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INNOVATIVE VIRTUAL REALITY LEARNING MEDIA WITH A PROBLEM-BASED LEARNING MODEL TO ENHANCE COGNITIVE ENGAGEMENT

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ABSTRACT

Engaging learning experiences are often more memorable and effective, contributing to long-term retention of knowledge. One effective approach to enhancing the appeal of educational content is through the development of innovative learning media that leverages digital technology. This study focuses on the creation of Virtual Reality (VR)-based learning media, which integrates video, audio, text, and music to enrich the educational experience. The aim is to optimize the learning process by utilizing VR to deliver compelling and immersive content. To further enhance learning efficiency with VR media, this research employs the Problem-Based Learning (PBL) methodology as the pedagogical framework. The development process of the learning media follows a design thinking approach to ensure the media is both engaging and educationally effective. Validation results from student assessments indicate that the VR learning media, incorporating the PBL method, has successfully improved students' cognitive abilities. The media demonstrated a gain value of 0.57, reflecting a moderate increase in learning outcomes.

Keyword: Virtual Reality, Learning Media, Problem Based Learning, Cognitive.

INTRODUCTION

Technology is one of the factors that influences the development of the learning process. In the learning process, technology is not only used as a learning aid but is also an integral part of the learning method itself. One technological innovation that is starting to be widely applied in education is Virtual Reality (VR). VR has great potential to create immersive learning experiences (Halabi, 2020; Mulders et al., 2020) which allows students to experience learning as if they were in the real environment. Apart from that, the interactive process in learning can be achieved more optimally so that it can make it easier to achieve the learning targets carried out (Ericson & Miller, 2020; Lim et al., 2020). Ferguson et al. (2020), have developed VR which can support the interaction process in learning with serious games. The results of his research show that the interaction process with VR succeeded in increasing cognitive interest and the feeling of presence felt by students (Tong et al., 2023).

However, the use of VR technology in education cannot stand alone without being supported by an appropriate learning model. The Problem Based Learning (PBL) learning model has been proven effective in improving students' critical thinking and problem-solving skills (Isroqmi et al., 2018). PBL emphasizes students' active involvement in the learning process through solving real problems that are relevant to the material being studied.

The combination of VR and PBL can be an innovative solution to improve students' cognitive abilities. VR provides a realistic and fun learning environment, while PBL provides a framework for in-depth exploration and problem solving. By combining these two approaches, it is hoped that students will not only understand theoretical concepts but also be able to apply them in real situations.

This research aims to develop VR-based learning media that adopts the PBL learning model, as well as testing its effectiveness in improving students' cognitive abilities. Thus, this research not only contributes to the development of educational technology, but also to the innovation of learning methods that can be implemented in various educational contexts.

Through this research, it is hoped that new ways can be found to overcome challenges in learning, such as lack of student motivation and difficulties in understanding abstract material. It is hoped that the development of VR-based learning media using the PBL model can be an effective solution in improving the quality of education, especially in terms of improving students' cognitive abilities.

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METHOD

The research method used in this research is the ADDIE research method using a design thinking approach. The integration of Design Thinking and ADDIE can create a holistic approach, better guiding project design and paying special attention to user needs and experiences, as mentioned by Design HIs T, (2019) this allows the development of more contextual and satisfying solutions. So Design Thinking is suitable for use by researchers because it uses UX as the core of VR development goals as in Figure 1.

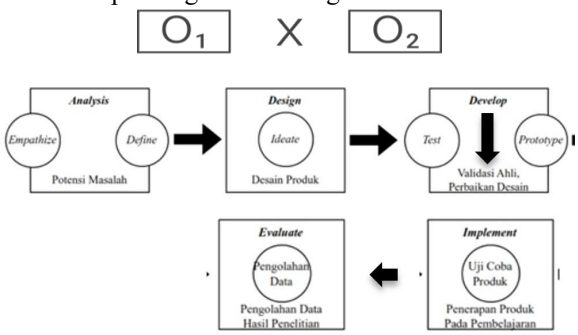

Figure 1. Research Methods

The research design used is One Group Pretest-Posttest experimental design which is carried out by comparing the situation before and after using the new system (before-after). The experimental model used can be described as Figure 2. Experiment Design with O1 is the value of student engagement and student UX towards Virtual Reality. Meanwhile, O2 is the value of student engagement and student UX towards the new Virtual Reality, meaning that X here is the use of the new Virtual Reality or what is called treatment.

Analyst

The analysis process is carried out to determine needs and define them. This analysis stage consists of 2 processes: empathize and define.

