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The Influence of Using Virtual Reality (VR)-Based Geometry Lab media on Student Learning Achievement at UIN Walisongo Semarang

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Abstract

In research on the development of virtual media for a geometry lab using the ADDIE stage model. This model, as the name suggests, consists of five main phases or stages, namely (A) analysis, (D) design, (D) development, (I) implementation, and (E) evaluation. The Implementation and Evaluation stage was carried out in the second year, with expanded tests carried out at UIN Walisongo Semarang and UIN University Semarang in a fun and enjoyable manner, with posttests and user response questionnaires given with the following results: Based on research at UIN Walisongo, posttest results were processed using tests t results obtained are 0% <5%, then H0 is rejected. This means that we accept H1, which means that the results of learning mathematics in the Virtual Lab Geometry media based on Virtual Reality (VR) are better than the conventional learning model. Looking at the average learning achievement in the mean column, Group Statistics table, the experimental class average is 84.53. while the control class average was 70.33. These results show that the learning outcomes of the experimental class are better than the control class. R Square value is 0.832 = 83.2%. This value means that the influence of virtual lab media on learning achievement is 83.2%, while 16.8% of learning achievement is influenced by other variables outside of the independent variables in this study.

Keywords: *Development, Virtual Lab, Geometry, Cognitive Ability, Spatial Ability*

INTRODUCTION

Several obstacles emerge in the educational area during this present pandemic period, such as online learning, which makes it harder for learners to grasp mathematical teachings [1, 2]. The educator then struggles with providing material that demands students to practice and be innovative [3, 4]. Then, when it comes to learning mathematics in college, such as the geometry course, students fail to comprehend the knowledge that is presented without practice. When the Covid-19 tragedy has not yet occurred, pupils must sketch flat objects and construct spaces with a compass and ruler. Nonetheless, students should sketch with accuracy, precision, and effort. Finally, interviews with various students from Universitas PGRI Semarang and Universiti Teknologi Malaysia demonstrated that virtual learning is critical to helping students understand geometry in theory and practice. The second difficulty is that mathematics education students at UIN Walisongo Semarang struggle to understand geometry concepts. The results of the 2019-2020 academic year's Final Semester Examinations indicated that 60% of UIN Walisongo Semarang students have yet to master the theory and practice of geometry efficiently and correctly. This makes it our responsibility as educators to provide the best intention so that they can understand geometry material properly and adequately. One option is to provide learning equipment that can improve their cognitive and spatial abilities in studying geometry material, with the device in question being a well-packaged and up-to-date virtual geometry lab media.

Because mathematics laboratories for geometry are still overcrowded, few people in Indonesia employ virtual labs to create geometry learning. [5] Those who use virtual labs are typically in healthcare and science, but no one has established a virtual geometry lab using virtual reality to study mathematics, particularly geometry, despite the fact that many campuses around the world have formed and use virtual labs to teach mathematics and sciences. Because it is critical to develop a virtual reality application that can demonstrate the placement of flat wakes and real space using virtual reality, this must be done in Indonesia so that learning geometry, which has been a scourge in various universities and the private sector in Indonesia, becomes a possibility. Especially in light of the COVID-19 outbreak. As educators, we are responsible for compressing material that students

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can access anywhere, whether online and offline, and one of our tasks is to create a virtual geometry lab application utilizing the VAN HIELE THEORY framework that successfully and appropriately mixes technology, pedagogy, and material content. The objective of this project is to create an application that can be used with a VR camera, stick, smartphone, or computer connected to the Virtual lab application on geometry materials, namely congruence and parallelism materials, and can be comprehended both online and offline.

Domestically, there are now virtual laboratories for scientific or health education run by [6] reveals that employing mobile virtual reality to obtain physics curriculum may assist pupils boost their analytical ability. [7–9]. It demonstrates how virtual reality packaged as a game may improve students' engagement and learning outcomes in biology. [10] shown how employing a virtual reality-based virtual lab may boost kindergarten children's cognition when learning about different types of fish. On the other hand, [11, 12] indicated that they were able to improve their skills by learning mobile augmented reality-based geometry resources. In addition, [13] demonstrate that mobile augmented reality is quite useful for studying geometry at the collegiate level. The VAN HIELE THEORY framework, which has been successfully implemented in several schools or institutions, is used to integrate technology, pedagogy, and material in a useful and engaging manner. According to [14], The VAN HIELE THEORY technique, which combines technology, pedagogy, art, and material content, makes it simpler for students to comprehend the information since it is packed with sustainable technology and the content is properly transmitted. [15] remarked that VAN HIELE THEORY makes it easy for professors to connect course content to renewable technology, making learning more enjoyable for pupils. In this case, research was conducted at UIN Walisongo Semarang to construct a virtual geometry lab for online learning.

