
**PENGEMBANGAN MEDIA PEMBELAJARAN PENGENALAN PERALATAN OLAHRAGA TENIS
MEJA BERBASIS AUGMENTED REALITY**

***DEVELOPMENT OF LEARNING MEDIA INTRODUCTION TO TABLE TENNIS SPORTS
EQUIPMENT BASED ON AUGMENTED REALITY***

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Abstrak

Penelitian ini bertujuan untuk mengetahui kelayakan aplikasi *Jambura Table Tennis* (JTT) yang merupakan produk pengembangan berbasis augmented reality pada pembelajaran tenis meja. Metode pengembangan menggunakan model *Multimedia Development Life Cycle* (MDLC). Adapun tahapan yang dilakukan: 1) Pengonsepan ide produk melalui wawancara dan observasi lapangan, 2) Perancangan produk yang akan dikembangkan, 3) pengumpulan bahan yang dibutuhkan, 4) Pembuatan produk, 5) Pengujian alpha dan beta oleh ahli media dan ahli isi yang menggunakan uji Gregory validasi 100% serta uji efektifitas perorangan 95,4%, uji kelompok kecil dengan subjek 7 orang 95,57% dan uji lapangan kelayakan produk dengan subjek 33 orang kelas X SMA N 1 Dulupi sebesar 89%, 6) Pendistribusian produk aplikasi *Jambura Table Tennis* (JTT). Dari hasil tersebut dapat disimpulkan bahwa produk aplikasi *Jambura Table Tennis* (JTT) sangat valid dan layak untuk digunakan di SMAN 1 Dulupi. Adapun kelebihan dari produk ini yaitu lebih fleksibel karena dapat digunakan di *smartphone* masing-masing siswa serta tidak memerlukan data dalam penggunaannya, sedangkan kelemahan produk yaitu hanya membahas materi tentang pengenalan peralatan tenis meja.

Kata kunci: tenis meja, augmented reality, jambura table tennis

Abstract

This study aims to determine the feasibility of the Jambura Table Tennis (JTT) application which is a product development based on augmented reality in table tennis learning. The development method uses the Multimedia Development Life Cycle (MDLC) model. The stages carried out are: 1) Conceptualizing product ideas through interviews and field observations, 2) Designing the product to be developed, 3) collecting the required materials, 4) Making the product, 5) Alpha and beta testing by media experts and content experts using the Gregory test with 100% validation and individual effectiveness test of 95.4%, small group test with 7 subjects 95.57% and field test of product feasibility with 33 subjects of class X SMA N 1 Dulupi of 89%, 6) Distribution of the Jambura Table Tennis (JTT) application product. From these results it can be concluded that the Jambura Table Tennis (JTT) application product is very valid and feasible for use at SMAN 1 Dulupi. The advantage of this product is that it is more flexible because it can be used on each student's smartphone and does not require data for use, while the weakness of the product is that it only discusses material about introducing table tennis equipment.

Keywords: table tennis, augmented reality, jambura table tennis

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INTRODUCTION

The educational paradigm continues to develop along with technological advances to create superior human resources that are able to compete with developed countries (Pratasik & Ahyar, 2022). Rapid technological developments have a major indirect influence on the world of education (Firmansyah et al., 2019). Learning media has now undergone a significant transformation through the use of increasingly developing technology (Laseinde & Dada, 2023).

Ideally, learning designed by teachers can provide space for students to develop their creativity, independence, and interests and talents (Ashari et al., 2022). According to (Liono et al., 2021), one of the reasons for students' low learning motivation is because they consider books as a less interesting learning medium. Therefore, teachers need to analyze students' needs and problems to generate creative ideas in choosing the right learning media (Mislan & Santoso, 2019). Research (Rodríguez-Abad et al., 2022) shows that the use of augmented reality is increasingly popular among educators to support the learning process. Innovative learning methods that are responsive to technological developments are becoming increasingly important to meet the learning needs of today's students (Candra et al., 2024).

