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Prototype of Manipulative Basic Movement Learning Model Based on Augmented Reality

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ABSTRAK

Dalam era digital yang semakin maju, teknologi telah merambah ke berbagai aspek kehidupan, termasuk dalam bidang pendidikan. Salah satu inovasi teknologi yang memiliki potensi besar untuk meningkatkan kualitas pembelajaran adalah Augmented Reality (AR). AR memungkinkan penggabungan antara dunia nyata dengan elemen-elemen digital, memberikan pengalaman belajar yang lebih interaktif dan imersif. Dalam konteks pendidikan jasmani, khususnya dalam pembelajaran gerak dasar manipulatif, penerapan AR dapat menjadi solusi untuk mengatasi berbagai kendala yang dihadapi selama ini, seperti keterbatasan fasilitas, kesulitan visualisasi gerakan, dan minimnya interaksi praktis. Penelitian ini bertujuan untuk mengembangkan model pembelajaran gerak dasar manipulatife berbasis augmented reality serta dikembangkan menjadi panduan bagi mahasiswa dan guru olahraga dalam mengajarkan gerak dasar. Produk yang dihasilkan adalah model pembelajaran gerak dasar manipulatife berbasis augmented reality, buku panduan penggunaan aplikasi. Penelitian ini dikembangkan dengan mengadaptasi penelitian dan pengembangan pendidikan model Borg & Gall. Prosedur pengembangan yang digunakan meliputi tahapan menganal isi produk yang dikembangkan, mengembangkan produk awal permainan, validasi ahli, ujicoba lapangan, revisi produk Teknik analisis data yang digunakan dalam penelitian ini melalui dua cara yakni kuantitatif dan kualitatif. Hasil penelitian menunjukkan bahwa model pembelajaran gerak dasar manipulatife berbasis augmented reality dapat menilai kemampuan siswa sekolah dasar, aplikasi yang dikembangkan oleh peneliti juga mudah digunakan oleh guru PJOK dalam menilai model pembelajaran gerak dasar manipulatife berbasis augmented reality yang dapat dibawa kemana saja oleh guru PJOK yang bersifat portable. Implikasi penelitian ini dapat memberikan panduan bagi pengembang perangkat lunak pendidikan untuk menciptakan aplikasi AR yang lebih relevan dan bermanfaat dalam konteks pembelajaran.

ABSTRACT

In the increasingly advanced digital era, technology has penetrated various aspects of life, including the field of education. One technological innovation that has great potential to improve the quality of learning is Augmented Reality (AR). AR enables the combination of the real world with digital elements, providing a more interactive and immersive learning experience. In the context of physical education, especially in learning basic manipulative movements, the application of AR can be a solution to overcome various obstacles faced so far, such as limited facilities, difficulties in visualizing movements, and lack of practical interaction. This research aims to develop a model for learning basic manipulative movements based on augmented reality and develop it into a guide for students and sports teachers in teaching basic movements. The resulting product is a basic manipulative learning model based on augmented reality, a guidebook for application use. This research was developed by adapting the Borg & Gall model of educational research and development. The development procedures used include the stages of analyzing the content of the product being developed, developing the initial game product, expert validation, field trials, product revision. The data analysis technique used in this research is in two ways, namely quantitative and qualitative. The results of the research show that the augmented reality-based basic manipulative movement learning model can assess elementary school students' abilities, the application developed by researchers is also easy to use by PJOK teachers in assessing the augmented reality-based basic manipulative movement learning model which can be carried anywhere by PJOK teachers. portable. Implications This research can provide guidance for educational software developers to create AR applications that are more relevant and useful in learning contexts.

1. INTRODUCTION

Technological developments are currently increasingly rapid, technological sophistication can be seen from the development of devices such as smartphones, tablets, notebooks and so on (Setia Hasibuan et al., 2023; Supriadi et al., 2023). One of the ways in which technological progress is proven is the widespread use of gadgets among the public, various types and features of services have been provided so

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that they have become an attraction for users. Technological developments are also accompanied by developments in devices, namely software. An example of technological development as supporting software is Augmented Reality (AR) (Ridwan et al., 2021; Rizal et al., 2018)