RELATED WORKS

This section discusses the relevant works that fall within the scope of this research.

Virtual Reality

Virtual reality (VR) is a technology that allows users to interact with a computer-generated environment, a replicated real-world one, or a completely fictional one. Contemporary virtual reality settings generally provide a visual experience, which is displayed on a computer screen or through a stereoscopic viewer; however, some simulations also feature supplementary sensory information, such as sound through speakers or headphones [16]. Virtual Device Reality. Sensory-immersion VR interface devices that directly include sensory emotions include headmounted displays (VR helmets), data gloves (gloves), and bodysuits (VR vests). A blinded helmet (headmounted display) provides a fresh perspective on the object being viewed. Once moved, the pictures will shift so swiftly that we will believe we are causing them with our head movements. Humans are the cause of the effect, not the outcome. Projection Interaction with an object shown on a big screen that depicts an artificial virtual environment, such as CAVE (Cave Automatic Virtual Environment) or Responsive Work, is considered VR. The VR Simulator includes a physical environment to bring it closer to the user [17]. In the car sector, a replica of the passenger cabin is often produced, complete with a monitor that acts as a windshield and a VR device, allowing the mockup to dynamically offer natural feelings such as vibration or shock. Desktop VR is the equipment that shows the VR modeling process on a computer screen. Applications of virtual reality in everyday life include: 1) education and training, The goal of adopting virtual reality (VR) in training is to help professionals conduct training in a genuine artificial environment where they may increase their abilities without the risk of damage [18].

Geometry

According to [19], "the study of the relationships between points, lines, angles, surfaces, and solids is known as geometry." Geometry is the study of the relationships among points, lines, angles, planes, and spatial structures. Geometry is a branch of mathematics that studies the complexities of flat forms and shapes. Geometry comprehension is organized in stages, beginning with the simplest things and is called the basic notion, leading to elements that require boundaries/definitions by using the basic comprehension, then axioms/postulates have been compiled, namely the basic assumptions that are approved on are true and do not need to be proven, based on the existing axioms/postulates and derivations [19].

Spatial Thinking

Given that many previous studies found that youngsters failed to understand geometric objects or figures, the issue of spatial thinking is quite interesting to investigate. Spatial thinking is a set of cognitive skills that includes three components: spatial concepts, representational tools, and reasoning processes [20]. Spatial Learning outcomes are a key idea in spatial thinking. It may classify spatial learning results into three categories: (1) spatial perception, (2) mental rotation, and (3) spatial visualization. According to the findings of the following study, spatial student achievement is critical for improving in the context of mathematics, particularly geometry, so that every student should strive to develop learning outcomes and spatial sensing that are very useful in understanding relations and properties in geometry to solve mathematical problems and problems in everyday life [21].

RESEARCH METHODOLOGY

This research makes use of research and development (R&D). Development research is a method of generating specific things and evaluating their usefulness. The ADDIE approach is employed in this development research, which is divided into five stages: analysis, design, development, implementation, and evaluation.

Research Design

The ADDIE model was used as the research design for this study, which was divided into five phases: analysis, design, development, implementation, and evaluation. These five processes are implemented in a consistent and methodical manner.

Population And Sample/ Study Group/Participants

Students from the Mathematics Education study program at UIN Walisongo Semarang participated in this study, taking two experimental classes and one control class.

Data Collection Tools

The research data was gathered through a questionnaire response validation of material experts, learning media experts, and user responses, followed by pretest and posttest tests to evaluate students' cognitive and spatial abilities, and then a N Gain test to evaluate the improvement of process skills and cognitive learning outcomes before and after studying at UIN Walisongo Semarang.

Data Collection

The data was collected using a Google form and validated by material professionals and learning media professionals, followed by a student response questionnaire, which was also completed using a Google form, while the pretest and posttest were completed in writing and scanned results were sent via email for detailed evaluation.

Data Analysis

The average score and N Gain test were used to measure students' progress in process skills and cognitive learning implications for evaluating the outcomes of research data collecting using a Likert scale linked to user replies and expert validation.