One of the main problems in learning table tennis in schools is the limited facilities, especially equipment such as tennis tables, rackets, and balls. Many educational institutions do not have adequate facilities, making it difficult for students to get enough practical experience, which is important for mastering game techniques and strategies. Research by (Ashari et al., 2022) shows that adequate sports facilities have a significant effect on student motivation and participation in sports activities. To overcome this limitation, augmented reality-based learning media can be utilized to present equipment virtually as an alternative to physical products (Pranoto & Panggabean, 2019).

There are many studies on the development of augmented reality-based learning media in various subjects such as biology, informatics and social sciences (Burhanudin, 2017; Aprilinda et al., 2020; Pratasik & Ahyar, 2022). However, there are not many in sports subjects, especially table tennis. The physical education learning process has so far utilized many video-based learning resources (Solihin, 2020; Ladjar, 2020; Suranta, 2023). According to (Chang et al., 2020) learning through augmented reality (AR)-based physical education is more effective than learning through video-based learning. This is due to the fact that augmented reality (AR)-based learning materials can offer a more interesting and dynamic learning environment to students, so that the subject matter is easier to understand. Augmented reality can increase student motivation because it produces a creative and interesting learning experience. Furthermore, students who use Augmented Reality (AR)-based learning materials can develop high autonomous thinking skills, creative thinking, and critical analysis (Bower et al., 2014).

The novelty of this study lies in the integration of augmented reality (AR) technology to introduce table tennis equipment, which is still rarely discussed in previous studies. Most studies related to AR in the field of sports tend to focus on performance analysis or its application in general training. This study aims to fill this gap by developing learning media specifically designed to introduce table tennis equipment, offering a more specific and targeted approach to meet students' learning needs (Banjar et al., 2023).

This study aims to produce a product in the form of an augmented reality (AR)-based application as a learning medium for introducing table tennis equipment that is designed to be informative, interesting, and interactive. It is hoped that the results of this study can be a reference in the development of relevant sports learning methods in the digital era. In addition, this study is also expected to contribute to the development of a more innovative physical education curriculum (Kim & Kim, 2024). In the development process, the involvement of experts in the field of table tennis and AR technology is very important to ensure that the resulting application product is not only technically accurate but also relevant and interesting to students. Feedback from teachers and students will be used as a basis for improving the

quality of the application developed (Putranto et al., 2022).

METHOD

This study uses the MDLC (Multimedia Development Life Cycle) Model method, which consists of several stages, namely planning, analysis, design, development, testing, and implementation. At the planning stage, identification of student needs and determination of learning objectives are carried out. The analysis stage involves collecting data related to relevant table tennis equipment. Furthermore, at the design stage, scenarios and learning media content are designed by considering aspects of visualization and interactivity. After that, the development stage focuses on creating a prototype of augmented reality (AR)-based learning media.

The testing phase aims to assess the effectiveness of the media in improving student understanding. At the implementation stage, learning media are introduced to students and integrated into the learning process. The use of the MDLC (Multimedia Development Life Cycle) model is very suitable for the development of educational resources based on augmented reality (Latif et al., 2023). This model includes six stages, namely conceptualization, design, material collection, development, testing, and distribution. The creation of augmented reality-based learning materials is carried out by following the six stages in the MDLC model, as shown in Figure 1.