Augmented Reality (AR) technology projects these objects in real time. Based on (Nelva Saputra et al., 2020) define "*Augmented Reality* is a variation of Virtual Environment or better known as Virtual Reality. Virtual Reality technology in its use places the user into a virtual world so that the user feels the sensation of entering the application environment (Ridwan et al., 2021; Sintaro et al., 2020). Meanwhile, at the same time, Augmented Reality technology is able to add reality to the real world with elements of virtual objects where the dividing wall between the real world and the virtual world does not seem to exist." This research combines technology. *Augmented Reality* Cards with regular cards or commonly called (AR-Cards). *Augmented Reality* The card (AR-Card) is a combination of cards equipped with Quick Response Code (QRC) type markers, and equipment to capture these markers to display the results with the help of technology. *augmented reality*. Augmented Reality (AR) can be defined as a technology that is capable of combining two-dimensional or three-dimensional virtual objects into a real environment and then displaying or projecting them in real time. AR can be used to help visualize abstract concepts for understanding and structure of an object model. Some AR applications are designed to provide users with more detailed information from real objects. Media is a tool or object that functions as a link between the recipient and sender of the message (Kustiawan et al., 2018; Timban et al., 2023).

Because the contribution of technology is getting bigger *reality* to various fields such as health, industry, military, and education, *augmented reality* is currently attracting public attention. One of the benefits of augmented reality technology in the health sector is that doctors and nurses can practice studying human anatomy without dissecting human anatomy directly, so this technology can provide benefits in the health sector (Abubakar, 2021; Endriani et al., 2019). Reality technology creates advertisements for its products, such as making advertisements on brochures with markers to make them look real. In the military field, augmented reality technology is used in war games, such as soldiers going to war (Dedy et al., 2019; Wahyudi & Arwansyah, 2019). Currently, technology is increasingly developing *reality* also contributes in the field of education, especially in the field of sports, in teaching basic movements to elementary school students so that the learning objectives of Physical and Health Sports (PJOK) in elementary schools (SD) can be achieved well.

The general aim of physical education in elementary schools is to stimulate physical, mental, emotional and social growth and development in line with efforts to form and develop basic movement abilities, instill values, attitudes and get used to healthy living (Dewi & Faridah, 2022; Imran Akhmad, 2022). Educational goals are achieved through movement and sports activities. The quality of achieving goals is determined by the physical education teacher's ability to carry out the learning process. Teachers must have knowledge about physical education (PE) and sports as well as knowledge about how to design PJOK learning media that stimulates students to be creative and play an active role in every PJOK lesson (Endriani et al., 2019; Sinaga et al., 2022). In learning in primary and secondary schools, it is very important to pay attention to basic movements in students, especially locomotor, non-locomotor and manipulative movements. Skills are actions that require movement activities that must be learned in order to obtain the correct form of movement (Dewi et al., 2019; Sinaga et al., 2022). A person is said to be skilled if he is able to carry out activities according to the correct movements.

Manipulative movements involve the act of controlling an object primarily with the hands and feet. There are two classifications of skills for manipulative movements, namely receptive and propulsive (Dewi et al., 2021; Verawati et al., 2021). States that manipulative movements are movements that require coordination with the space and objects around them. Manipulative movements or skills involve the act of controlling an object, especially with the hands and feet (Hidayat, 2019; Imran Akhmad, 2022). In manipulative movements there is something that is moved, for example throwing, catching, kicking, kicking, dribbling the ball, hitting, bouncing, bouncing, hitting with a racket, hitting with other tools and other movements related to throwing, catching something (Dewi et al., 2020, 2021; Dewi & Verawati, 2021). States that the ability to use large muscles in early childhood is classified as basic movement ability, this ability is carried out to improve the quality of life. Furthermore, basic movement abilities are divided into three categories, namely locomotor and non-locomotor and manipulative. Manipulative movements are usually described as movements that use certain objects as a medium, or skills that involve the ability of a person's body parts to manipulate objects outside themselves. States that these skills need to involve hand-eye coordination and speed, agility, eye-foot coordination, for example catching, throwing, kicking, hitting with a racket, stick or bat. Manipulative motor skills are the use and control of small, limited muscle movements, involving the hands, feet, and eyes (Dewi, Verawati, Pane, et al., 2022; Dewi, Verawati, Sukamton, et al., 2022). These manipulative movements include throwing and catching.

