Digitalization of Early Childhood Learning Media Based on 3D Virtual Teacher Figures

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Abstract. Digitizing early childhood learning media is an innovative educational solution to help children learn and develop independence in their learning process. This research focuses on the development of augmented reality (AR) technology-based learning media using virtual teacher figures in 3D form. The aim of this research is to create effective and attractive learning media for young children by using the latest technology to increase children's engagement in their learning process. Using the ADDIE model research and development approach with qualitative and quantitative approaches. This study obtained comprehensive results regarding media with proper interpretations implemented for early childhood by creating interest in independent learning using virtual reality 3D virtual teacher figures and improving learning outcomes. The development of this program consists of three documents which become a unit consisting of: material development, learning media with augmented reality technology, and media (print and digital) learning media markers that become scan boards to accommodate 3D objects of virtual teacher figures. This research contributes to the development of innovative and effective learning media for early childhood by presenting a disruption in the development of virtual teacher figures.

Keywords: Media, Learning, Early Childhood, 3D Virtual Teacher Figures.

1 Introduction

Early childhood education involving kindergarten education is education that focuses on the personal development of children in terms of personality [1], physical abilities [2], cognitive, verbal, artistic [3], social, emotional, spiritual, self-discipline, self-concept, and independence and development [4]. Children at an early age are at their best, physically and mentally, and have an extraordinary capacity to learn with enthusiasm [5]. Enthusiastic learning must be encouraged with educational infrastructure that is unique, up-to-date (not boring) and provides an excess of curiosity. Besides that [6] early childhood development is closely related to the environment and family as the main companion of the learning process [7].

With regard to the educational infrastructure, learning media is a system that has an absolute connection with the learning process planned, implemented, and evaluated systematically to achieve effective and efficient learning objectives [8]. In this regard,

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the educational assistant becomes the main object, because someone who accompanies and guides children in all stages of their growth [9], nurturing, protecting and guiding a child's new life at all stages of its development becomes important for early childhood [10].

Improving the quality of education infrastructure, teacher quality, and learning effectiveness is an emergency challenge that must be resolved immediately [11]. This happens because the mobility of an ideal learning model must be supported by a touch of technology that can simplify and increase student interest in certain subjects [7]. Problems that arise at this time in the early childhood learning process in the distance learning process (in the network) the media used are very identical to teleconference and video media [12]. The use of this media results in students finding it difficult to be independent and students' engagement with learning decreases. The ideal learning process the earlier the age at which independent development tasks are practiced, the easier independent values and skills will be obtained and will be firmly ingrained in the child [13]. Early childhood independence is defined as the ability to make choices, be creative, coordinate behavior, be responsible, and respect others. This is consistent with the statement [14]. Independence has a major impact on the life experience of completing tasks in everyday life.

Learning infrastructure [15], learning independence goals [16], and the learning process becomes everything that can be used to convey messages or educational content that stimulates thoughts, feelings, concerns [17], and skills of children so as to facilitate the achievement of the activity process. It is supported by Aditama the use of interactive learning media is very helpful in the learning process [18]. Augmented reality as an interactive learning media is very helpful in the learning process [19]. This application can create visual images of 2-dimensional objects into 3-dimensional objects so that they can interact with 3D objects with attractive colorful displays and audio quality [20]. This can describe the problems regarding the crisis of student independence in learning, the attention of parents and educators with virtual visual image learning media infrastructure and increasing teacher effectiveness in assisting students [21].

Several previous studies regarding the use of technology in early childhood learning have shown that technology can provide many benefits, such as increasing interest [22], and children's learning motivation [23], help children understand difficult concepts [24], and develop children's cognitive and motor skills [25]. However, the use of technology in early childhood learning still has several weaknesses, including: (1) Limited interaction between children and the technology used, so that they do not provide adequate learning experiences for children [26], (2) Lack of interesting and effective use of technology in early childhood learning, so that children are less interested and motivation to learn decreases [27], and (3) Lack of use of technology that is able to follow and adapt to the learning needs of individual children [7].