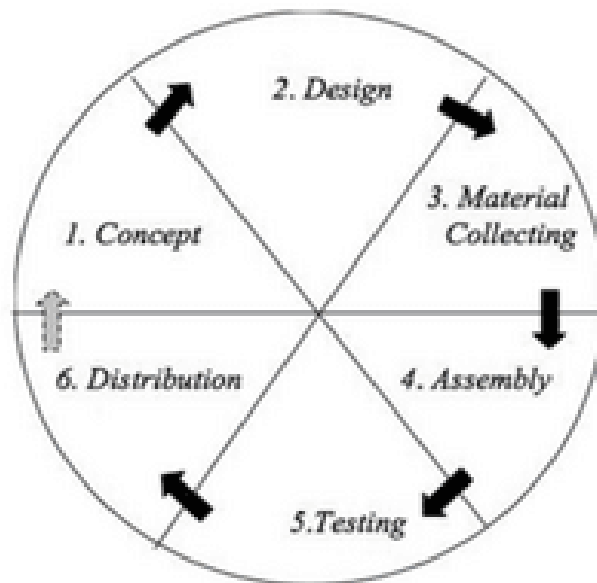


Figure 1. MDLC Model Development Cycle (Pratasik & Ahyar, 2022)

The initial stage (Conceptualization) in this study is to determine the basic idea of the product to be developed and the purpose of using the application through interviews and field observations. The results of the interviews and observations obtained two aspects of needs analysis, namely curriculum analysis and learning media.

In the second stage (Design) this stage creates a design to describe the flow of each scene and the material/material requirements needed and the appearance of the Augmented Reality application as a learning medium for table tennis games. The key aspect of this stage is the development of a storyboard to visually describe each scene and identify the hardware and software requirements for the application.

The third stage (Collection of materials), collection of introductory materials for table tennis equipment and materials such as 3D objects of table tennis equipment, text and barcode cards. Next, stage (assembly). This stage involves making the Jambura Table Tennis (JTT)

application product with the materials that have been collected. Then, testing stage that a series of steps taken to ensure the quality and responsiveness of the learning media that has been created, through alpha and beta tests. At this stage, the learning media undergoes a series of tests to assess the extent to which the media meets quality standards and whether it is suitable for use as learning media in the classroom.

Alpha testing

This testing process includes several steps, starting from the alpha testing test which involves the validation of learning media by two material experts and two media experts. Revisions in this section are in accordance with comments and input from experts.

Beta testing

Beta testing is conducted on expert media validators, namely media experts and material experts. After the product passes the Beta Testing stage, the product can be declared suitable for use and proceed to the distribution stage.

Effectiveness test

Effectiveness test where pretest and posttest are given to students to measure the effectiveness of the learning media that has been created. Through a questionnaire on student response data so that researchers can validate starting from individuals, small groups and the field

The following is a validity calculation by 2 experts using the construct validity formula:

$$\text{Validity of Content} = \frac{D}{A+B+C+D} \tag{1}$$

Information:

A: Both experts disagree

B: One expert agreed and two experts disagreed.

C: One expert disagreed and two experts agreed

D: Both experts agree

Table 1. Validation Criteria

Coefficient	Category
0,8 – 1,0	Very High
0,6 – 0,79	High
0,4 – 0,59	Medium
0,2 – 0,39	Low
0,00 – 0,19	Very Low

Last, Distribution stage. The jambura table tennis application can be distributed after it is considered suitable for use. After being validated and tested, this application will be distributed to users in the form of cards that are equipped with barcode scans so that they can be used by students.

