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Virtual Mathematics Laboratory Based on Cognitive Load Theory

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Abstract.

Teachers need high levels of creativity and innovation to deliver subject matter during this period of digital learning. Literacy and numeracy skills are top priorities in schools, and mathematics is very relevant for the acceleration of literacy and numeracy development. The goal of this study was to develop a virtual math lab based on the cognitive load theory to improve literacy skills. The ADDIE development model was used, consisting of the stages of analysis, design, development, implementation and evaluation. Data were obtained on the needs for a complete mathematical learning medium that would be accessible and fun. The virtual design was carried out using the Drag and Drop app builder software. In the next stage, a virtual lab design framework was implemented with this app builder. The validation results showed that 80% of the math teaching materials were in accordance with the school's math curriculum; 80% of the virtual math lab design was categorized as dynamic, and the remaining 20% was identified as needing synchronization between the videos displayed and the level of attractiveness and interactivity of the lab. According to the results, the modules and virtual laboratory that were developed are valid and suitable for use.

Keywords: virtual mathematics lab, cognitive load theory, literacy

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1. Introduction

The speed of technological development is very rapid, this requires rapid adaptation, especially in the field of education. Innovation and creativity in presenting adaptable learning with technological advances become an inevitability. More and more students who use computers, laptops and mobile phones with internet networks become their main source of information. Even mobile phones can also be used to make multimedia and interactive props**[1-2]**. Interactive multimedia can be interpreted as a combination of different types of media into one into one computer application that interests students by presenting images, animations, colours, and sounds.

This development is very important in order to provide life skills to students in order to face the challenges of social change and benefit the wider community**[3-4]**. Change in the world of education demands the innovation of education with technology is a

unity that cannot be separated. The existence of technology must be interpreted as an effort to increase effectiveness and efficiency and technology cannot be separated from the problem, because technology was born and developed to solve problems faced by humans. Acceleration in the world of education is also responded to by a shift in the function of educational laboratories**[1, 4-7]**. Mathematics teaching aids are used to assist students in doing abstraction activities or finding mathematical concepts and principles. Because it is manual, in using this student are in direct contact with the props so that a number of props are needed in the classroom**[8]**. In addition, the use of manual props also requires a variety of materials. Mathematics teaching aids that have been studied Physically; it can be developed in multimedia form on adaptive e-learning platforms. This adaptive e-learning platform should be adapted to the level of development of students and their psychology, especially in digital learning as it is today. Thus, mathematical props need to be virtualized to be more interactive and practical in terms of their use**[3-9]**. This adaptive e-learning platform should be adapted to the level of development of students and their psychology, especially in digital learning as it is today. The implementation of Cognitive Load Theory (CLT) in making virtual props through ICT is considered appropriate to help the process of accelerating the literacy and numeracy of students in schools in accordance with the purpose of education in Indonesia in the future.

The issue raised in this study is how is the development of virtual laboratories as a valid mathematical learning medium in improving the mathematical literacy skills of middle school students?

2. Methods

This research is a type of development research, which is a research process used to develop a product. The products resulting from this research are mathematical learning laboratory application products that can be accessed in android **[5]**. Figure 1 describes the stages of development research that follow addie media development procedures (Analysis, Design, Development, Implementation, and Evaluation)**[10-11]**.

The research stage conducted in development is: the analysis stage i.e., researchers will conduct an assessment analysis with junior high school teachers, analysis with students using questionnaires; analysis of network condition technology and multimedia completeness in schools. The design stage is the Pre-Production stage that prepares a virtual lab with Drag and Drop App Builder Software. The next stage is Development

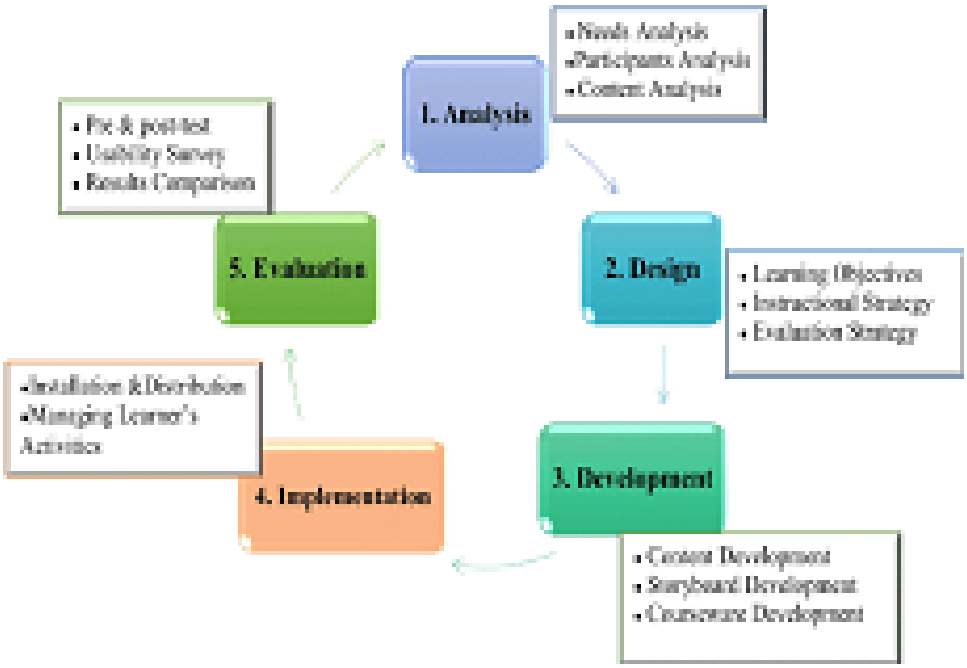

Figure 1: Research Stage.