For this reason, teachers must be able to combine advances in science and technology as well as teacher skills in teaching basic manipulative movements based on science and technology, so that researchers try to offer an appropriate technology by visualizing learning basic movements into technology, *augmented reality* so that students are able to enrich and visualize at a high level *sequential thinking skills* before they can carry out the exercise. In fact, this technology really helps teachers in teaching and creating creations related to the use of science and technology as PJOK learning media. Several relevant studies have been conducted by previous researchers through research journal studies which reveal that the use of educational media using Augmented Reality can stimulate students' mindsets in thinking critically about problems and events that occur in everyday life, because of the nature of educational media. is to help students in the learning process whether or not educators are present in the educational process, so that the use of educational media with augmented reality can directly provide learning wherever and whenever students want to carry out the learning process (Dedy et al., 2019; Mustaqim et al., 2019a).

AR Learning Media can visualize abstract concepts for understanding and structure of an object model, making AR a more effective media in accordance with the objectives of learning media. Previous research also revealed that Augmented Reality technology can increase learning motivation and can introduce basic pencak silat movements (Ridwan et al., 2021; Sudarmilah et al., 2019). Other research shows that the feasibility test results for the Augmented Reality Magic Card Application show that the feasibility percentage for material experts is 89.68% with the category very suitable for testing, for the results from media experts it is 92.70% with the category very suitable for testing, and the assessment results are 91 .42% of respondents were in the Very Eligible category to be tested. Based on the test results, the Magic Card Augmented Reality Application for Basic Sundanese Dance Movements is Very Suitable for Use. The final conclusion based on respondents' assessments is good with a graphics percentage of 64%, software engineering presentations of 71% and entertainment applications of 81%. In the future, applications can be developed using the markerless method so that it attracts more student interest in learning (Larasati & Widyasari, 2021; Nurhayati Sri Mulyani, 2021; Nurwijaya, 2021).

To strengthen the background of the problem that the researcher describes, the researcher tried to conduct preliminary research through a preliminary survey conducted in the city of Medan through PJOK teachers throughout the city of Medan. 90% percent of teachers have not implemented school-based learning, *augmented reality*, even PEJOK teachers still wonder what augmented is *reality*. So from these results the researchers tried to design basic manipulative movement learning based on augmented reality for PJOK teachers. The aim of this research is to develop and evaluate a prototype of a basic manipulative learning model based on Augmented Reality (AR) that can be used in physical education. Specifically, this research aims to create an AR application prototype that can visualize basic manipulative movements interactively and realistically, test the effectiveness of using the AR application in improving students' understanding and skills regarding basic manipulative movements, evaluate the level of student satisfaction and motivation in using AR technology as a learning medium and provide recommendations for developers and educators regarding the implementation of AR in the physical education curriculum. Thus, it is hoped that this research can make a significant contribution to innovating teaching and learning methods that are more effective and interesting.

2. METHODS

The research method used is a development research method with a qualitative approach. Development research is not to create theories or test theories but rather to develop manipulative learning models based on augmented basic movements *reality*. The development method used in this research is the Borg and Gall development model with 7 steps. Development research can be stopped until a final design is obtained, without testing the results (Dewi & Faridah, 2022; sugiyono, 2010). The results or impact of implementing the development of a learning model based on basic manipulative movements are enlarged *reality* already exists in small group trials and large group trials. The data obtained is described in detail to determine the level of validity, practicality and the effectiveness of the manipulative-based basic motor learning model is improved *reality.*

This research procedure was carried out through several main stages. First, a literature study and needs analysis was carried out to understand the concept of basic manipulative movements and the potential application of AR in learning. Second, the design and development of an AR application prototype was carried out, which involved visual and interactive design in accordance with the needs of learning basic manipulative movements. Third, an initial trial of the prototype was carried out on a small group of students to obtain initial input and feedback. Fourth, observation sessions and in-depth interviews were held with teachers and students to evaluate the effectiveness and experience of using the prototype. Fifth, the results of observations and interviews were analyzed qualitatively to identify the strengths, weaknesses and

opportunities for improvement of the prototype being developed. Finally, the prototype was revised and refined based on the results of the analysis, followed by the preparation of a research report which included the main findings, implications and recommendations for further development. This procedure is expected to produce a prototype that is not only functional, but also relevant and useful in the context of physical education learning.