RESULTS

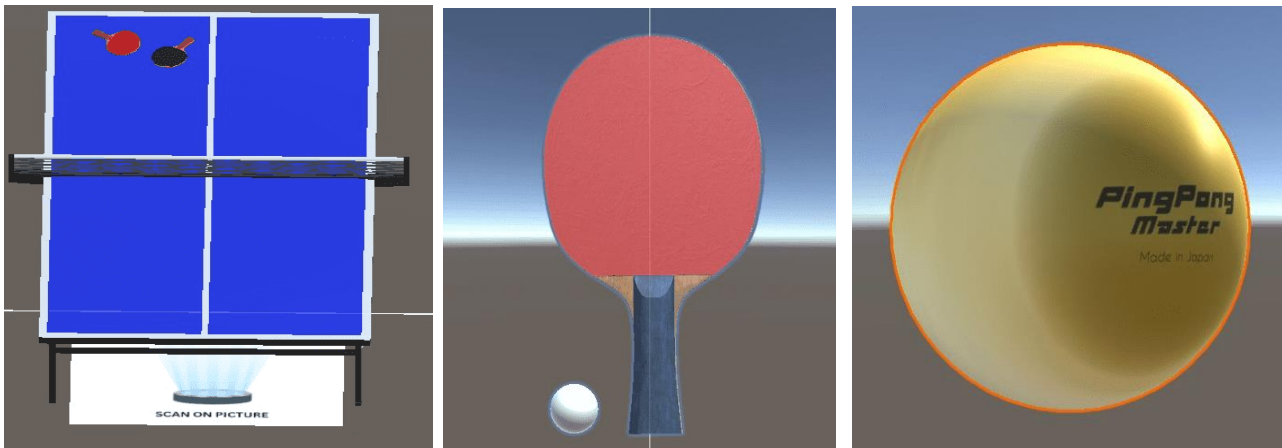
This research obtained the final result in the form of augmented reality-based learning media about the introduction of table tennis equipment that can be accessed via smartphone using a barcode. The following are the results of the Jambura Table Tennis application creation process.

Concept

After analyzing that there is table tennis game material in the Senior High School (SMA) curriculum and based on school conditions, the development of JTT learning media is very suitable to be carried out at SMAN 1 Dulupi, this is due to the lack of facilities and infrastructure at the school.

Design

Determine the objects of table tennis equipment, namely the table, bed and ball. After that, each scene contains a description of the equipment used starting from the shape, size and function of the equipment.



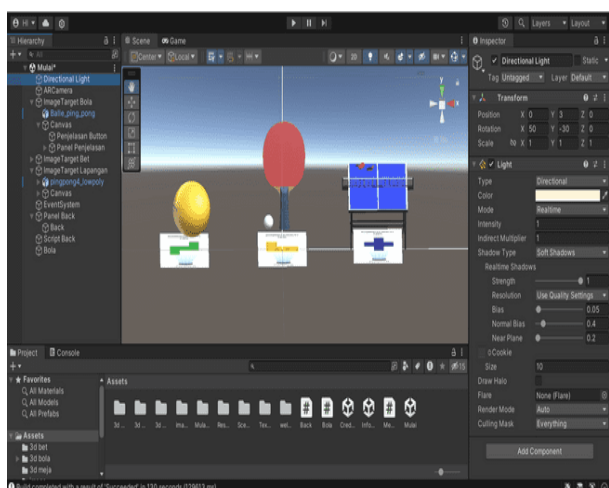
Picture 3. 3D Table, Bed and Ball

Material collecting

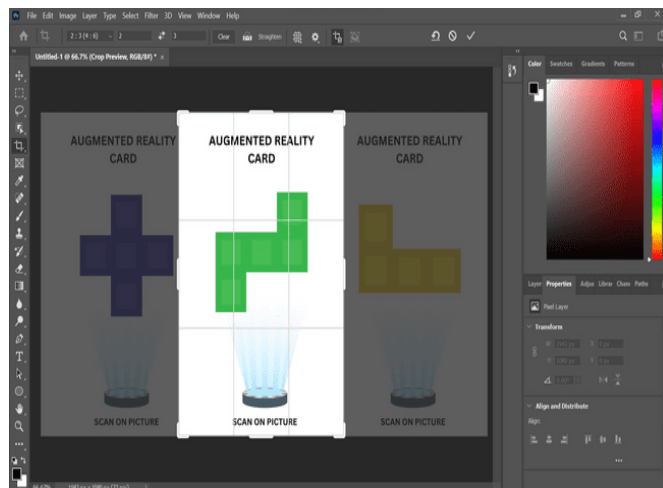
Collection of materials includes the collection of materials based on needs, especially by collecting information in the form of educational resources. on the introduction of table tennis equipment such as the length, width and height of the table, the diameter and weight of the ball used and the composition of the bed used in table tennis. In addition to equipment at this stage, materials such as animation, text and sound are also needed which will be presented as educational content. You can search for free resources used to create educational materials for the launch of augmented reality-based table tennis equipment using popular programs.