In this regard, this research and development study is present as a solution to overcome this gap. This research develops interactive learning media that uses 3D figures and virtual teachers as a more effective and interactive learning approach. This learning media can better accommodate children's interactions with the technology used and provide a more adequate learning experience for children. In addition, 3D figure technology and attractive and effective virtual teachers can increase children's learning

interest and motivation, so that learning becomes more effective. This technology can also adapt to the learning needs of individual children, so that learning becomes more effective and efficient. In addition, this research is also expected to contribute to the development of better learning approaches in the future as a disruption of independent student technology without a teacher.

This 3D virtual teacher development study in learning media makes a major contribution in the field of learning media development which is ideal for supporting the independence of students and teachers through the latest technology that is efficient and effective [10]. In the process, this media development study became the first development study on the application of 3D virtual teachers in the development of early childhood learning media, especially kindergarten education. This can contribute to the process of developing learning media that is identical to virtual figures in the application of learning without using virtual reality specifically in early childhood learning. The main contribution of this development is to support the pilot project of digitizing learning through modern learning infrastructure [27]. This process is an effort to support teacher professionalism to become a pilot project for implementing ideal learning media, support holistic learning, and increase the effectiveness of the teacher's role in the learning environment without worrying about the achievement of learning outcomes not being fulfilled.

The aim of this research is to develop an interactive and engaging digital learning system for early childhood using 3D figure technology and virtual teachers. In particular, this study aims to create a learning media that can help children understand subject matter more easily and fun, and increase children's interest and motivation to learn. In addition, this research also produces a learning model that can be applied in the context of more effective and efficient early childhood education, and can reduce the teacher's workload in providing subject matter. The lessons presented pay attention to the characteristics of early childhood who need learning media that are easy to understand and fun in implementing the independent curriculum. The developed learning system is expected to help children understand subject matter more easily and pleasantly, and can increase children's interest and motivation in learning.

2 Methods

2.1 A Subsection Sample

The research process uses the ADDIE Model research and development approach [28]. This is to obtain research results that are detailed, structured in the process, and holistic in the development process in accordance with the research objectives. This research process has the output of three documents which become a unit consisting of: material development, learning media with augmented reality technology as the main technology for 3D virtual teacher figures, and media (print and digital) learning media markers that become scan boards to accommodate 3D objects of virtual teacher figures. This research was tested at two levels, the first was a trial based on an educational institution at the Kindergarten Laboratory Kindergarten, State University of Malang,

East Java. Second, a random community with various Kindergartens which was tested in the open field with a sample of children with a kindergarten equivalent education.

This study follows the flow of development research development, this consists of identifying problems (providing the results of needs analysis), material development design, media development design, expert validation, and implementation. The research process consists of 5 (five) strategic stages including analysis, design, development, implementation, and evaluation. The following is a workflow chart of the research conducted.

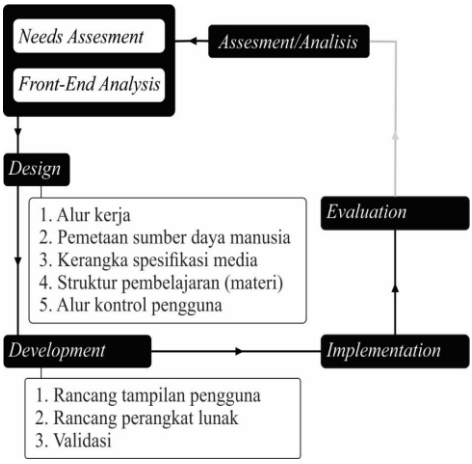


Fig. 1. Chart of Research and Development Procedure Model (Bamrara & Chauhan, 2018)

2.2 Research Procedure

This research and development procedure refer to the researcher's process of aligning related research processes. The observation stage is the stage for obtaining a needs analysis about the learning process, problems that need to be resolved, and the scope of solving problems that occur. This process was supported by an interview process with kindergarten teachers who were involved in the media research and development process. The next step refers to the development flow of this research, entering the design stage. This design stage process determines the media that will be used to solve the problem. After the media has been created, the next process is to carry out expert validation using a media validator questionnaire, this process is to support the feasibility study of the implementation of the research process during the media trial stage into two stages (educational agencies and the community). The final process is conducting random trials on kindergarten and community educational institutions.

