The Development of Table Tennis Learning Media Based on Digital Augmented Reality Technology

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ABSTRACT

Background. One of the learning media with the utilization of digital technology is Augmented Reality-based learning media.

Objectives. This study aims to develop table tennis learning media with Augmented Reality (AR) based technology application design. Augmented Reality (AR) is the latest technology that can be a solution for educators to present innovative, informative, interesting learning, and can present virtual objects in virtual 3D in real form and presented in real time (real time), so as to present abstract concepts to be more real. Methods. This type of research is development research with Research and Development research procedures through the following stages: exploration of potential problems, data collection, product design, design validation, design revision, product trials, product revision, usage trials, product revision and mass production.

Results. This study shows validation by learning design, material experts and media expert validation is 89.33%. Student responses to the use of this media in small group trials were 91.27% in very good qualifications, and large group trials were 90.67% including very good qualifications. Conclusion. Table tennis learning media based on Digital Augmented Reality Technology Application is valid, practical and efficient to be implemented at the Faculty of Sports Science at Padang State University.

Keywords: Learning Media, Augmented Reality, Table Tennis

INTRODUCTION

With the rapid development of science and information technology in the era of globalization and all modern technology, this makes technology a necessity in facilitating daily human activities, such as military, government, office, entertainment and other activities (Septri et al, 2023);(Nelson et al, 2022);(Veradinata et al,2020);(Ghali,2012). One of them is education, with the application of sophisticated technology that can certainly help activities in the teaching and learning system (Al-Shara,2015). The technology in question is Augmented Reality (AR). Augmented Reality is a combination of real and virtual objects that are in the real environment in real time (real time) and are well integrated and clear. Augmented Reality technology can provide advantages in the interaction between humans and computers through the display of objects that are attractive and resemble real objects (original) and shaped 3 dimensions (3D) so that it looks clearer and real time (Setyawan et al, 2019)(Septri et al, 2023)(Ediyono et al, 2019);. With interesting learning media such as impressions or moving displays will make it easier for students to remember and absorb material (Crompton et al, 2020);(Xavier & Francis, 2017).

Augmented Reality technology can be applied in the world of education, because it can provide information that is practical, easy to understand and can describe illustrations of the information provided. Table tennis is one of the elective courses in the sports education program. Table tennis is a sport played by two players (singles) or two pairs of players (doubles) facing each other using a small ball, a wooden bet covered with rubber, and a playing field in the form of a table. In the world of education, table tennis learning media still use books for theory lessons while technology has developed, ranging from print technology, computers to a combination of

print and computer technology. Textbooks provide great benefits in the teaching and learning process, in this case students in learning gain meaningful relationships to solve problems (Surahman & Yeni,2019). In addition to supporting educators in the learning process, books are also a source of knowledge for students (Asri,2017).

In a book not only contains the text that is the content of the book, but there are also pictures that represent the illustration of the content of the text. But the pictures in the book are only silent illustrations. This makes it a little difficult for readers to describe the meaning of the image. Therefore, a technology is needed to help readers better understand the meaning of the illustration. One technology that is currently being developed is Augmented Reality. Digital technology-based learning media have been widely produced, but learning media are produced without understanding the lecture syllabus and student needs. The above conditions bring thoughts for the author to utilize existing facilities. By utilizing current technological developments, researchers try to apply digital technology learning media based on Augmented Reality Book (AR Book) which is designed as attractive as possible. This learning media can be studied by students anywhere, anytime and there is no time limit to study so that an effective and efficient learning process will be created (Weng,2019);(Nelson et al;2018).

MATERIAL & METHODS

This study uses the research and development method (R and D), which is to develop table tennis learning media products based on Augmented Reality (AR) technology. The type of research is Research and Development (R&D) development research [15] consisting of the following steps: 1) exploring potential and problems, 2) data collection, 3) product design, 4) design validation, 5) design revision, 6) product trial, 7) product revision, 8) usage trial, 9) product revision, and 10) mass production. To validate the development of the instrument, several experts from the field of table tennis and the field of learning technology and the media field were involved.

This development research produces Augmented Reality (AR) learning media products in table tennis courses that have been validated by experts. The validation stage by learning technology experts includes aspects, technical quality, media quality, and product display quality. Validation by the material, namely aspects of the content and aspects of the accuracy of the material. While media experts provide validation of aspects of media content quality, and aspects of media display quality. Small-scale and large-scale product trials were conducted as a whole to students who were taking table tennis courses to see student readability and observe student responses to the use of Augmented reality (AR) based table tennis learning media products.