Assembly

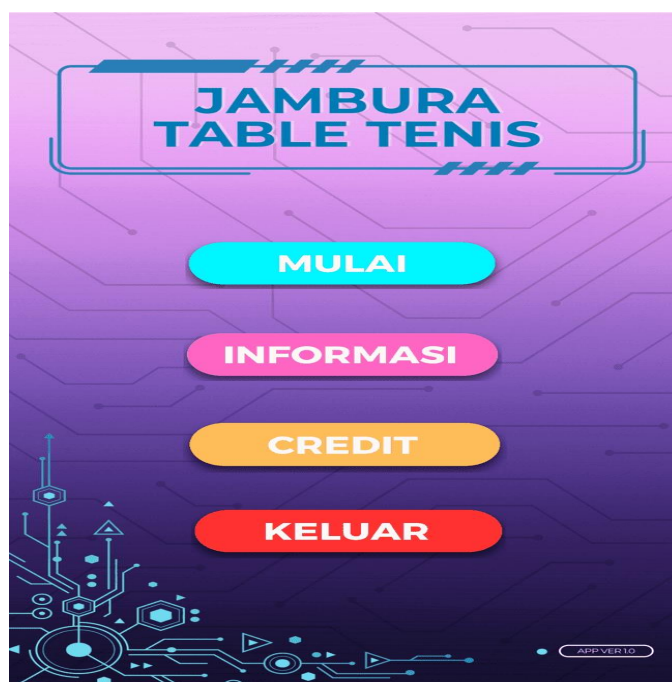
Making learning media using all the required equipment and multimedia materials. This creation requires an organized and methodical production process to ensure efficient and on-schedule production, in line with the intended timeline. The stages of creating learning media designs are; (1) The first stage is creating 3D objects of table tennis equipment such as balls, tables and beds. Images of this equipment can be created using the 3D modeling application blender. (2) The second stage is creating QR cards to scan objects using Photoshop. (3) The third stage is determining the target image of objects and cards using the vuforia engine. (4) The final stage is creating the Jambura Table Tennis application based on Augmented Reality (AR) using unity.



Picture 4. 3D Modeling Equipment View



Picture 5. QR Card Making



Picture 6. Front view of the application

Testing

This testing process includes several steps, starting from the alpha testing test which involves the validation of learning media by two material experts and two media experts. Furthermore, beta testing is carried out on students to evaluate the feasibility of the media based on their assessment. The last step is the effectiveness test, where pretests and posttests are given to students to measure the extent of the effectiveness of the learning media that has been created. Thus, this testing stage is an integral part of the learning media development process which aims to ensure the success and effectiveness of its use in the learning environment.

1) Material Expert Test

To validate the material, it was carried out by 2 experts in table tennis learning materials, who used an alpha test with calculation results.;