3. RESULT AND DISCUSSION

Results

The results of the research developed an augmented learning model based on basic manipulative movements *reality* This is explained based on each stage in development research, namely: *First, need analysis,* Manipulative movements involve the act of controlling an object primarily with the hands and feet. There are two classifications of manipulative movement skills, namely receptive and propulsive. The ability to use large muscles in early childhood is classified as basic movement ability, this ability is carried out to improve the quality of life. Furthermore, basic movement abilities are divided into three categories, namely locomotor and non-locomotor and manipulative. Manipulative movements are usually described as movements that use certain objects as a medium, or skills that involve the ability of a person's body parts to manipulate objects outside themselves. These skills need to involve hand-eye coordination and speed, agility, eye-foot coordination, for example catching, throwing, kicking, hitting with a racket, stick or bat.

For this reason, teachers must be able to combine advances in science and technology as well as teacher skills in teaching basic manipulative movements based on science and technology, so that researchers try to offer an appropriate technology by visualizing learning basic movements into technology, *augmented reality* so that students are able to enrich and visualize at a high level *sequential thinking skills* before they can carry out the exercise. In fact, this technology really helps teachers in teaching and creating creations related to the use of science and technology as PJOK learning media. Several relevant studies that have been carried out by previous researchers through research journals include:

To strengthen the background of the problem that the researcher describes, the researcher tried to conduct preliminary research through a preliminary survey conducted in the city of Medan through the KKG for PJOK teachers in the city of Medan. 90% percent of teachers have not implemented school-based learning, *augmented reality*, even PEJOK teachers still wonder what augmented is *reality*. So from these results the researchers tried to design basic manipulative movement learning based on augmented reality for PJOK teachers throughout the city of Medan.

Second, design revision, after the researcher made a designed a basic movement learning model based on augmented manipulatives *reality* Next, the researchers submitted the design to lecturers who were experts in movement learning development, physical education teacher experts and media experts. The aim is to get input and revisions regarding this matter designed a basic movement learning model based on augmented manipulatives *reality* which will be developed to improve the results of the research carried out.The design that the researcher gave to the expert did not receive revisions, so the researcher could proceed to the next stage, namely product creation, because according to the expert, a trial must be carried out first to see the extent of the weaknesses. profit as well as effectiveness and efficiency from using a basic movement learning model based on augmented manipulatives *reality* which has been planned by the researchers.

Phase I trials were carried out on the 20th elementary school students, the purpose of conducting phase I trials is to provide input and assess the results of trials on samples to see the usefulness of the augmented-based basic manipulative movement learning model *reality* developed by researchers. The results of the Phase I trial were carried out through distributing questionnaires to determine the effectiveness of the product being developed. The results of phase 1 product trials are presented in Table 1.

Table 1. Phase I Product Trial Results

Respondent	Amount	P(%)
1	15	75.00
2	15	75.00
3	14	70.00
4	15	75.00
5	12	60.00
6	18	90.00
7	14	70.00
8	13	65.00

Respondent	Amount	P(%)
9	15	75.00
10	14	70.00
11	13	65.00
12	17	85.00
13	15	75.00
14	13	65.00
15	15	75.00
16	15	75.00
17	17	85.00
18	13	65.00
19	15	75.00
20	14	70.00
Amount	**292**	**75**

Based on the table above, we can find out how effective the manipulative-based basic movement learning model is *reality* in small group product trials as measured by a questionnaire containing 20 questions about the augmented manipulative basic motor learning model *reality*. From the values obtained, it is known that the empirical score obtained is 75% (Quite Valid or Effective), so it can be stated that the product is an augmented-based manipulative basic movement learning model. *reality* effective in measuring basic movement skills.

Phase II trials were carried out on 40 students SD Gajah Mada Medan, SD Islam An-Nizar, the aim of conducting Phase II trials is to provide input and assess the results of trials on samples to see the usefulness of the basic movement learning model based on augmented manipulatives *reality* developed by researchers. Based on data analysis, we can find out how effective the manipulative-based basic movement learning model is *reality* in large group product trials as measured by a questionnaire containing 40 questions based on the augmented manipulative basic movement learning model *reality*.

From the values obtained, it is known that the empirical score obtained is 85% (Very Suitable for Use), so it can be stated that the product is an augmented basic manipulative movement learning model. *reality* effective for basic movements of elementary school students. Student responses to large group game trials have been better, student enthusiasm and enthusiasm have improved. Students were also motivated by the narrative of the questionnaire results regarding the manipulative-based augmented basic movement learning model *reality* that on average the basic manipulative movement learning model is augmented *reality* provide a good impact on the assessment of basic movement abilities.