The prototype phase begins with a needs assessment and then continues with the development of a prototype of table tennis learning media using Android-based AR technology. In this phase, the preparation of flowcharts, storyboards, and the design of andred-based AR applications, making markers and marker books.

In the prototyping stage, markers and marker books are also developed which contain table tennis learning subconcept material according to the syllabus which can be scanned using the AR application that has been developed with the marker. The markers made are collected in a marker book, in which in addition to markers that can be scanned using AR media applications, there are also materials and demonstrations of basic table tennis techniques.

Data collection in this study was conducted using (1) a questionnaire survey: This was designed to determine whether the product used was suitable for learning and to find out students' responses to the product development. Questionnaires were distributed to learning design experts, media experts, material experts and students: (2) Documentation: to strengthen the data obtained from the questionnaire results. Data analysis techniques are applied to obtain learning media that are feasible to use and meet effectiveness criteria. The assessment of expert test results is based on data using a Likert scale (1, 2, 3, 4, 5 points).

Table 1. Likert Scale

No	Category	Score
1	Very Worthy	5
2	Worthy	4

3	Decent enough	3
4	Not worth it	2
5	Not	1

Source: (Sugiyono, 2011)

The results obtained in percentage form are converted back to qualitative form according to the rules described to determine the qualification category of the learning video. If the expert test results meet the minimum feasible category, it can be declared feasible.

RESULTS

This research was at the Faculty of Sports Science, Padang State University. This educational media using augmented reality was built by utilizing the research and development model from Borg & Gall which involves ten stages, namely:

1. Collecting Research and Data. Based on the insights from the initial observations detailed in the introduction, the initial step in the development process is to accumulate information through several examinations: (a) market examination, (b) user examination, (c) content examination, and (d) examination of facilities and resources.
2. Strategizing. In this stage, the plan encompasses the media content that will be developed according to specifications, alongside product designs, proposals for markers to be created, and tactics for executing the media.
3. The development of this augmented reality content adhered to a sequential process, moving through phases such as requirement gathering, design, coding, testing, and continual maintenance.
4. The media has been affirmed by experts, including professionals skilled in design, media creation, and content development.

The learning media designed is an application that utilizes Augmented Reality technology. This product is prepared with the aim that the community, especially students, can do learning and practice independently, especially for beginners with basic table tennis material that refers to the guidebook and education syllabus. Thus, the learning media developed with basic table tennis techniques using Augmented Reality technology is expected to be a learning reference and alternative media to introduce basic table tennis techniques to beginners, especially among students during lectures. In addition, the use of Augmented Reality-based media is expected to encourage students to more actively interact with learning content, increase their independence, and develop their skills in the future. The following is an example of an experimental process in the Unity application.