$$\text{validity of material} = \frac{D}{A+B+C+D} = \frac{7}{0+0+0+7} = 1,00$$

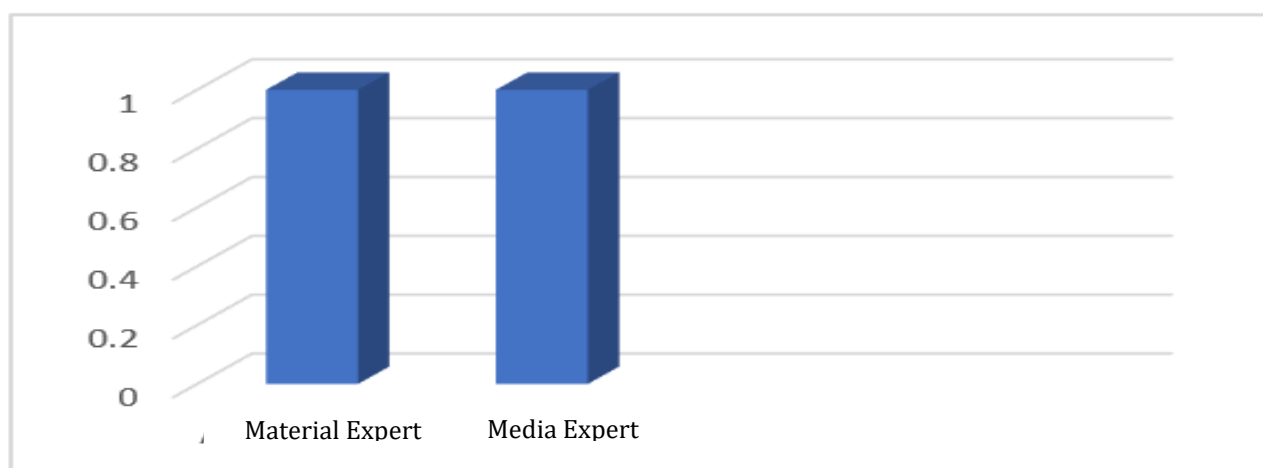
Based on these results, it can be concluded that the content achievement is very high so that it is "very suitable" to be used as a learning medium.

2) Media Expert Test

To test the validity of the media, this was done by 2 media experts, with calculations;

$$\text{Media Validity} = \frac{D}{A+B+C+D} = \frac{11}{0+0+0+11} = 1,00$$

From the calculation results, it can be concluded that the level of validity of the media expert instrument is very high and very suitable for use. This test uses the Gregory test, namely to see the agreement of 2 content experts and media experts. However, there are also comments from experts that must be revised to improve the learning media. The experts' revision is to eliminate the sound in the explanation of the equipment because it can reduce interaction between teachers and students.



Picture 7. Graphics of results from material experts and media experts

3) Individual Test

Three students of class X of SMA Negeri 1 Dulupi were used as individual test subjects. The individual test response from the JTT (Jambura Table Tennis) learning media was 95.4% with very good criteria.