Data from phase I and phase II trials shows an increase in respondents' answers given the basic movement learning model based on augmented reality, augmented reality media including learning media which is relatively new for students so that learning to use AR media can increase students' motivation and curiosity. the student himself. A comparison of improvements in phase I and II trials is presented in Figure 1.

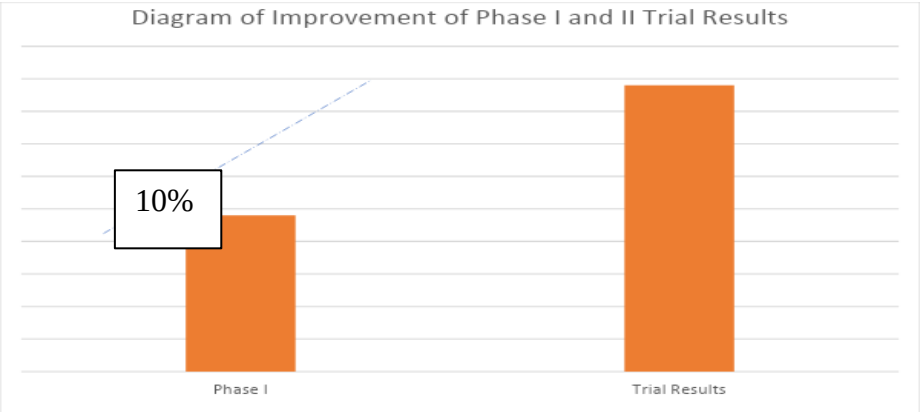

Figure 1. Diagram of Improvement of Phase I and II Trial Results

From the results of the trial data, it can be seen that the number of respondents' answers increased by 10%, where these results are the results of the answers given by respondents chosen by the researcher to be used as research samples.

Discussion

Augmented Reality (AR) is a combination of real objects and virtual objects in a real environment, running interactively in real time, and there is interaction between objects in three dimensions, namely virtual objects that are integrated into the real world. Combining real and virtual objects is possible with appropriate display technologies, interactivity is possible through certain input devices. *augmented reality* is a technology that combines 2D and 3D objects into a reel environment and then projects images of those objects in real-time. *augmented reality* is a combination of real and virtual objects in a real environment, running interactively and in real time. There is interaction between objects in three dimensions, namely virtual objects that are integrated in the real world. Combining real and virtual objects can be achieved with appropriate display technologies, interactivity can be achieved through specific input devices, and good integration requires effective tracking. The use of Augmented-reality technology is very broad, including in the fields of health, manufacturing and repair, entertainment, military training, navigation. One of the Augmented Reality methods currently being developed is the Markerless Augmented Reality method. With this method, users no longer need to use markers to display 3D or other objects (Dewi & Verawati, 2021; Timban et al., 2023). The application continues to run by scanning objects, but the scanned coverage is wider compared to Marker Based Tracking. Based on previous research findings, it is revealed that as is currently being developed by the largest Augmented Reality company in the world, Total Immersion (Dewi et al., 2021; Mambu et al., 2019; Verawati et al., 2021).

In learning PJOK the most important characteristic is carrying out movement activities, activities automatically require a force that supports various activities so that movement can occur. Basic movement skills are skills that students usually use to improve their quality of life. Basic movement skills are divided into three categories, namely: locomotor, nonlocomotor, and manipulative. Based on previous research findings, basic skills are movements carried out in a simple or stationary environment or target, for example kicking a ball in place. Movement skills are a manifestation of the quality of coordination and control of the body in carrying out movements (Dedy et al., 2019; Saputra et al., 2015). Movement skills are obtained from the learning process, namely by understanding movements and carrying out movements repeatedly with awareness of whether the movements carried out are correct or not (Setia Hasibuan et al., 2023; Supriadi et al., 2017). In learning in primary and secondary schools, it is very important to pay attention to basic movements in students, especially locomotor, non-locomotor and manipulative movements. Skills are actions that require movement activities that must be learned in order to obtain the correct form of movement. A person is said to be skilled if he is able to carry out activities according to the correct movements.

