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Development of Augmented Reality-Based Learning Media to Increase Student Learning Motivation: Computer Networks

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ABSTRACT

Teachers are now required to be able to use flexible and innovative learning methods and media to help motivate and engage students. In order for students to have this ability, technology-based learning media are needed, one of which is Augmented Reality, which is able to visualise 3D shapes more realistically. This research also aims to determine the increase in students' learning motivation after being given treatment in the form of learning using learning media based on Augmented Reality, PPT and quizzes in basic computer networking subjects. The subjects of this research were students of class X (ten) in one of the high schools in Bandung city. The reason for conducting this research was also because it was seen from students' problems with the learning media used by conventional teachers, which was seen from literature review sources and researchers' observations in the field. The research method used in this research is experimentation and a development model using MDLC (Multimedia Development Life Cycle). The findings of this research are: 1) The results of learning motivation using Augmented Reality media with PPT get a score of 75% (high motivation), and 2) The results of learning motivation using Augmented Reality media with Quizizz get a score of 65%.

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1. INTRODUCTION

In the era of rapid globalization, technological advancements are accelerating, particularly in the field of education, where technology has become a necessity in daily activities (Arisandi et al., 2022). The integration of technology in the education sector must be utilized effectively, as it can support various needs in the teaching and learning process (Salsabila et al., 2020). One essential effort is to create a learning environment that enables students to engage in the learning process by utilizing all available resources and employing effective and efficient methods. In this context, learning media serve as crucial tools to support and enhance the learning process.

The problem that often arises from technological developments in the teaching and learning process is that the media used are still conventional, such as modules and textbooks. This makes students feel bored and lazy quickly because the learning is less interesting. When students experience difficulties in understanding the basics of networking material, they will certainly experience difficulties in the next learning material. Rusman explained (in Mahardika et al., 2021), to create good learning experience there are five components including objectives, materials, learning method strategies, media, and learning evaluation.

Several factors contributing to the decline in student motivation are the fact that the teachers are still using conventional learning media such as modules and textbooks as handbooks which are then read by students. The results of this research showed 40.90% with low criteria using student learning motivation observation sheets. Sometimes, these are students who do not understand the module and tend to get bored if they only see pictures and writing, so students' understanding is less compared to using videos, animations, or other more interesting media. In the second research by Cahya (2013), the lack of student understanding and motivation in Network Topology material is caused by teachers who still use the lecture method so that the material taught is less interesting for students, leading to boredom. Furthermore, the third research by Arisandi et al. (2022) regarding Computer Network material in universities also experiences various problems, namely that in general lecturers teaching about Network Topology still use conventional media such as textbooks and PowerPoint slides displayed on projectors and other media. Based on a survey of students, indicate that the learning media used in teaching is still less engaging, and there is a lack of student understanding and motivation towards the material explained by the lecturer.

Based on these problems provided by previous research, creating learning media using can be one of the solutions. Developing a learning media based on Augmented Reality (AR) can serve as the alternatives because it can depict objects realistically and can combine virtual and real objects in 3D (Uliontang et al., 2020). Furthermore, in today's modern era, learning modules can be combined with Augmented Reality. Old modules that only contain writing and a few pictures can be combined with two-dimensional virtual ones or what are called markers to scan 3D images so that interactive, creative, interesting, and innovative learning modules will be created. With the help of Augmented Reality, students can learn and understand the material and can see animations or 3D learning objects before using the actual tools.

One of the aims of this research is to increase students' learning motivation by using AR learning media, which will later be compared with PPT and Quizizz media as a research experiment.