FINDINGS

This research used the ADDIE paradigm to create a Geometry Virtual Lab product. A detailed breakdown of the product development outcomes based on the ADDIE development strategy is provided below:

Analysis

An analysis of geometry learning problems at UIN Walisongo Semarang in the Mathematics Education study program found that 60% of students are still inadequate in recognizing geometry material, particularly flat and spatial shapes, cognitive and spatial abilities, at this stage in the analysis. Based on the preliminary pretest results, they were still below 70, and the students stated that during the 2020-2021 pandemic, 90% of the

students at UIN Walisongo Semarang and Universiti Teknologi Malaysia urgently require learning media that can improve their understanding and spatial abilities related to geometry material, specifically congruence and parallelism.

Design

The product design is centered on the needs and attainment of learning objectives, specifically developing a Geometry Virtual Lab application that focuses on the material. Congruence of triangles using virtual reality technology makes Alignment interpretations clear, and it is envisaged that students' geometric spatial competency will be superior to other traditional media. This virtual geometry lab was created in Corel Draw and animated using Unity 3D, Blender software, and Vuforia Development. Following the execution of the application design product, a focus group discussion is scheduled that considers the design presentation as well as the depth of the content presented, namely congruence and parallelism. The results of the focus group discussion show that students need to practice picking the placement of congruence and aligning flat shapes in order to fully comprehend mathematics conceptually.

Development

During this stage of development, the proposed framework is finalized in order to create a deliverable item. The Geometry Virtual Lab media is created in line with the congruence and alignment material; after done, the android-based media is evaluated by media and material specialists by the validator in order to receive feedback and appraise based on the validator's comments. As a consequence, the Virtual Reality-based information is adjusted in response to validator feedback to help enhance the product.

During this stage of development, a virtual geometry lab was created and modified based on the results of a focus group discussion between lecturers and students about the design of virtual geometry lb media and the scope of the geometry material obtained. The product was then expert validated before being tested in the field, which included experts in geometry materials and virtual reality-based learning media experts. The following diagram displays the Visually Developed Geometry Virtual Lab products:

Figure 1. Front view of Virtual Lab's product geometry material.

Figure 2. Display of Materials Virtual Laboratory Material: flat geometry

The Geometry Virtual Lab product was validated by media professionals, with the following results: (1) The look of this virtual geometry lab product is appropriate as a virtual adjunct to geometry course content. (2) Color gradations associated with geometric alignment material can be visualized digitally and attractively. (3) The virtual geometry lab application is enjoyable for lectures because the quizzes are illustrated with fascinating animations. (4) The menu options in the virtual geometry lab application can be used in a pleasurable, convenient, and interesting way. (5) The product can correlate this congruence and parallel material to students' spatial skills with 3D (6) Established queries must be connected to the viewpoint of the most current triangular congruence difficulties (7) Virtual geometry lab applications can be used appropriately and in accordance with the IQF material; (8) Students can solve geometric congruence and parallelism problems in a chronological and captivating manner; and (9) This virtual geometry lab application product has no complications for customers. ((10) In terms of the practicality of the geometry virtual lab product design, the validation results reveal that the average outcome of the learning media expert assessment is 93, indicating that the virtual geometry lab item is exceptionally appropriate for use in learning.