2.3 Data Collection

The data collection process was carried out using interviews, observations, and questionnaires to kindergarten teachers with qualitative data. Structured semi-formal interviews to increase teacher perceptions in providing a description of the problems being faced, to be resolved, and increasing teacher motivation to engage in the development of this development research study up to the end point of the research. All processes

carried out are assessed by four expert validator assessments, including one learning media practitioner validator related to the learning media user interface, two teachers as principal implementers of education as material validators, and one school principal as a media practitioner validator with quantitative data measures. The involvement of the practicality and effectiveness trials of this research was divided into two groups, the first were students of the Malang State University Laboratory Kindergarten and The next process was carried out randomly with a sample of kindergarten students in an open room with the size and type of quantitative data. This process was also supported by six kindergarten teachers, one kindergarten principal, and the involvement of 4 research stakeholders as internal media development for kindergartens. Expert validator process to provide advice and input on product development results. The results of the input from the expert validator will be used as the basis for improvement in the ongoing implementation process.

2.4 Data Analysis Technique

Material and Media Validation Data

The media validation test was carried out by two material experts and two media experts. Data processing validation test results aims to determine the feasibility level of the media being developed. Scores on each validation test item can be seen in the following table:

Table 1. List of Validation Scores [38]

Score	Information
1	Strongly agree
2	Agree
3	Simply Agree
4	Disagree
5	Don't agree

While the validity category can be seen in the following table:

Table 2. List of Validation Scores [38]

Achievement Level (%)	Classifications
81-100	Very Worth it
61-80	Worthy
41-60	Decent Enough
21-40	Less Eligible
0	Not feasible

For the final measurement of the validation level, use the following formula by Salas-Rueda et al [37]:

$$V.ah = \frac{TSe}{TSh} \times 100\% \quad (1)$$

Descriptions:
V.ah. : Expert validation
TSe : Total Empirical Score
TSh : Total Expected Score

Learning Outcome Analysis Test

The normality test is carried out first as a prerequisite test to determine to assess the distribution of data in a group of data or variables, whether the data distribution is normally distributed or not. The normality test used is the Kolmogorov-Smirnov normality test. Paired t-test or paired t-test is used to analyze the hypothesis on paired sample data.

Practicality Test

The practicality questionnaire sheets in this study were designed to refer to the questionnaire grids. It is intended that the research instruments used can measure systematically and accurately through the practicality value formula through:

$$\%Practicality = \frac{Acquisition\ Score}{Maximum\ Score} x\ 100\% \quad (2)$$

3 Findings and Discussion

3.1 Needs Analysis

The research and development process is never separated from the results of the needs analysis. This process supports the continuity of development and linkage with the media output to be completed. Needs analysis is used to obtain exposure to data sources that will be used as basic needs for research and development of kindergarten learning media. The presentation of the needs analysis consists of a descriptive analysis of the results of interviews conducted with teachers. This process is to find out the barriers to learning, how to overcome obstacles and problems in learning, the main purpose of learning as the main goal of solving problems, exposure to ideal problem solving, and the involvement of human resources as research support so that researchers get contributions of thoughts and ideas from various parties.

Table 3. Summary of Needs Analysis

No	Topics	Results
1	Emergency problems of the learning process	The problems that occur can be described as follows: 1) learning based on digital learning media, students tend to get bored if learning is done with an online system; 2) the learning process in networks with digital media is less than optimal, this is related to assistants who must actively run learning media and actively accompany students, this reduces the independence of students to learn and get acquainted directly with the technology created; 3) the learning process must present the teacher virtually so that students feel cared for, accompanied, and prioritized.