&Implementation which includes: production i.e., implementing a virtual design framework of the lab with the help of Drag and Drop App Builder Software. Post-production is reviewing post-production quality and tested by experts' judgment through FGD to find out the feasibility of virtual mathematics lab that has been created which further gets product improvement advice. The virtual implementation stage of the lab is tested to math teachers and students with the aim to obtain a teacher and student assessment response to the virtual product of the mathematics lab. However, this article has not yet outlined the results of the lab's virtual implementation stage.

Results and Discussions

The virtual development of laboratories for mathematical learning was developed with several stages. The stages are as follows: The first stage is to analysed the competence and teaching materials of class VII junior high school that will be used in the virtual development of the laboratory. This material deals with the matter of Numbers, Sets, Algebraic Forms as well as equations and equalities. This process includes the study of mathematical materials in accordance with core competencies and basic competencies. 2) Collect references on the subject matter. 3) Plan and choose the type of learning media to be used. The selected learning media is in the form of learning applications with Drag and Drop App Builder Software. The second stage is the creation of a virtual laboratory for mathematical learning. This stage is the initial design of the creation of a virtual mathematical learning laboratory developed. Figure 2 shows the early development of virtual mathematical laboratories.

Figure 2: View from Virtual Laboratory.

The next stage after the initial development of a virtual mathematical learning laboratory is expert validation. Validation is carried out on virtual products of mathematical learning laboratories, learning modules as well as other learning devices. First the description of validity data based on expert assessment of materials and learning of learning modules to support the use of virtual mathematics laboratories. Material and learning experts consist of 3 people giving an assessment of the validity of mathematics learning modules. The results of this validity assessment are used as a prerequisite in filling in the content of material in a virtual mathematics laboratory. Expert assessment data of materials and learning is presented in Table 1.

TABLE 1: Validation of Module Eligibility.

Aspects assessed	Average score of validator			Average score	Criterion
	1	2	3		
Content eligibility	4.6	4.5	4.5	4.53	Excellent
Presentation eligibility	4.4	4.3	4.6	4.43	Excellent
Language eligibility	4.6	4.5	4.5	4.53	Excellent
Average total score				4.50	Excellent

Second, the description ofvalidan data based on media expert assessment of virtual laboratories. Media expert assessment data on virtual mathematical learning laboratories for SMP students is presented in Table 2.

The validation results in Table 2 show that about 80% of math teaching materials according to the school math curriculum, the quality of the design of the virtual mathematical laboratory by 80% is dynamic, and the remaining 20% needs synchronization

Table 2: Validation of Virtual Feasibility of Laboratories.

Aspects assessed	Average score of validator			Average score	Criterion
	1	2	3		
Quality design	4.2	4	4	4.07	Good
Visual attraction	4.4	4.2	4	4.20	Good
Interactivity	4.2	4.4	4	4.20	Good
Coherency with Curriculum	4	4	4.2	4.07	Good
Average total score				4.12	Good

between the videos displayed need to be set in terms of the attractiveness and interactivity of the laboratory. Virtual mathematics laboratory has reached 84%. Based on the validation results in Table 1 obtained the total average score is 4.5 with excellent criteria and validation results in Table 2 obtained a total average score of 4.12 which includes good criteria. According to criteria validity that has been established, the modules and laboratory virtual that have been developed can be said to be valid and suitable for use. However, improvements are still made in accordance with the input and advice of the validator.

A virtual laboratory is a practice room in a virtual world or social space where scientists interact in cyberspace. A virtual laboratory is a medium used to help understand a subject and can solve the limitations or absence of laboratory devices. Virtual laboratory is a form of learning media by using a laboratory to conduct observations or experiments through software run by a computer, where all the equipment needed by a laboratory is contained in the software. Virtual laboratory is a form of animation that can visualize abstract phenomena or complex experiments conducted in real laboratories, so as to increase learning activities in an effort to develop skills needed in problem solving. Virtual laboratories are a form of computer animation, consisting of moving images that represent the state in a real laboratory.

3. Conclusion

Based on the results of research and discussion obtained the conclusion that the results of development in the form of virtual laboratory and mathematical learning modules are declared valid based on the assessment of material and learning experts, and media experts. The assessment of such experts consistently categorizes learning modules in excellent categories and the results of validation of virtual laboratory of mathematical

learning in good categories. Furthermore, it is necessary to test practicality in the use of virtual laboratory in mathematics learning in grade VII junior high school students.

4. Authors' Contributions

Yanuar Hery Murtianto contributed to the concept of the virtual laboratory, Bambang Agus Herlambang contributed to the development of the virtual laboratory, and Muhtarom contributed to the development module and teaching material.

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