A. Empathize

This stage aims to empathize or understand students regarding their experiences in using Virtual Reality. This stage begins with observing students using Virtual Reality to learn Data Analysis. After observations are made, students fill out a questionnaire to measure User Experience (UX). After the questionnaire is given to students, an analysis is carried out on the results of the questionnaire used to assess UX. This aims to find out which students are right to take part in in-depth interviews and become the basis for problems that need to be corrected. This in-depth interview aims to explore the problems experienced by students in using Virtual Reality. The questions asked in the in-depth interview session to students were prepared based on deficiencies in previous research and regarding students' UX towards Virtual Reality. After the in-depth interview is conducted, the next step is to prepare an empathy map based on the results of observations on students and the results of the in-depth interview. In compiling the empathy map, the observation results used were the results of the researcher's observations during the observation, while the in-depth interview results used were all the results of the in-depth interview session with students.

The User Experience Questionnaire (UEQ) is used to assess user experience in this research. User Experience Questionnaire (UEQ) developed by Martin Schrepp and translated into Indonesian by Harry B. Santoso. The UEQ questionnaire has 26 statements with a Guttman scale answer format of 1-7. This questionnaire is prepared by combining two negative statements on the left then followed by two positive statements on the left. The combination is used up to the 26th statement to avoid inconsistent answers from respondents

B. Define

This stage is the stage where the problem will be defined with several steps in it. This stage begins with creating a user persona to describe the users who will use the product. In creating a user persona, the results of the empathy map and some of the results of the in-depth interview will be used as a reference for determining the characteristics of Virtual Reality users later. After creating the persona, continue with defining the problem. In defining the problem, start by stating the user needs (user need statement) based on the user persona that has been created. In determining the user needs statement, there are three parts that must be defined, namely user, need, and goal. The user used here is the user persona, then need is what the user needs, and goal is the goal or result of the user's needs that will be met. After the user needs statement is defined, the next step is to define the problem based on the user's needs using the form of a how might we question.

Ideate

This stage is the stage for getting an idea to become a solution to the problem that was defined in the previous stage. This stage begins with brainstorming to get many possible solutions to the problems that have been defined in the previous stage, then after various solutions have been obtained, these solutions are grouped if there are similarities to produce

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a feature. So that from these solutions the best solution will be obtained to solve the problem or provide the elements needed to avoid problems that will occur later. All solutions that have been obtained need to be prioritized which ones are carried out first. After getting the priority solution, then draw up a Flowchart to map out what features are being built.

Prototyping and Testing

A. Prototyping

After getting a solution and arranging various needs in the previous stage, at this prototype stage a design is created that will resemble the original product, so that product development using the assets provided will save time and costs. This stage begins with creating an initial scene from Virtual Reality, namely using a storyboard as the basic design of the application being developed. At this stage it is necessary to pay attention to what has been produced in the previous stage, so that the results of this stage lead to user needs, especially the functionality.

B. Testing

The test stage is a stage used to assess whether the solution created in the previous stage meets the user's needs or whether there are problems that have not been resolved. At this test stage we use usability testing which refers to UEQ to test the prototype that has been created through the application.

This stage begins with the use of Virtual Reality by students and continues by giving students time to try Virtual Reality in order to gain independent learning experience without an instructor. After students have finished trying Virtual Reality, students fill out a questionnaire to measure student engagement and measure UX using the UEQ questionnaire.

Implementation

This stage is carried out after validating the media and question instruments which are declared appropriate by experts. At this stage, researchers implemented VR-based learning media with a PBL model at State Vocational High School 8 Bandung (SMKN 8 Bandung) for 32 class X TPTUP students. Before the learning process uses VR media, researchers first carry out a pretest to determine students' initial abilities in data analysis material. Using the VR application with the Problem Based Learning model for student learning. In Figure 2 is the initial display when entering the scene, the user will be directed how to use it.

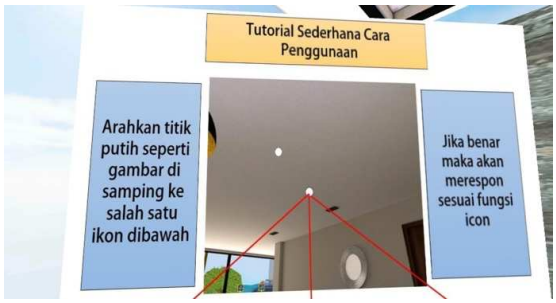

Figure 2. Initial Scene

One of the features is a video that will appear after the centre point is directed to the play icon, then the user can select several menus on the video such as play, stop, volume, video speed and video duration. Namely by directing the middle white dot to one of the menu options visible on Figure 3.