2	Ways to solve the problem (temporary and not optimal)	The things that the teacher has done to solve these problems are: 1) conducting video teleconferences; 2) creating learning videos for each learning theme; 3) using conventional paper-based learning media.
3	Learning is done on the basis of the process of problems that occur so that they are resolved immediately	The teacher strives for the learning process in an obstructed state to carry out digital innovations to support effective and efficient learning, in this case related to topic point 4.
4	Development of dream media to solve problems that occur	Interactive learning media that can display teachers in the learning process with virtual reality conditions.
5	The state of supporting human resources	Supporting human resources fulfill aspects of media use starting from: 1) technology implementation, media application to students; 2) research carrying capacity; 3) and media maintenance carrying capacity. Teachers volunteer to be fully involved as development collaborators through the development research process.

Based on this needs analysis, kindergarten teachers agreed to provide material development with the theme I Love the Earth, This material will be given as initial material in the first semester learning process of kindergarten.

Table 4. Distribution of Development Materials

Theme	**Topics**
I love Earth	Get to know me
	Get to know my gender
	Get to know my birth date
	Get to know my home address
	I'm grateful to have a complete body
	The parts of my body and their characteristics
	I have five senses
	Maintain a healthy body
	My favorite food
	My drink
	My traditional cake
	I love animals
	The variety of land animals and their places of life
	Variety of aquatic animals and their places of life
	The variety of aerial beasts and their places of life
	My beautiful environment
	Caring for plants
	My green environment

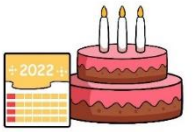
The beauty of the universe Natural wealth in my country Take care of nature

Media Asset View

Display 1. Interactive Augmented Reality Marker

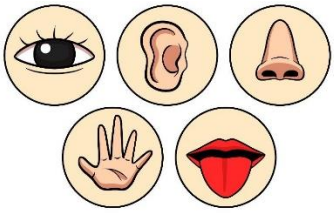
Sub-theme 1: Know Myself

Know my gender, know my date of birth, and know my home address



Sub-theme 2: I'm grateful to have a complete body

The parts of my body and their characteristics and I have five senses

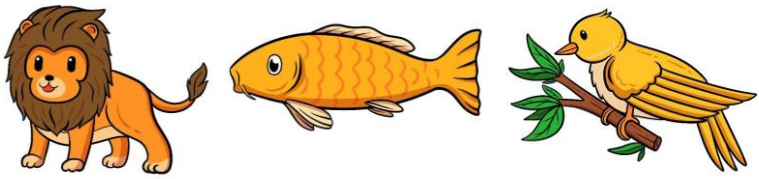


Sub-theme 3: Maintaining a healthy body

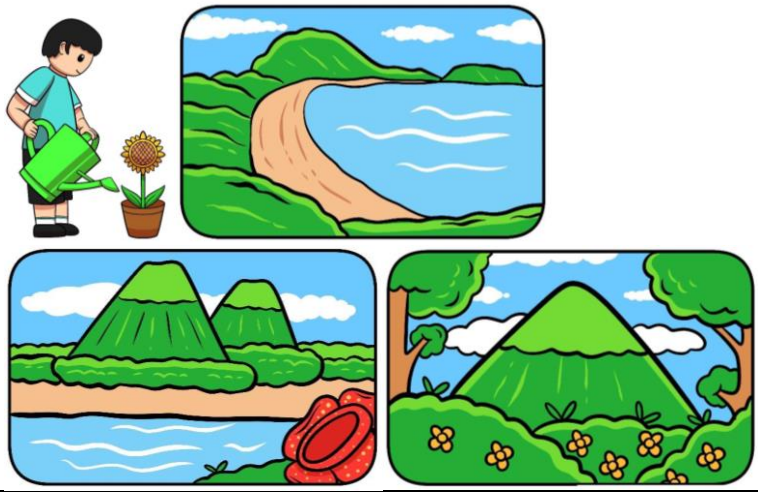
My favorite food, my drink, and my traditional cake

Sub-theme 4: I love animals

The Variety of land animals and where they live, and the Variety of aerial beasts and where they live.