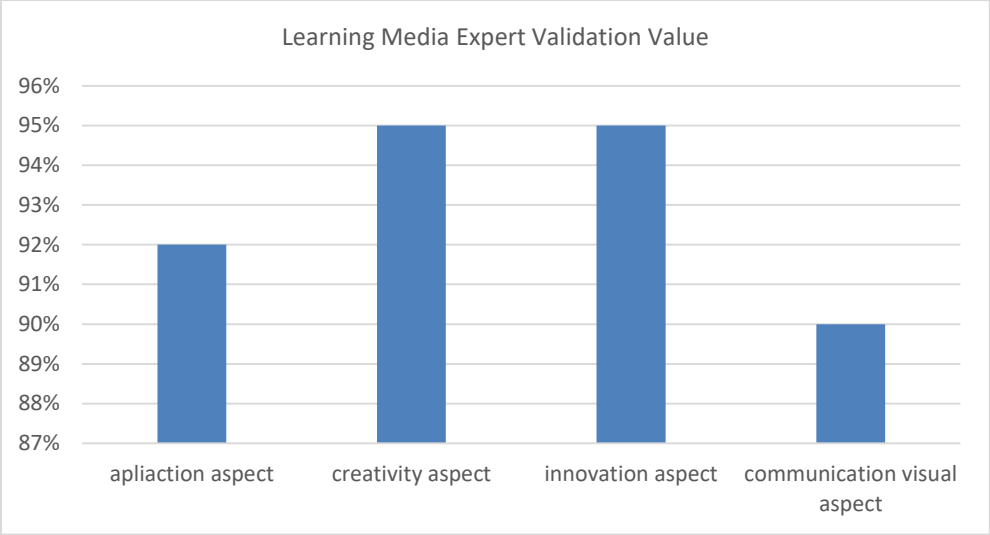

Figure 3. The results of the virtual geometry lab product review by learning media professionals.

Furthermore, based on material expert evaluation, the following conclusions were reached: (1) This virtual geometry lab product is ideal as a virtual adjunct to geometry course content; (2) Principles related to congruence and geometrical alignment material can be understood virtually; (3) The virtual geometry lab program is fascinating to use in other courses; and (4) The menu options of the virtual geometry lab application can be used in an exciting and pleasant manner. (5) This geometry congruence and parallelism content may be related to students' spatial cognition; (6) Recent issues must be linked to the framework of the most recent congruence and alignment challenges; (7) This virtual geometry lab application can be used appropriately and in accordance with KKNI content; (8) Students can address congruence and parallelism problems sequentially; and (9) This virtual geometry lab program is easy to use. (10) According to an expert evaluation of geometry educational materials, the data provided in the virtual geometry lab media is very likely to be implemented in learning geometry courses, with an average value of 95, indicating that the geometry material used is organized in a way that is very appropriate for use in learning.

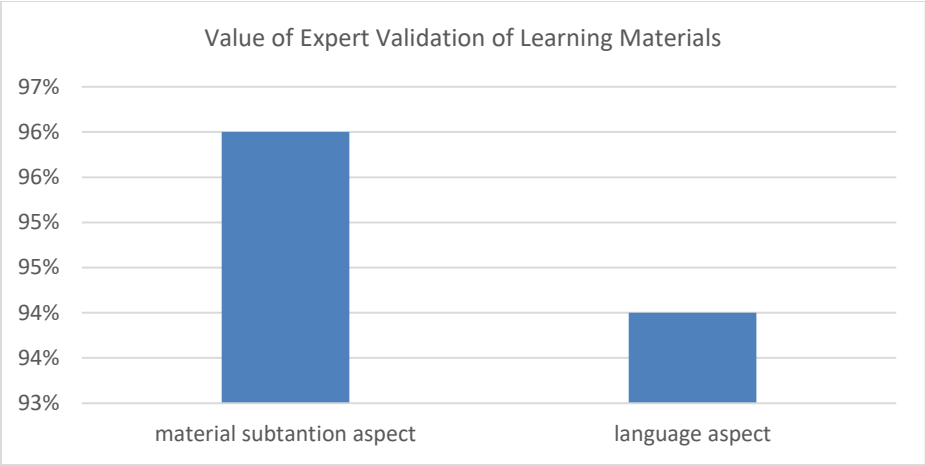

Figure 4. The results of the learning material experts' certification of the depth of the geometry lab virtual product material

Implementation

At this point, students at UIN Walisongo Semarang use the Virtual Lab Geometry product to study and understand geometry classes on congruence and parallelism materials. They begin by installing the virtual application geometry lab for congruence material, followed by a pretest before studying geometry and a post-test. Following participation in the Virtual Lab Geometry study, this activity is conducted online via Zoom meetings.

Evaluation

This research and development include examining the quality of virtual geometry lab instructional media products as well as the impact of employing virtual geometry laboratories at PGRI Semarang University and UIN Walisongo Semarang, specifically

The quality of teaching media is evaluated using a questionnaire distributed to learning media experts, material experts, and trial participants. This evaluation can help to enhance the virtual geometry lab application. According to the results gathered from material experts and media development experts, the virtual geometry lab product is valid and advantageous since it meets the material and media indicator requirements with an average score of 94, indicating that it is typically useful.

Evaluate the effectiveness of utilizing a virtual geometry lab application to assess students' cognitive and spatial abilities, with an emphasis on posttest questions. This assessment is designed to inform the deployment of Android-based educational content in online or offline classrooms, as well as Virtual Reality. One of the advantages of utilizing this Geometry Virtual Lab Application is that the post-test results were 86.25, which is considered good. The following is one of the outcomes of the alignment material pretest and posttest:

According to student feedback from UIN Walisongo Semarang, the virtual geometry lab significantly improves students' cognitive and spatial abilities when learning geometry.