Figure 3. Vide Access for Learning Activities

Subject Participant Validation

The research subjects in this study were class X students majoring in TPTUP at SMKN 8 Bandung and class X students majoring in Computer and Network Engineering at SMKN 4 Bandung. Based on the subject of this research, the research objects in this research include: 1) User experience towards Virtual Reality, 2) Student engagement towards Virtual Reality, 3) User experience towards the new Virtual Reality, and 4) Student engagement towards the new Virtual Reality.

RESULT AND DISCUSSION

Media Validation

Expert validation tests on media are carried out to determine the suitability of the media developed by researchers. Researchers asked experts who were lecturers in Computer Science education who referred to the 2004 Multimedia Mania validation instrument.

Table 1. Validation Test

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No	Criteria	Value
1	Mechanism	15
2	Multimedia	7
3	Information structure	15
4	Documentation	7
5	Content quality	48,5

To get the media validation percentage value, the data is substituted with the rating scale formula with the following conditions.
h the following conditions.

$$Percentage\ of\ Validation = \frac{data\ score}{ideal\ score}\ x\ 100\%$$

$$Percentage\ of\ Validation = \frac{92,5}{100}\ x\ 100\%$$

$$Percentage\ of\ Validation = 92,5\%$$

Percentage of media validation Based on the calculations above, the percentage of expert validation data obtained is 92.5%, so the results of validation by experts for media are categorized as very good and the media is suitable for use in research can be seen in Figure 4.

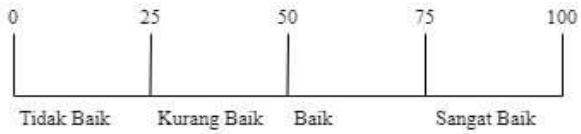

Figure 3. Validation Scale

Cognitive Value

Research that has been carried out by researchers, obtained the results of pretest, posttest data and experimental activities. Data obtained from pretest and posttest activities will be analyzed using the N-gain test. The N-gain test is used to determine the increase in student learning outcomes regarding learning using VR learning media.

Table 2. Gain Index

Group	Category	*Pre-test*	*Post-test*	Gain
Upper	Max	84.44	100.00	1.00
	Min	68.89	73.33	0.14
	Avg	73.94	87.47	0.51
Middle	Max	64.44	97.78	0.96
	Min	40.00	57.78	0.17
	Avg	51.43	79.05	0.58
Lower	Max	31.11	86.67	0.81
	Min	0.00	37.78	0.35
	Avg	17.46	66.98	0.61

The results of the Gain index analysis show that the Upper group has a maximum pretest score of 84.44 points, has a maximum posttest score of 100 points, has a maximum Gain of 1.00, has a minimum pretest score of 68.89 points, a minimum posttest score of 73.33 points, has a minimum Gain 0.14, has an average pretest score of 73.94 points, has an average posttest score of 87.47 points and has an average Gain of 0.51. Furthermore, the Middle group has a maximum pretest score of 64.44 points, has a maximum posttest score of 97.78 points, has a maximum Gain of 0.96, has a minimum pretest score of 40.00 points, a minimum posttest score of 57.78 points, has a minimum Gain of 0, 17, has an average pretest score of 51.43 points, has an average posttest score of 79.05 points and has an average Gain of 0.58. Then finally the Lower group has a maximum pretest score of 31.11 points, has a maximum posttest score of 86.67 points, has a maximum Gain of 0.81, has a minimum pretest score of 0 points, a minimum posttest score of 37.78 points, has a minimum Gain of 0, 35, has an average pretest score of 17.46 points, has an average posttest score of 66.98 points and has an average Gain of 0.61.

Table 3. Gain

Group	Number of students
Upper	11
Middle	14
Lower	7

CONCLUSION

This research shows that the development of Virtual Reality (VR) based learning media using the Problem-Based Learning (PBL) method has succeeded in improving students' cognitive abilities. The integration of various digital technologies such as video, audio, text and music in VR learning media aims to create a more interesting and effective learning experience. By applying the PBL method in learning scenarios, this media is designed using a design

thinking approach to ensure effectiveness and student involvement. The results of the validation carried out on students showed that VR learning media using the PBL method succeeded in improving students' cognitive abilities with a gain value of 0.57, which is classified as a moderate improvement in learning outcomes. These findings confirm the potential of PBL-based VR media in improving students' learning experiences and academic outcomes. Future research could explore the use of other learning methods besides PBL in combination with VR media. Methods such as project-based learning or collaborative learning can be tested to evaluate their impact on improving learning outcomes and student engagement. In addition, to increase the effectiveness of VR-based learning media, it is recommended to explore the addition of more sophisticated interactive features, such as mixed reality-based simulations or gamification elements. These features can increase student engagement and deepen understanding of the material.

DISEMINATION

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