Sub theme 5: The beauty of my environment
Taking care of my plants, My green natural environment, The beauty of the universe, Natural wealth in my country, and Protecting nature.



The next stage is to carry out the coding and developing process to accommodate material development in order to form media that can support target users including: 1) media suitable for use by users; 2) the media is suitable for use by teachers; 3) learning media can accommodate student interest.

Display 2. User Interface and Application Display

User Interface (UI) is a visual display and interaction between the user and the system that is used to facilitate the user in carrying out certain tasks easily and efficiently. UI typically consists of elements such as menus, buttons, icons, text inputs, images and other visual displays designed to provide an intuitive and responsive user experience. The main goal of UI is to increase usability, affordability, and user satisfaction by creating a system that is easy for students or student assistants to use and understand.

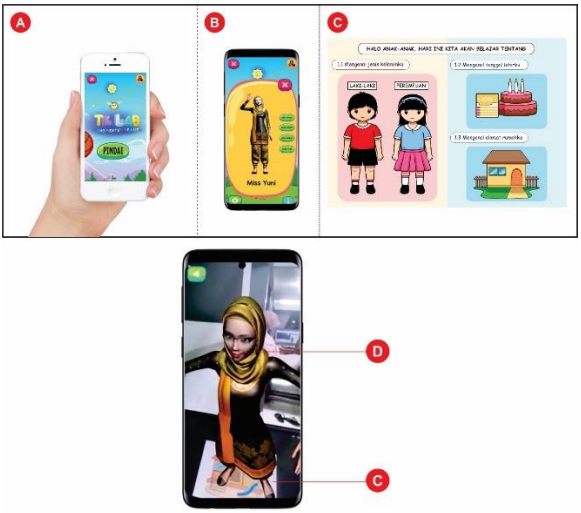


Fig. 2. User Interface Software

The user interface in the description of this software includes four functional buttons consisting of:

A) Marker Scanner Menu

The augmented reality marker scanner menu in the application is used to read and recognize markers in a real environment. Each marker has a certain pattern that can be recognized by the augmented reality marker scanner application, so that when the marker is scanned, the application will display a three-dimensional object or image associated with the marker on the device screen.

B) Teacher Figure Selection Process

The selection of teacher figures in an application developed for digitizing early childhood learning media based on 3D virtual teacher figures aims to provide a more interesting learning experience and interactive for children. In selecting teacher figures, attention must be paid to the desired characteristics in order to motivate children to learn and provide optimal learning experiences.

C) Marker Augmented Reality

Augmented reality markers are used to project 3D virtual objects on physical objects in the real world that have been marked with these markers. The use of AR markers can help improve interaction and user experience in accessing information visually, and provide a more interactive and enjoyable learning experience.

D) Virtual Teacher Figure Visualization

Visualization of Virtual Teacher Figures is used to strengthen interactions between early childhood and learning media. Visualization of virtual teacher figures using 3D technology, virtual teacher figures can be made more attractive and realistic so as to increase interest in learning and children's participation in learning.

3.2 Expert Validation

Based on the empirical score given by the material expert validator regarding all aspects of research media in the development of learning media, a score of 226 is obtained from an expectation score of 250. If the score is interpreted as a percentage, then the final result is 90.4%. Thus, it can be concluded that the research media for the development of learning media is very worthy of being tested for validation in every aspect. The media expert validator's assessment of all aspects of the material in this learning media development research, obtained an empirical score of 233 out of an expectation score of 250. If the score is interpreted in the form of a percentage, then the final result is 93.2%. With these results, it can be concluded that this learning media development research is very feasible to be tested for validation in every aspect.