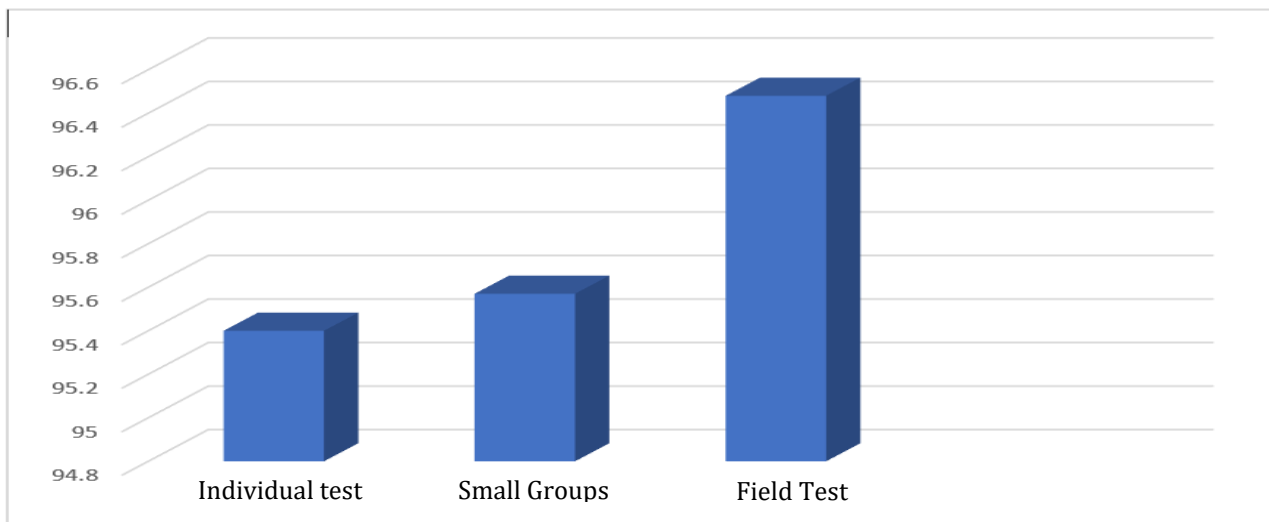
4) Test for Small Groups

The subjects of the small group trial were seven students. The response rate of the small group test with very good criteria was 95.57%. Field Test 33 only 96.48% of respondents who filled out the questionnaire met the very good criteria. The results of the individual, small group, and individual response tests were in the "very good" category with scores of 95.4%, 95.57%, and 96.48%. Based on the responses of students and teachers of SMA Negeri 1 Dulupi, Boalemo Regency, it can be concluded that the learning media for introducing table tennis equipment based on augmented reality is very feasible to use.

5) Field Test

The field trial subjects for the augmented reality-based table tennis equipment introduction learning media were 33 class X students of SMA Negeri 1 Dulupi, Boalemo Regency. From the

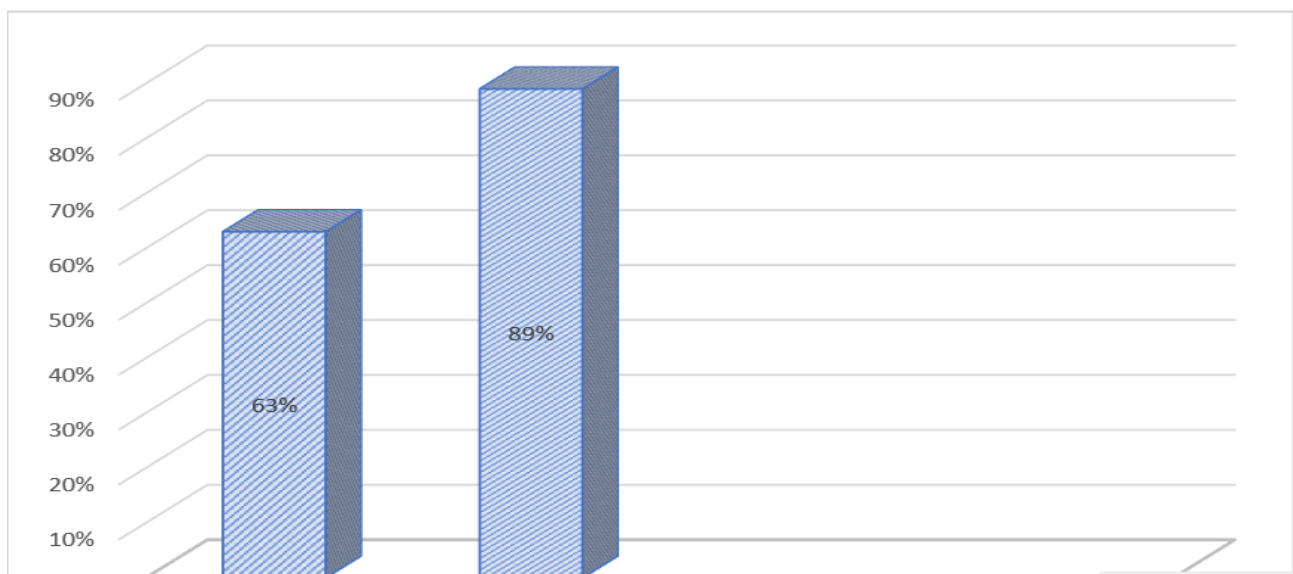
results of filling out the questionnaire, the results were 96.48% with very good criteria. The results of the individual, small group and individual response tests were 95.4%, 95.57% and 96.48% which were included in the "very good" category. So it can be concluded that the augmented reality-based table tennis equipment introduction learning media is very feasible to use, this can be seen from the responses of students and teachers at SMA Negeri 1 Dulupi, Boalemo Regency.