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2. METHODS

2.1. Multimedia Development Model

This research uses experimental research methods and the MDLC (Multimedia Development Life Cycle) multimedia development model. MDLC steps were taken because they were in accordance with the needs of the researchers, where there were problems and needs in developing learning media. The multimedia development methodology consists of six stages, namely "concept (conceptualization), design (designing), material collecting (material collection), assembly (manufacturing), testing (testing), and distribution (distribution)." These six stages do not have to be sequential in their implementation because they can interchange positions. Even so, the concept and distribution stages still have to be the first and last things to be done. **Figure 1** is a picture of the MDLC development stages:

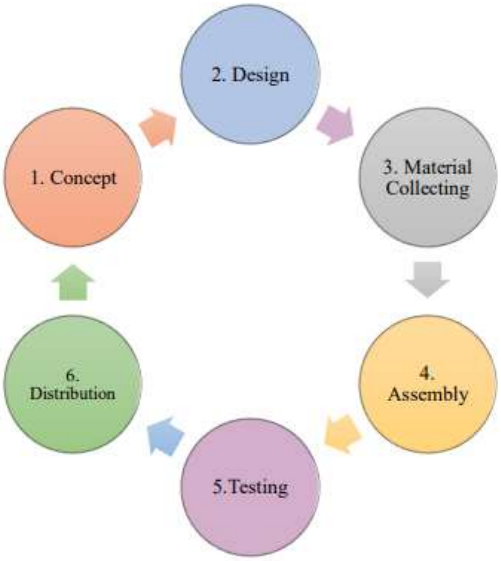

Figure 1. Multimedia Development Life Cycle (MDLC) Diagram

Figure 1 is an explanation of the steps in the Multimedia Development Life Cycle (MDLC) development design, where there are six stages in product development, namely Concept, Design, Material Collecting, Assembly, Testing, and Distribution.

2.1.1. Concept Stage

To provide a clear picture of this Augmented Reality system, a clear concept is needed in carrying out the design according to needs, namely as follows:

i. System Concept

The concept of how this system works is also very important to explain for both researchers and readers so that it is easier to understand how Augmented Reality works. An example of the concept is shown in **Figure 2**:

Figure 2. System Concept

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ii. Material Concept

The material used in this content is the Informatics material for the basic Computer Networks chapter for class X based on the Independent Curriculum. The 3D objects in this material consist of Bus Topology, Star Topology, Mesh Topology, Ring Topology, LAN, MAN, WAN, Router, NIC, Switch, and HUB. The reason this component was chosen was that, according to literature reviews and observations in the field, many students had difficulty understanding the basic concepts of the network, so that it would be difficult to understand in the future. Another reason is that the school is not yet complete enough regarding network equipment, such as the absence of routers, switches, and HUBs.

2.1.2. Design Stage

At the design stage, the process carried out is to create a wireframe and UML (Unified Modeling Language), which consists of Use Case Diagrams and Activity Diagrams.

i. Use Case Diagrams

The use case in this learning media to describes the flow of interaction between the user and the application system.

