using AR-based learning media. The results of this study indicate that children who learn from school (BDS) have a better average social emotional development than children who learn from home (BDR). Children who are BDS want to share helping and/or helping friends in using media, children can follow the rules in using media based on instructions, and children are disciplined in learning to use AR media. This is in line with the research of Kusuma & Sutapa (2021) which shows that children's social-emotional behavior appears less cooperative due to online learning from home, children also appear less socialized with their peers.

IV. CONCLUSION AND RECOMMENDATION

Based on the results of this study, the conclusions obtained from this study include: (1) the characteristics of the media developed, namely (a) independent learning resources for children during the Covid-19 pandemic, (b) using Augmented Reality technology to display virtual three-dimensional learning objects. into the real environment, (c) the learning media is contextual, (d) has a flash card; (2) the development of Augmented Reality-based learning media in early childhood learning has been valid after going through a slight revision so that this media product is worthy of use in learning in PAUD institutions in Kendari City; (3) Development of Augmented Reality-based learning media is effective for use in the learning of children of age in PAUD institutions in Kendari City.

The advice related to this research is limited coverage of research participants considering the covid-19 pandemic. Hopefully, augmented reality-based learning media can be implemented in all PAUD institutions in Kendari City, but due to covid-19 conditions and security risks, test subjects are only conducted in 2 schools. Researchers can then attempt to develop this application on other learning themes and the application it develops can be accessed by all parties through installation on the play store.

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