Figure 1. Main Menu

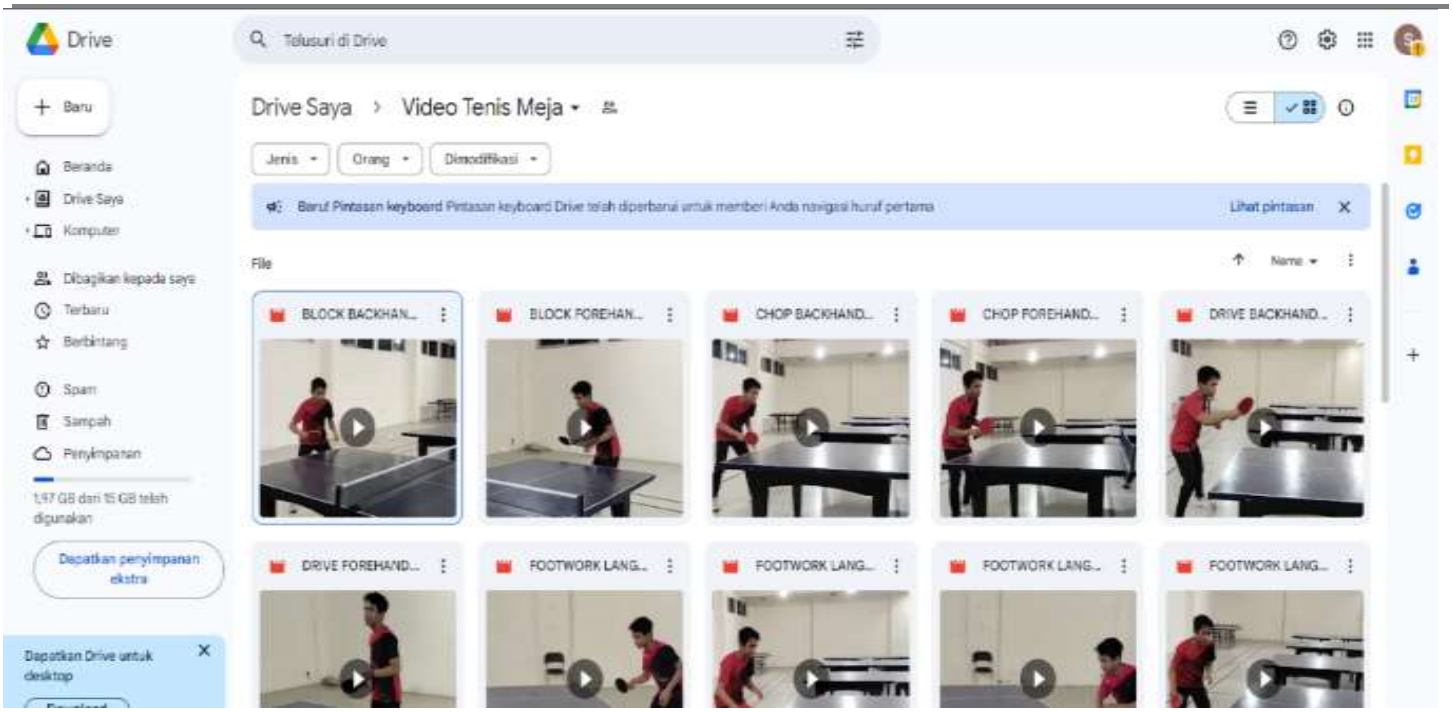

Figure 2. Video Display

The evaluation results by learning design experts totaled 85.5%. The elements assessed by the design expert include elements of media content quality, appearance, and presentation method. With the total value and average value for each element as shown in table 2 below:

Table 2. Learning Design Expert Assessment Results

Table	Max Score	Score	Persentase	Description
Media content quality	30	27	86,6%	very good
Media display	45	38	84,4%	very good
Average Score			85,5%	very good

Based on table 2, the results of the evaluation by learning design experts concluded that Augmented Reality (AR) learning media is in the "Very Good" category when viewed in terms of quality and media appearance.

Next, the evaluation results by media experts show an average value of 87.73%. The dimensions analyzed include media quality, technical quality, and appearance. The average value for each dimension is reflected in table 3 below:

Table 3. Media expert validation results

Variable	Max Score	Score	%	Description
Program quality aspect	30	27	90%	Very good
Media design aspects	15	13	86,6%	Very good
Aspects of material presentation	30	26	86.6%	Very good
Average score			87,73%	Very good

Based on the information contained in Table 3, it can be concluded that the Augmented Reality (AR) learning tool is classified as “Very Good” when viewed in terms of media quality, technical quality, and appearance.

Table 4. The verification results from teachers who serve as material experts show an average score of 94.77%. Elements evaluated by material experts include content and material elements. The verification results show that the product is in the excellent category. With total scores and average scores for each element as listed in the table.

Table 4. Material Expert Assessment Results

Variable	Max Score	Score	%	Description
Content aspect	20	19	95%	Very good
Aspects of material accuracy	55	50	94,54%	Very good
Average score			94,77%	Very good

Based on the data obtained, the average value of evaluation by learning design experts, media experts, and material experts is 89.33% with a very good assessment. This indicates that the media is ready to be tested in the experimental class with some suggestions or minor revisions before the trial implementation.

Product revision, this revision was obtained from the input of experts.

Application of media in the test class.

The number of students involved in the experimental class was 20 students. Students who participated in this experiment will no longer be included in the large group trial. The results of the small group product trial for martial arts learning media using Augmented Reality at the Faculty of Sports Science, Padang State University showed very satisfactory results (91.27%) with a note of the need for improvement.

Product revision, refined again when there are still product problems.

Large scale trial. In large-scale trials carried out for the experimental class, while for the small group class did not receive treatment.

The product trial on a large group is the final trial, the trial was conducted by 30 students of the Department of Sports Education, Faculty of Sport Science, Padang State University. The process of implementing the product trial on this large group is by providing a product for developing Augmented Reality-based Table Tennis learning media and then to determine the quality of the product developed, the researcher provided an assessment sheet to respondents. Based on the results of the large-scale product trial on the Augmented Reality-based Table Tennis learning media product at the Faculty of Sport Science, Padang State University, it is included in the Very Good qualification (90.67%) with the statement that it does not need to be revised.