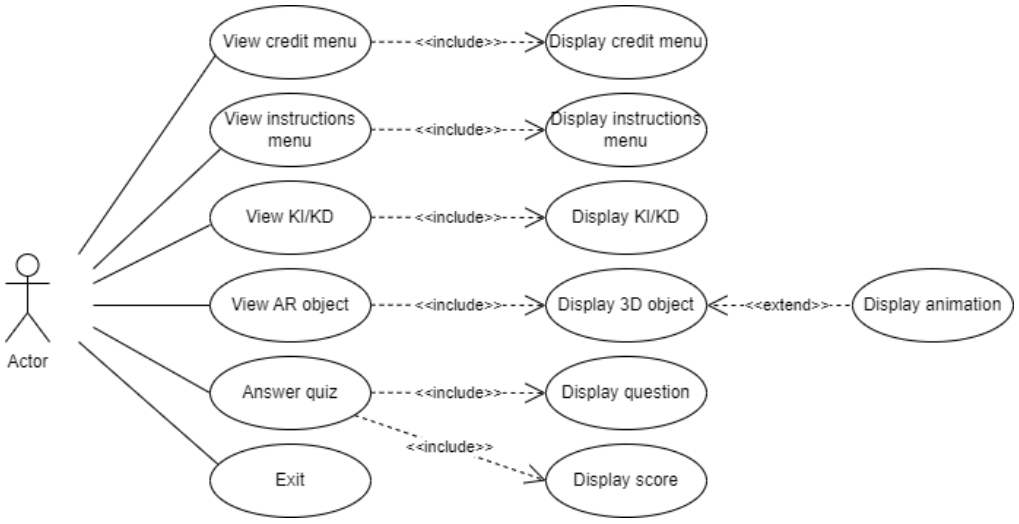

Figure 3. Use Case Diagrams

ii. Activity Diagrams

An Activity Diagram or activity diagram is a UML diagram that provides an overview of the processes of a system. All processes in the system will be depicted by this diagram in **figure 4**.

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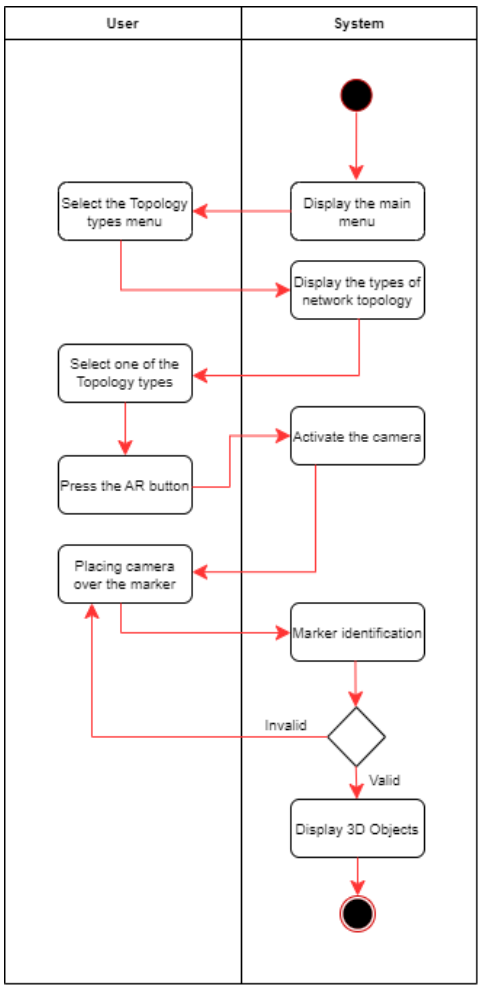

Figure 4. Activity Diagrams AR App

iii. Wireframe

Wireframe is the initial framework before a website page or application interface is designed. Wireframes are very important stage in product design that must be well understood. After the wireframe is created, it must be approved by stakeholders to correct the location of application information before the user interface design is created. **Figures 5** explain the wireframe of the main page, which consisted of three different menus.

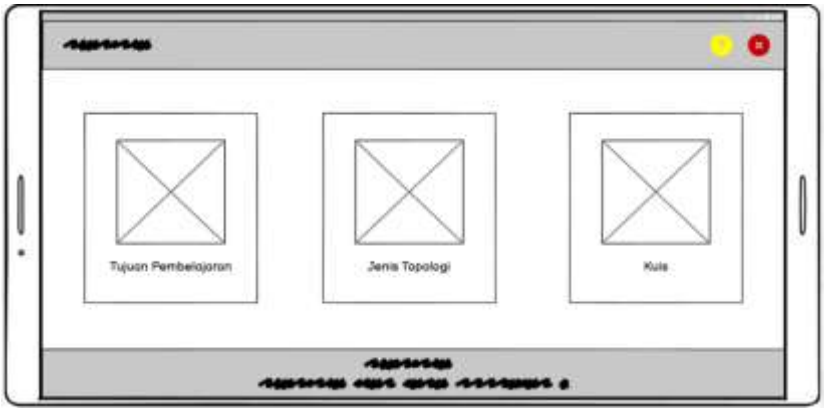

Figure 5. Main page

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Figures 6 displays the layout of the learning objectives which the students can read before starting the lesson. This is considered important because student must know what is the goal of their study.