3.3 Analysis of Student Learning Outcomes

Based on prerequisite test analysis. The results of the significance value (Sig) were obtained. the Kolmogorov-Smirnov normality test is above the 5% confidence level or 0.05, which is 0.099 or monte carlo Sig. (2-tailed) > 0.05. This means the data distribution is normal.

Table 4. Normality Test: Analysis of Student Learning Outcomes

One-Sample Kolmogorov-Smirnov Test		
		Unstandardized Residual
N		100
Normal Parameters[a,b]	Mean	.0000000
	Std. Deviation	4.83319939
Most Extreme Differences	Absolute	.081
	Positive	.081
	Negative	-.079
Test Statistic		.081
Asymp. Sig. (2-tailed)		.099[c]

Paired t-test or paired t-test is used to analyze the hypothesis on paired sample data. The hypothesis proposed is:

H_0: There was no significant increase in the value of the pre-test and post-test results after the implementation of media development

H_a: There is a significant increase in the value of the pre test and post test results after the implementation of media development

In an effort to test the hypothesis above, the results of the paired t-test analysis are presented in the form of paired sample statistics, paired sample correlations and paired sample test (sig-2 tailed) in the table below:

Table 5. Paired Samples Statistics

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre Test	71.63	100	4.213	.421
	Post Test	83.39	100	4.872	.487

The results of the paired t-test above show that the average of the 100 samples shows the results of the pre-test value before implementing the media is 71.63 dan the average value of the post test results after the implementation of the media is 83.39. From these results it can be seen that the average post test score after applying the media tends to increase. This means that there is a significant increase in the value of the pre-test and post-test results after the implementation of this learning media development research. Based on the results of data analysis, it shows that students' pre-test and post-test scores tend to increase after the implementation of this media development research. This can be seen in the graphic below.

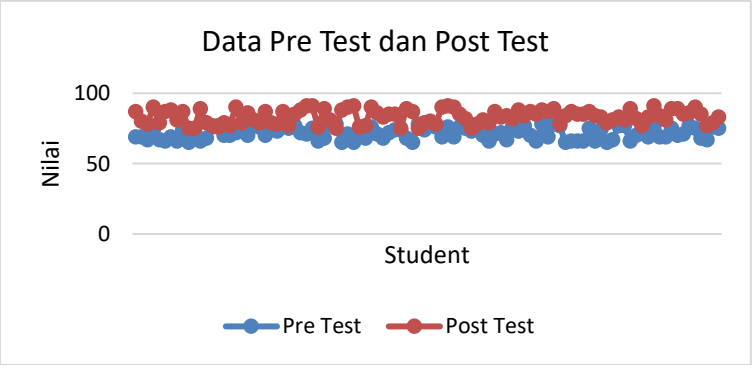


Figure 1. Data Pre Test dan Post Test

This means that there is a significant increase in the value of the pre-test and post-test results after implementation in Table 6. The following Paired Samples Correlations:

Table 6. Paired Samples Correlations

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pre Test & Post Test	100	-.126	.212

The results of the paired sample correlations test show that there is a correlation coefficient value (correlation) between the pre-test and post-test variables -0.126 (low) with a significance value (Sig). of 0.212. Because the value of Sig. 0.212 > probability 0.05, it can be said that there is no relationship between the pre-test and post-test variables.

Table 7. Paired Sample Test

Paired Samples Test									
		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre Test - Post Test	-11.760	6.830	.683	-13.115	-10.405	-17.218	99	.000

The results of the t-test in the form of the Paired sample test show that the significance value is 0.000, which means it is less than 0.05 or 0.000 <0.05, then H0 is rejected and Ha is accepted. It can be said that there is a significant difference in the value of the pre-test and post-test results after the implementation of the media.