Table 5. Large Group Test Assessment Results

Variable	Max Score	Score	%	Description
Aspects of product outcomes and aspects of effectiveness for students	2000	1813,4	90,67%	Very good
Average score			90,67%	Very good

Based on Table 5, student assessments show that the resulting product is classified as very good with a percentage reaching 90.67%. In the large group product trial, there were no suggestions or comments for product revision. This means that the development of this Augmented Reality-based table tennis learning media is suitable for use by beginners, students, and lecturers as a learning resource or learning media for table tennis. From this description, it can be concluded that the obtained augmented reality-based pencak silat learning media is suitable for use to support the student learning process.

The ninth step is the revision of the final product.

Mass production and implementation stage.

In the development phase, table tennis learning media is made that utilizes Augmented Reality technology, which is equipped with a package of images and markers of basic table tennis techniques to be used in the learning process. The applied media must get a valid statement from experts. Validity, according to Nieven in Rochmad (2012), can be analyzed through consistency between Augmented Reality (AR) media products and other related products (materials). Based on the validation score from a team of experts consisting of two media experts and one material expert, the media to be used is declared valid, meaning that it can be used with minor changes. Furthermore, the device can be applied in field tests and can then be further refined based on input and suggestions from all learning elements.

DISCUSSION

Related to the effectiveness of learning media developed, students feel more involved in the learning process when using Augmented Reality (AR) media. This is in line with the findings presented by Hamilton & Ole Newa (2010) which states that Augmented Reality creates a natural learning situation and is suitable for various ways of learning, thus providing a beneficial impact. The Augmented Reality technology applied to design this media is marker-based AR technology, which means that in order to see virtual objects in the form of 3D motion models in this application, a marker image scanned with a smartphone camera is required. This marker image is known as “target marker.”

With Augmented Reality technology that uses markers, an object can only appear on the screen from one marker only and to display the same object again, another additional marker is required. This condition poses a challenge where the necessary markers must be taken and printed to show several objects that can be activated (Gutierrez, 2017).

The use of Augmented Reality (AR) technology in the development of educational media offers a unique experience, both for teachers and students. Augmented Reality makes the learning process easier and more enjoyable, and creates a supportive learning atmosphere (Morales, 2018), so that the reaction of users or students becomes better and is positive.

In a systematic analysis of research and applications, the utilization of Augmented Reality (AR) in the education sector has proven successful for various purposes, such as improved learning performance, encouragement to learn, student participation, and positive attitudes (Wojciechowski & Cellary, 2018)

According to Gutierrez and colleagues (Chiang et al, 2014), the obstacles in using Virtual Reality and Augmented Reality technologies in education do not come from the technology itself, but from the learners' learning methods. Virtual learning experiences are not only aimed at acquiring knowledge, so it is important to design a learning environment with a constructivist approach so that the benefits of learning can be optimized. Research by Morales and Saunches (Hsiao et al, 2016) on the use of AR in education shows that AR can improve motivation, learning outcomes, and create a positive view of the learning process and make it easier for students to understand the material better.

AR provides opportunities for individuals to apply their knowledge and skills, combining digital data with real-world conditions. The use of AR-based learning applications has a positive effect on academic achievement. For example, Chiang and colleagues ((Wojciechowski & Cellary, 2018) noted in their study on AR that this technology allows students to learn practically in a fun atmosphere. (Hsiao et al, 2016) In another study, Hsiao and his team indicated that AR resulted in better comprehension, recall, focus, interaction, and a more engaging learning experience compared to conventional educational methods.

CONCLUSION AND SUGGESTIONS

By utilizing Augmented Reality technology, a table tennis learning media has been developed. The response from students to this application is very positive based on the results of product trials conducted. The data

obtained from the trial questionnaire showed a “very good” category. This shows that this application is enthusiastically received by students and is considered feasible as a learning tool to support learning activities in class and independently. The product created is not limited to the application only, but also includes a guidebook for using the application and a textbook equipped with markers. The application is easily installed on smartphones and designed to be easily used by lecturers and students.

Augmented reality technology in media is widely used by students and teachers as an educational tool that can be accessed anytime and anywhere, so as to achieve learning outcomes in an effective and efficient way.

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