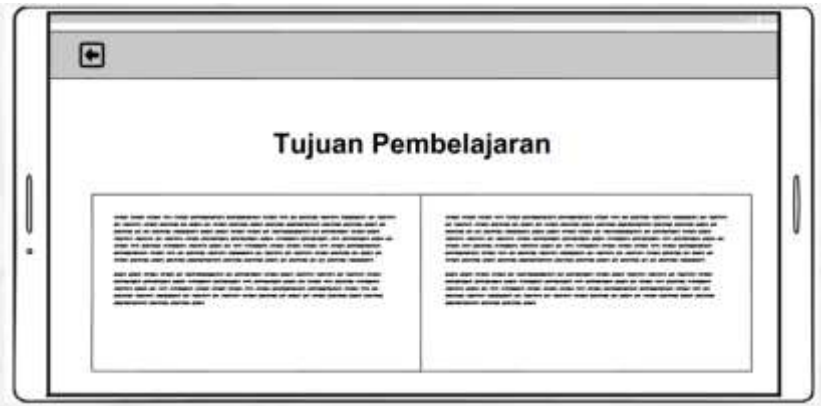

Figure 6. Learning Objectives Menu

After the student read the learning objectives, they are guided to read the teaching material. There are three choices on how to digest the materials. Firstly, student can read the provided text material. They can also choose to use Augmented reality and video materials. **Figures 7** illustrate the wireframe of the material menu and the three materials option.

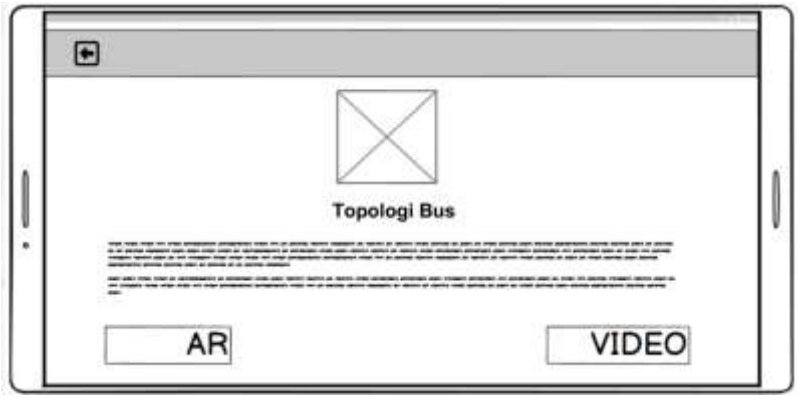

Figure 7. Material Menu

After reading, watching or experimenting with the materials presented in the previous menu, student will be directed to quiz menu to help test their current understanding of the materials. **Figures 8** depict the layout for the quiz menu.

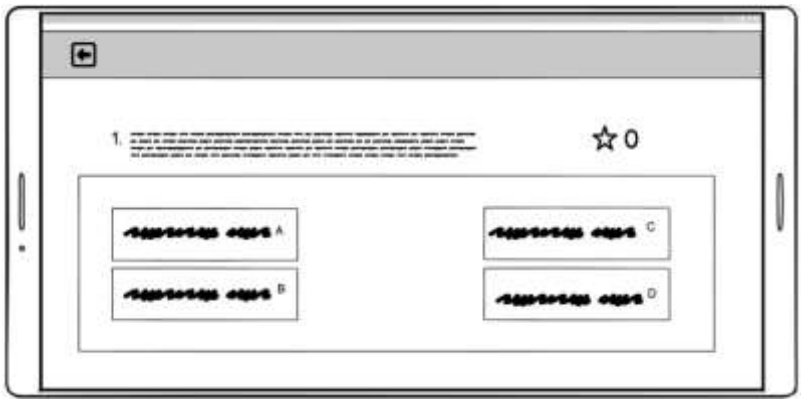

Figure 8. Quiz Menu

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2.1.3. Material Collecting Stage

Third, at the material collecting stage, the researcher collects the teaching materials used or learning materials obtained from interviews with informatics teachers, reading books, and obtaining internal sources. In addition to collecting teaching materials, the researchers must also prepare materials for future software such as markers, 3D objects, Unity scripts, and more.