Picture 8. Response test result graph

6) Effectiveness Test

The last stage is the effectiveness test of the learning media for introducing table tennis equipment based on augmented reality. The effectiveness test was conducted on 33 students of class X of SMA Negeri 1 Dulupi with the results of the pretest and posttest analysis of 89% with the criteria of "very high" so that this media is very effective for use in the subject of Physical Education and Health, small ball game material, table tennis.



Picture 9. Pretest and posttest result graphs

Distribution

Distribution of the Jambura Table Tennis application can be done after it is considered suitable

for use. Once approved, this application will be distributed to users in the form of cards that are equipped with barcode scanners that can be directly installed and used by students via their respective smartphones. The school's expectations are that teachers and students will further develop the material on the Jambura Table Tennis (JTT) application, not just small ball games but all the material studied for 2 semesters. This is a challenge for researchers for the sustainability of the development of learning media in the future.

DISCUSSION

Educational tools have proven effective in improving the learning and teaching environment in the classroom and even changing the way we view education (Lima et al., 2022). The application of augmented reality (AR)-based table tennis equipment introduction learning media produced interesting findings. Research on the use of AR as an enabling technology for teaching and learning began with a university project on an AR book (Buchner & Kerres, 2023). Through the use of AR, students showed a significant increase in understanding of table tennis equipment. The use of learning media through interactive 3D models allows them to see in detail each component of the equipment, from the bat, ball, to the table, with the ability to rotate 360 degrees, creating a unique and more engaging learning experience. According to (Latif et al., 2023) learning with AR allows them to visualize learning materials so that they help them memorize or remember an object.

The introduction of augmented reality-based table tennis equipment is expected to be an innovative solution to overcome the limitations of facilities and infrastructure in schools. According to (Saurina, 2016; Stoner et al., 2023) the concept of AR applications involves the seamless integration of the real world and the digital world, without changing the physical properties of objects in the real world. With this media, students can learn about various table tennis equipment, such as tables, beds/rackets, and balls, and their functions in the game. The learning media developed will include interactive visualizations that allow students to understand and recognize the equipment in depth, without requiring physical access to the equipment (Pramono & Setiawan, 2019). Research by (Chang et al., 2020) shows that AR applications can increase students' motivation and interest in learning science subjects, which can also be applied in a sports context.

The application of AR in table tennis learning brings new and important aspects, especially in the context of equipment introduction. According to (Al-Ansi et al., 2023) the use of augmented and virtual reality are the two most appropriate for the advancement of innovative technology in today's world, and their potential to improve the education system is enormous. Therefore, through AR, students not only understand the concept theoretically, but can also engage in direct experience with the equipment. This opens up opportunities to develop practical skills along with conceptual understanding. In addition, AR technology can be adapted to the latest developments in sports equipment. 3D model updates can be easily done to cover the latest innovations in the world of table tennis, making learning always relevant to industry developments.

The impact of this study involves significant improvements in the process of sports learning, especially table tennis game material. The response of teachers and students to the use of augmented reality should be all physical education subject matter, not just table tennis game material. However, the limitations of this study need to be acknowledged because the generalization of these findings may be limited to certain populations or special learning conditions. Therefore, for further research suggestions, it is possible to create a table tennis learning application that discusses more complex discussions, not just introducing equipment, but adding technical, tactical and refereeing materials.

CONCLUSION

The results of the development of learning media for introducing table tennis equipment based on augmented reality in the form of the Jambura Table Tennis (JTT) application in the physical education subject have been successfully implemented at SMAN 1 Dulupi. The response to this learning media was very positive from both teachers and students. The JTT application is a learning guide for students to increase motivation, focus, and attention during the learning process. This research also has broader implications, not only for table tennis, but also for other sports. The concepts and methods developed in this study can be applied to various sports fields, allowing the development of similar learning media. Thus, this research contributes to the development of innovative learning methods that can be adapted by educators around the world. Thus, this research not only aims to develop innovative learning media, but also to create a positive impact on the development of physical education. Through a technology-based approach, it is hoped that students can be more motivated, involved, and able to achieve their best potential in the field of sports.

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