Manipulative movements involve the act of controlling an object primarily with the hands and feet. There are two classifications of manipulative movement skills, namely receptive and propulsive. Previous research also reveals this that the ability to use large muscles in early childhood is classified as basic movement ability, this ability is carried out to improve the quality of life(Setia Hasibuan et al., 2023; Verawati et al., 2019). Furthermore, basic movement abilities are divided into three categories, namely locomotor and non-locomotor and manipulative. Manipulative movements are usually described as movements that use certain objects as a medium, or skills that involve the ability of a person's body parts to manipulate objects outside themselves. Kogan, quoted in. These skills need to involve hand-eye coordination and speed, agility, eye-foot coordination, for example catching, throwing, kicking, hitting with a racket, stick or bat (Hidayat, 2019; Kustiawan et al., 2018; Rahmah et al., 2019).

For this reason, teachers must be able to combine advances in science and technology as well as teacher skills in teaching basic manipulative movements based on science and technology, so that researchers try to offer an appropriate technology by visualizing learning basic movements into technology, *augmented reality* so that students are able to enrich and visualize at a high level *sequential thinking skills* before they can carry out the exercise. In fact, this technology really helps teachers in teaching and creating creations related to the use of science and technology as PJOK learning media. Several relevant studies that have been carried out by previous researchers through research journal studies include (Endriani et al., 2019; Larasati & Widyasari, 2021).

Several relevant studies that have been carried out by previous researchers through research journal studies include: The use of educational media using Augmented Reality can stimulate students' mindsets in thinking critically about problems and events that occur in everyday life, because of the nature of educational media. is to help students in the learning process whether or not educators are present in the educational process, so that the use of educational media with augmented reality can directly provide learning wherever and whenever students want to carry out the learning process. AR Learning Media can visualize abstract concepts for understanding and structure of an object model, making AR a more effective media in accordance with the objectives of learning media(Dewi & Faridah, 2020; Mustaqim et al., 2019b). Augmented Reality technology can increase learning motivation and can introduce basic pencak silat

movements. The results of the feasibility test for the Augmented Reality Magic Card Application show that the feasibility percentage for material experts is 89.68% with the category very suitable for testing, for the results from media experts it is 92.70% with the category very suitable for testing, and the assessment results are 91.42% of respondents is in the Very Eligible category for testing. Based on the test results, the Magic Card Augmented Reality Application for Basic Sundanese Dance Movements is Very Suitable for Use (Nurhayati Sri Mulyani, 2021; Rahmah et al., 2019). The final conclusion based on respondents' assessments is good with a graphics percentage of 64%, software engineering presentations of 71% and entertainment applications of 81%. In the future, applications can be developed using the markerless method so that it attracts more student interest in learning (Mustaqim et al., 2019a; Nelva Saputra et al., 2019; Nurwijaya, 2021).

The implications of this research have the potential to make significant contributions to the fields of physical education and educational technology. The development and implementation of a prototype of a basic manipulative learning model based on Augmented Reality (AR) can be a breakthrough in teaching methods that are more effective and efficient. With AR technology, teachers can present more interesting and interactive learning material, thereby increasing student motivation and participation in the learning process. Apart from that, the use of AR can also help students understand and master basic manipulative movements better through clear and practical visualization. Practically, this research can provide guidance for educational software developers to create AR applications that are more relevant and useful in learning contexts. In the long term, the adoption of this technology has the potential to be integrated into the physical education curriculum more broadly, providing a positive impact on the quality of education and students' motor skills.

This study has several limitations that need to be noted. First, the limited research sample involved only a small number of students from one or two schools, so the results may not be generalizable to a wider population. Second, technical limitations in prototype development, such as hardware and software limitations, which can affect the performance and quality of the user experience. Third, time constraints may not be sufficient to observe the long-term effects of using AR in learning basic manipulative movements. To overcome these limitations, several recommendations can be provided. First, further research needs to be conducted with a larger and more diverse sample to increase the generalizability of the findings. Second, developing collaboration with technology experts and software developers to improve the technical quality of the AR prototype. Third, a longitudinal study was conducted to observe the impact of using AR in learning over a longer period of time. In addition, training and assistance for teachers in using AR technology can strengthen the implementation and effectiveness of learning. Thus, it is hoped that further research can provide more comprehensive and valid insight into the application of AR in physical education.

4. CONCLUSION

Based on the data from field tests conducted by researchers, a conclusion was obtained The manipulative-based basic movement learning model was added *reality* can assess the abilities of elementary school students, the application developed by researchers is also easy for PJOK teachers to use assessing a basic motor learning model based on augmented manipulatives *reality* which can be taken anywhere by PJOK teachers and is portable. So development of a basic movement learning model based on augmented manipulatives *reality* This can be applied in assessing basic movements in elementary school students.

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