2.1.4. Assembly Stage

Fourth, at the Assembly stage, the researcher creates a product where the materials and design must be ready, so all that remains is to implement it according to the concept plan. Several software applications must be prepared to create Augmented Reality, namely Unity version 2021, Visual Studio Code, Adobe Photoshop, and Blender.

2.1.5. Testing Stage

Fifth, at the Testing stage, the researcher carried out a feasibility test of the product to determine whether it was in accordance with the harmony of media functions, such as buttons, the display of each page, audio-visuals, and 3D objects. Testing is conducted through alpha testing. One of the methods used in alpha testing is the black box method. The black box approach has the same goal as the alpha testing concept, including testing functionality and identifying glitches or bugs.

2.1.6. Distribution Stage

At the distribution stage, this stage is the final step of developing multimedia products that are distributed to students and teachers at SMAN 2 Bandung, if the results of the testing stage get a good enough score.

2.2. Data Analysis Technique

In this research, the instruments used include media and material expert validation. If declared valid, a questionnaire is then given to gather student responses after using the interactive multimedia based on Augmented Reality.

2.3. Population and Sample

The population in this research consisted of several Class X students from SMAN 2 Bandung. The data collection method employed a 1-4 Likert rating scale to simplify the process of obtaining responses from all students. The number of students involved in the experiment using PPT and AR was 55, while the experiment using Quizizz and AR involved 64 students.

3. RESULTS AND DISCUSSION

3.1. Augmented Reality Multimedia Results

3.1.1. Homepage

In this main menu, users will see various options, namely: 1) Main Menu, 2) Information Menu, 3) Network Topology Material Menu, 4) Quiz Menu, 5) About Menu, 6) Exit Menu, and 7) CP/TP Menu, all while listening to background sound. When the user selects the Material Menu, the system will automatically activate the AR and video cameras. The main menu page can be seen on **figure 9**.

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Figure 9. Main page

If the user selects the AR button, they only need to point the camera at the marker. **Figure 10** depict the student trying the Augmented reality provided in the application.

Figure 10. AR Implementation

3.1.2. Video and Quiz Menu

This quiz display contains 10 multiple-choice questions for students to answer. Each correct answer is worth 10 points. After completing the quiz, the system will display the total score, and students can choose whether to repeat the quiz or not.

Figure 11. Quiz Page

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The video material menu about networks, which contains offline videos to make it easier for users to learn and serves as a complement to the material content.

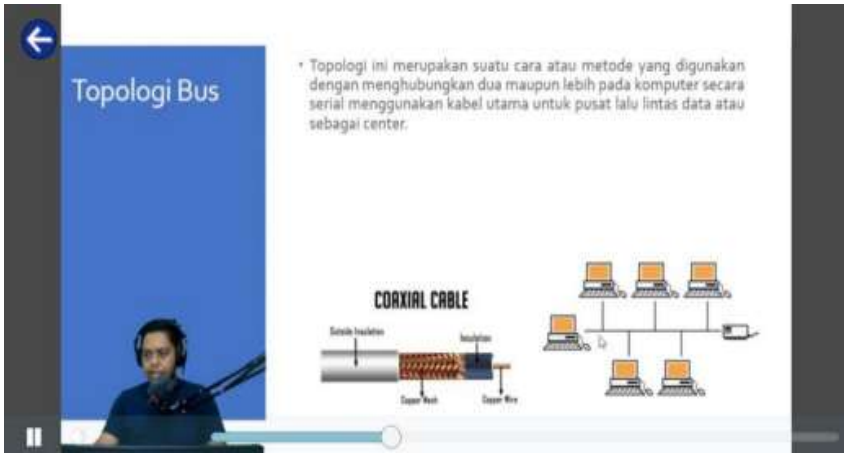

Figure 12. Video material menu

3.2. Material and Media Validation Data Analysis

3.2.1. Media Expert Validation

The expert media validation is conducted before the the appliacation was given to the student. This is done to ensure the quality and feasibility of the final product. The vadiation is conducted through questionnaire and media testing by the expert. **Table 1** explain the result of the media validation process**.**