DISCUSSION

During the ADDIE model's research development stage, the following components were especially developed:

During the analysis stage, it was discovered that up to 60% of students in the Mathematics Education study program at PGRI University Semarang and Malaysia University of Technology lacked mastery of geometry material, especially congruence and parallelism, due to their inability to practice virtually during the pandemic. The appropriate solution analysis is to create media that can optimize students' practical skills in geometry material, allowing students to practice virtually during a pandemic, one example being the use of interesting virtual reality-based media that can improve students' cognitive and spatial abilities. [24] Showed that using a virtual lab to teach biology increased students' attention and learning experience. Then D [17]. Explaining why

learning using virtual labs Combining e-learning increases students' enthusiasm in studying, which is supported by [25], xwho suggests that virtual reality-based online learning increases pupils' acquisition of learning knowledge.

The design approach resulted in a virtual geometry lab learning media app compatible with all Android devices. Geometry course content is available in virtual media design, which contains flat and space-building materials that are neatly and beautifully packed with color gradations and animations capable of engaging students' cognitive and spatial abilities through exercise. [16] said that implementing a virtual physics laboratory encouraged pupils to be more critical while exploring an issue; nevertheless, [26] discovered that virtual reality-based chemistry training boosted capacities. Students who are inventive in mixing drugs that have been examined in the laboratory. Then [22] The effectiveness with which learners grasp a learning material differs between virtual and traditional learning.

A virtual geometry lab product was built and evaluated by learning media and material professionals, indicating its suitability for geometry learning. Following expert review, the virtual geometry lab product was introduced into the Mathematics Education study program at UIN Walisongo Semarang. [23] The Android-based Hijaiyyah Letter Recognition application, created using Unity 3D, shows that the usage of augmented reality might help students absorb Koran study material more easily. [29] It was later established that educational games based on virtual augmented reality can improve students' motivation and spatial ability by providing interesting exercises. Then, [18] demonstrate how the virtual lab in physics instruction helps students better comprehend the material's structure. According to [30], virtual reality is a renewable technology that enhances the learning experience in schools and colleges. It will fascinate the pupils.

During the implementation phase, students at UIN Walisongo Semarang were enthusiastic about using virtual geometry lab products. The app displayed engaging objects and encouraged students to master measuring angles, congruences, and parallels.

As stated by [24] Students at UIN's vocational education study program were assigned internships depending on their ability to understand technology; one of the media taught is virtual reality, which is very effective in learning geometry and design-based computer science. Then, [25] emphasized Campuses must provide students with knowledge of virtual reality tools so that they can package learning in an interesting and relevant way. In addition, L. [26] claimed that the novelty of studying with virtual reality media motivates students to learn and attempt to generate fascinating media supplements to their learning [34]. clarified that in today's pandemic era, the world of education cannot be distinguished from augmented reality and virtual reality, both of which are very encouraging of the learning process, with students encouraged to explore the virtual world and the existence of an entertaining augmented reality.

During the assessment phase, students from UIN Walisongo Semarang took a pretest and posttest. Results indicate that utilizing a virtual geometry lab product enhanced their cognitive and spatial abilities. The N boost test likewise shows a significant boost in cognitive ability and student spatial; however, one student's score is lower than the maximum since the pretest and posttest were performed at different places. [27] demonstrated that the training technique that incorporates virtual reality in its instruction amazes and encourages participants. [36] mentioned that virtual reality for education is quite interesting to hear since it makes learning more fun and enjoyable at all educational levels. [37]explained that vocational education in Malaysia has learned a lot about using virtual reality in mathematics instruction since students are seen to be comfortable with using sustainable media and keeping up with the times.

CONCLUSION

According to the results and discussions, the virtual geometry lab product development is a virtual geometry lab application built on the VAN HIELE THEORY framework that is valid and practicable for usage as one of the online learning media options at UIN Walisongo Semarang. Although the N-Gain is negative, this is because the posttest questions are more difficult than the pretest questions. However, according to student feedback, the Virtual Lab Geometry product was favorably received. As a result, future research should focus on developing test instruments for the degree of difficulty in the pretest and posttest equivalents.

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