3.4 Media Practicality and Effectiveness Test

Response data is the result of filling out the media practicality questionnaire sheet. The data obtained was then analyzed and the results presented. Based on the results of the analysis of the results of filling out the media practicality questionnaire, the overall average value was 87.60%. When referring to the practicality value table, the practicality of the media is at a very practical level. The results of the practicality questionnaire analysis are presented in the following table:

Table 8. Practicality Test Results

Items	Practicalities	Interpretation
1	87,88	Very Practical
2	87,88	Very Practical
3	88,16	Very Practical
4	87,72	Very Practical
5	86,36	Very Practical

It is important to study the process of digitizing early childhood learning media based on virtual teacher 3D figures, referring to the following findings: (1) Improving the effectiveness of early childhood learning supported by the learning system developed in this study is designed to optimize children's understanding to the subject matter by paying attention to the characteristics and needs of early childhood. The use of 3D figure technology and virtual teachers is expected to increase the effectiveness of early childhood learning, so that they can more easily understand and apply the subject matter provided; (2) Increase children's learning motivation. Which is supported by the learning presented in this study is designed to be more interesting and fun for children, so as to increase their learning motivation. The interactive use of 3D figure technology and virtual teachers can make children more interested and engaged in learning; (3) Reducing the teacher's workload. Development of an interactive digital learning system, teachers can take advantage of this learning media to speed up the learning process and reduce their workload in providing subject matter directly. This can improve efficiency in learning and allow teachers more time to provide guidance and development to

children; (4) Making early childhood education more modern. The use of 3D figure technology and virtual teachers in this learning system can also bring early childhood education in a more modern and up-to-date direction. This can open opportunities for the development of early childhood education that is more innovative and adaptive to changing times; (5) Broad application projections are supported by the process and implementation of learning facilities developed in this study can be widely applied in early childhood education. This can have a positive impact on the development of early childhood education in various countries and learning environments.

Digitalization of learning media in early childhood using virtual teacher 3D figure technology and augmented reality (AR) has the potential to improve the quality of learning and enrich children's learning experiences [29]. Virtual teacher 3D figure technology enables more interactive and visual teaching which can help children understand concepts better [30]. The virtual teacher will guide the children in learning by using interesting and easy-to-understand animations or 3D images. Children can also interact with these 3D figures, thus providing a more interesting and interactive learning experience [12].

Meanwhile, AR technology enables a more lifelike and real learning experience [26]. By using this technology, children can integrate information from the real world and the virtual world in the learning process. For example, children can view virtual objects in the real world using their smartphone or tablet camera. In the context of developing this study AR technology can be used to combine 3D figures and virtual teachers with real environments, thus providing a more lively and interesting learning experience for children. Virtual and AR teacher 3D figure technology can be adapted to the needs and characteristics of early childhood. Early childhood has different cognitive and psychomotor characteristics than older children, so that the technology needs to be adapted to meet the learning needs of children [31]. Therefore, the development of digitizing learning media in early childhood uses virtual teacher 3D figure technology and AR needs to be done by taking into account the characteristics and learning needs of children [32], so as to provide optimal results in the process of learning and learning.

The concept of developing virtual teachers as early childhood learning media has advantages in supporting children's independence in the learning process [33]. Children can learn independently with the help of virtual teacher 3D figure technology that presents learning materials visually and interactively. In this case, virtual teachers can act as substitutes for teachers or parents who guide children in learning. Children can access learning materials anytime and anywhere with the help of this technology, so that they have the flexibility to study according to their needs and time. In this way, children can study efficiently and productively, without having to be tied to a specific time and location.

In addition, virtual teacher 3D figure technology also has advantages in increasing children's learning motivation. Children can learn in a more interesting and interactive way, thereby sparking their interest in learning [29]. Through interactive learning media, children can experience a more fun, creative and entertaining learning experience [13]. This can trigger them to continue learning and acquiring new knowledge. In the long term, the concept of developing virtual teachers as learning media can help children to develop their learning abilities independently. In an increasingly advanced

digital era, this technology can be an alternative to overcome challenges in learning that occur in the surrounding environment [34]. In this way, children can develop their ability to search for information, develop critical thinking and problem solving skills.