Table 1. Media expert validation result

No	Criteria	Media Expert	Total
1	Ease of title in providing a general overview of Augmented Reality media.	3	3
2	Easy operation guide.	3	3
3	The consistency of layout proportions (text and image layout) is well-maintained.	2	2
4	The text used is clearly visible.	3	3
5	Matching text and image colors.	4	4
6	Accuracy in choosing the type of text and fonts presented.	3	3
7	The image quality is clear.	3	3
8	Icons and navigation buttons are easy to understand.	3	3
9	Accuracy of menu layout.	2	2
10	The learning media provides students with the opportunity to practice theoretically.	4	4
11	There were no bugs, errors, or force closes detected in the application while in use.	4	4
12	All navigation buttons in the application function properly and are easy to understand.	4	4
Amount		**38**	**38**

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Based on the results of a questionnaire from media experts**,** with a total score of 38 out of 12 questions and an expected score of 48, it can be concluded that the calculation using the feasibility percentage formula is as **Equation 1**:

$$\%score\ interpretation \frac{The\ total\ score\ obtained}{Skor\ maksimum} \times 100\%$$

$$= \frac{38}{48} \times 100\% = 79\%$$

The results obtained from media expert validation were 79% which was included in the "Eligible" category.

3.2.2. Material Expert Validation

Aside from media validation, the researchers also conducted material validation by experts. This is done to ensure the quality of the teaching materials which will be presented to the student. **Table 2** explain the result of the material validation.

Table 2. Material expert validation

No	Criteria	Materials Expert	Total
1	In general, the subject matter is in accordance with the Informatics subject in the basic Computer Networks chapter of class X SMA	4	4
2	Animation of 3D objects in media makes it easier to understand the material	4	4
3	The content of the material is clear and can be understood by students	4	4
4	Increase insight into learning	4	4
5	Bringing students' learning experience to a more active and motivated level	4	4
6	The language used is easy for students to understand	3	3
7	Example questions according to the material	4	4
8	Compared to other media, this teaching media can have a positive influence on learning	4	4
9	Modules and media can help students learn independently	4	4
10	Modules and media can attract student interest	4	4
Amount		**39**	**39**

Based on the results of a questionnaire from material experts with a total score of 39 out of 10 questions and an expected score of 40, it can be concluded that the calculation using the feasibility percentage formula is as Equation (2):

$$\%score\ interpretation \frac{The\ total\ score\ obtained}{Skor\ maksimum} \times 100\%$$

$$= \frac{39}{40} \times 100\% = 97\%$$

(2)

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The results obtained from media material validation were 97% which was included in the "Very Appropriate" category.

3.3. Experimental Results

3.3.1. PPT Experiment with Augmented Reality

Researchers distributed a questionnaire with 15 questions regarding the comparison of learning motivation using PPT and AR, which was answered by 55 students. From the questionnaire, the overall average result was 75% categorized as strong student motivation in AR learning compared to PPT. The average value of the answers can be seen in **Figure 13**:

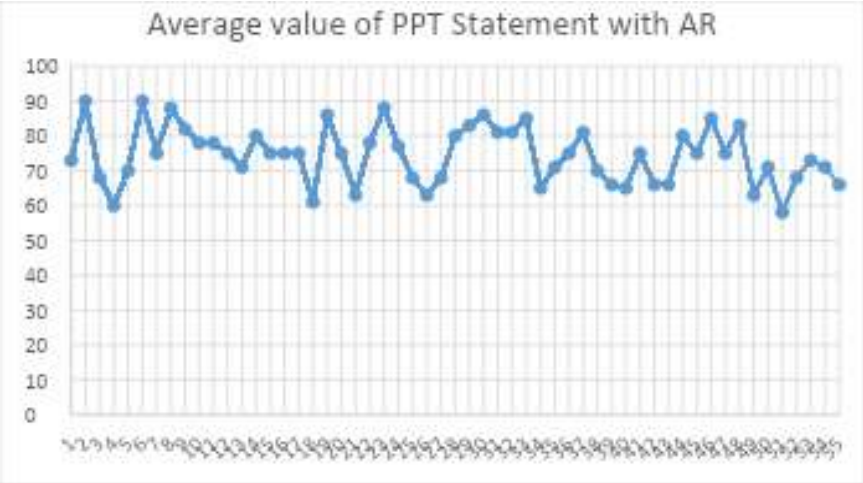

Figure 13. Average value of AR with PPT

Apart from measuring student motivation using questionnaires, researchers also observed student behavior and involvement in the classroom during learning. According to Appleton et al., (2006), student engagement can be measured using four indicators: academic engagement, psychological engagement, cognitive engagement, and behavioral engagement. Classroom observations revealed that students actively participated in discussions, achieved good grades, and displayed enthusiastic facial expressions while using Augmented Reality learning media. Therefore, these observations align with the results of the experimental questionnaire.

3.3.2. Quizizz Experiments with Augmented Reality

Next, the researchers distributed another 15-question questionnaire regarding the comparison of learning motivation using Quizizz with AR, which was answered by 64 students. From the 15 statements carried out, the overall average result was 65% which was categorized as sufficient student motivation in AR learning compared to Quizizz. The average value of the answers can be seen in the **Figure 14**:

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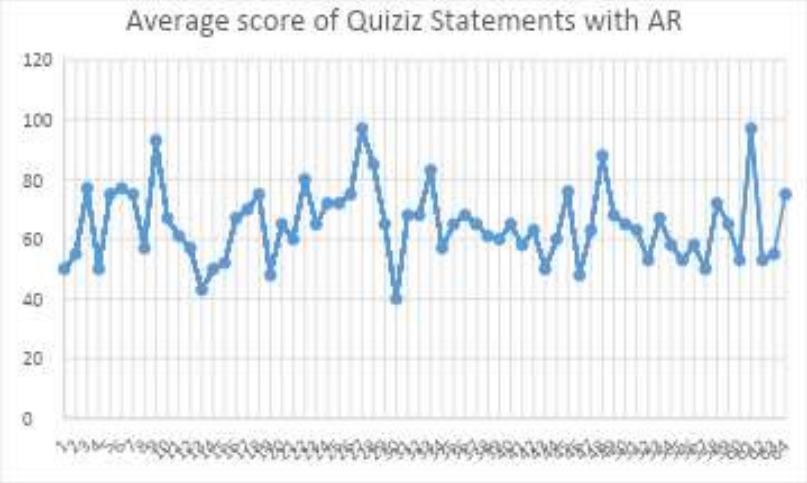

Figure 14. Average AR score with Quizizz

Another observation from classroom observations is that some students are happier with Quizizz. The reasons are: 1) Quizizz does not require a large application compared to AR applications, and 2) Quizizz can be used on various operating systems, such as iOS, while the AR application is still under development for Android. However, despite these results, students remain motivated to learn about AR technology.

4. CONCLUSION

The development of Augmented Reality-based learning media for basic computer network material can enhance student learning motivation compared to PPT and Quizizz. This is evidenced by the comparison of AR-based learning media with PPT, which scored 75% (high motivation), while AR in conjunction with Quizizz scored 65% (sufficient motivation). Additionally, classroom observations revealed that students actively participated in discussions with enthusiasm while learning to introduce Augmented Reality technology. This indicates that AR technology can help create more effective learning media.

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6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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