Overall, the development of virtual teachers as early childhood learning media can be a promising solution for the future of education. With the support of increasingly sophisticated technology, the development of this virtual teacher can provide many benefits for children in their learning process, increase their independence and motivation to learn, and help them develop more independent and effective learning abilities. In the previous research process, there were several weaknesses in the development of early childhood learning media. One of the main drawbacks is the lack of interaction and a fun learning experience [27].

Many learning media are still static and do not attract children's attention, thus making them less motivated to learn [7]. Hal This certainly has an impact on the effectiveness of learning and the child's ability to understand the subject matter properly. Apart from the lack of interaction and a pleasant learning experience, Another weakness of early childhood learning media is the lack of flexibility in learning time and location. Children often have to come to a certain place of learning at a certain time, which makes learning feel rigid and inflexible. This is certainly an obstacle for parents who are busy and find it difficult to adjust their child's learning schedule with their own schedule. Finally, another weakness of early childhood learning is the lack of independence in the learning process. Children still depend on guidance and direction from teachers or parents in understanding learning material. This is certainly not ideal, because children should be trained to be independent and able to learn independently.

However, the concept of developing virtual teachers as early childhood learning media is able to accommodate these weaknesses. With interactive and fun virtual teacher 3D figure technology, children can be involved in the learning process more actively and enthusiastically. Augmented reality technology can also provide a more immersive and realistic learning experience, so that children can more easily understand the subject matter. Virtual teacher development also provides flexibility in time and location of learning. Children can learn anywhere and anytime, so they don't need to be tied to a rigid learning schedule. This is of course very helpful for parents who are busy and find it difficult to adjust their child's learning schedule with their own schedule.

The concept of developing virtual teachers can also help children develop independence in the learning process [35]. Interactive and fun learning media, children can understand the subject matter more easily and quickly. They can also learn in a more creative and active way, thus triggering them to continue learning and developing their learning abilities. In this context, the concept of virtual teacher development can be a new idea in the future of early childhood education to support independence and effectiveness of learning [36]. In the current situation, the development of innovative and interactive learning media can be presented to improve the quality of children's learning.

Research on digitizing early childhood learning media based on virtual teacher 3D figures with augmented reality technology is an interesting breakthrough in the world of education. Implementation of the concept of virtual teacher development, early childhood can learn in a way that is more fun, interactive and independent. As a result,

this research can be a solution to overcome the weaknesses of previous learning media which tend to be monotonous and less interactive.

The use of augmented reality technology in learning provides an advantage in visualizing information that is easily understood by young children. This is because augmented reality technology can display interactive three-dimensional images from digital devices, so that children can learn in a way that is more interesting and fun. In addition, this technology also allows children to actively participate in learning, which can help increase their motivation and interest in learning. From a learning independence point of view, virtual teachers can also provide significant benefits for young children. Long-term implementation, this can help increase children's independence in learning and help them to become more independent in the future.

In closing, digitizing early childhood learning media based on virtual teacher 3D figures with augmented reality technology can provide many benefits for early childhood, such as a more interactive, fun, and independent learning experience. Therefore, this research has the potential to make a positive contribution in the world of education and is worthy of further development in the future.

4 Conclusion

The development of virtual teacher 3D figure-based early childhood learning media has been tested as valid and feasible to implement. The results of the development are in the form of three documents which become a unit consisting of: material development, learning media with augmented reality technology, and media (print and digital) learning media markers that become scan boards to accommodate 3D objects of virtual teacher figures.

This development provides opportunities for collaborative research across disciplines broadly to increase the focus of collaborative media development. Furthermore, this process has arrived to answer the problems that occur and describe the problems of the learning process. The challenges that have been answered support the development of sustainable research on special early childhood education issues (in this case kindergarten). However, the researcher realizes that this development research process has limitations. First, the variety of samples with minimal multi-geographical samples. Second, the limitations of the study involving kindergartens with a major zero grade (TK A). Finally, the empirical findings are limited to a single school and the community in general (with a sample kindergarten education level).

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