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USING VIRTUAL LEARNING ENVIRONMENT ON REALISTIC MATHEMATICS EDUCATION TO ENHANCE SEVENTH GRADERS' MATHEMATICAL MODELING ABILITY

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ABSTRACT

Many research studied that realistic mathematics education (RME) can be an alternative solution to students' difficulties in learning mathematics. Various forms of technology additionally are further employed to support students' mathematical achievements. However, research on the implementation of virtual learning environments (VLE) with the RME approach is still lacking. The main goals of this research were to create an instructional process of virtual learning environments on realistic mathematics education to improve seventh graders' mathematical modeling abilities and to examine the effect of designs on mathematical modeling ability. Theory of realistic mathematics education and virtual learning environment literature were integrated. The design model developed was verified by experts to be tested. The pre-test / post-test test method was carried out to see the effectiveness of the design. The sixty-seventh graders from a secondary school in North Sumatera were selected as samples. The instructional process developed consists of four stages, namely (1) purposing contextual problems, (2) defining situations from contextual problems, (3) solving problems individually or in groups, and (4) reviewing and comparing solutions. The developed virtual learning environment consists of 5 components, namely (1) users management, (2) content and activities management, (3) resources management, (4) visualization and communication management, and (5) evaluation and assessment management. The mathematical modeling ability concerning experimental group students is significantly higher after being taught through a realistic mathematics education instructional process via a virtual learning environment. Comparison of the experimental group with the control group also showed the same results.

Keywords: Realistic Mathematics Education, Virtual Learning Environment, Modeling Ability.

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INTRODUCTION

Realistic mathematics education remains a learning approach with the principle of inviting students to rediscover, redesign, and develop symbolic models informally from contextual problems (Armanto, 2002; Gravemeijer & van Eerde, 2009). Interpreting between the contextual problems and mathematics into symbolic models is called mathematical modeling. This ability has a significant role as a supporting foundation for students to solve mathematical problems. Some studies show that students experience difficulties in the process: (1) formulating daily activities problems into mathematical models, interpreting the context into a mathematical model, and understanding mathematical structures (including order, relationships, and patterns) in problems, (2) evaluating the reasonableness of mathematical solutions in the context of real-world problems. This challenge is the impact of poor management of the learning process (Sumirattana et al., 2017). The obstacles experienced by students in following the practice of learning mathematics have become a particular concern for researchers for a long time. They researched and developed several learning models and methods that could be offered to reduce these problems. Cognitive demands (Borromeo & Germany, 2006), construction between reality and mathematical models(Erbaş et al., 2014), and the invention of a learning environment that is appropriate to the cognitive domain of students (Bakker et al., 2003; Blum & Ferri, 2009; Kang, 2012) were an essential concern in developing and modifying mathematical models. Therefore, the creation of a learning environment remains accepted as a significant effort in supporting the quality of students' mathematical learning.

The Indonesian Ministry of Education and Culture encourages the use of information and communication technology to support the efficiency and effectiveness of student learning in schools (Kemendikbud, 2016). Furthermore, information and communication technology implied integrated into the lesson plan systematically and effectively according to the classroom situation and conditions. This situation requires the teachers and students to be able to use information and communication technology in learning. On the other hand, several studies had shown the success of information and communication technology-based learning to improve students' ability in mathematical literacy (Hayati & Ulya, 2021; Salim & Maryanti, 2017). However, some of these efforts still focus on the use of learning media and have not touched the management of the learning environment based on an approach to learning mathematics.

Several examinations (Bakker et al., 2003; Blum & Ferri, 2009; Kang, 2012) showed that the developed learning environment can create opportunities to help students achieve better mathematical modelling competencies. Furthermore, (Phungsuk et al., 2017) identified that the lack of use of learning models in supporting the implementation of instruction in a virtual learning environment influenced students' learning achievement and problem-solving ability. Mathematics instructional needs to manage learning material, learning activities, and assessment (Mailani, 2014; Okita, 2014; Zulkardi, 2002). As stated above, learning environments need to be created to help and improve students' mathematical modelling skills. Therefore, this study aims to create an instructional process of virtual learning environments in realistic mathematics education to improve

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mathematical modelling abilities.

RESEARCH METHODS

The research activities were conducted in 2 (two) phases. Phase 1 called the front-end analysis aims to analyze the problems of teaching and learning mathematics and curriculum which includes teaching materials, teaching methods, and assessment.

This activity is followed by a review of the relevant literature of teaching and learning mathematics by looking at the potential of realistic mathematics education approaches and the potential of the web as a tool in learning environments. Furthermore, realistic mathematics education instructional systems via virtual learning environments were designed. Through the justification, analysis, and evaluation of mathematics education experts, web design experts, and competent secondary school mathematics teachers, the initial model of the virtual learning environment for mathematics lessons at the secondary school was developed. Phase 2 the experiment of the developed instructional process via VLE.

Mathematical modelling tests are designed to measure students' mathematical modelling abilities in secondary schools. The contextual problems are arranged in the 5 essay tests. Each problemsrequiring students to:(1) understanding task; (2) establishing model; (3) Using mathematics; (4) explaining the result. Four mathematical modelling aspects constitute a solution plan for modelling tasks (Blum & Borromeo, 2009). The pre-test and post-test instruments were used to measure students' mathematical modelling competencies. Both tests were verified by 3 mathematics education experts and 2 mathematics teachers and Cronbach alpha showed thereliability of pre-test = 0.891 and reliability post-test = 0.949.

The class was split into 2 groups consisting of virtual learning environment class integrated with the instructional process of realistic mathematics education and normal classes with realistic mathematics learning as a control variable. Both groups were taught on the topic of geometry and measurement. the learning time of the topic is 2 months. Pre-test and post-test are planned to measure the ability of mathematical modelling. The utilization of instructional process via the virtual learning environment in the experimental group was observed. The student's solution process is also observed by the developed rubric for assessment of student work.

RESULTS OF RESEARCH AND DISCUSSION

Phase 1 is the development of instructional process via virtual learning environment. **Figure 1** clarifies the development of instructional process with realistic mathematics education approach via virtual learning environment to improve students' mathematical modelling abilities.

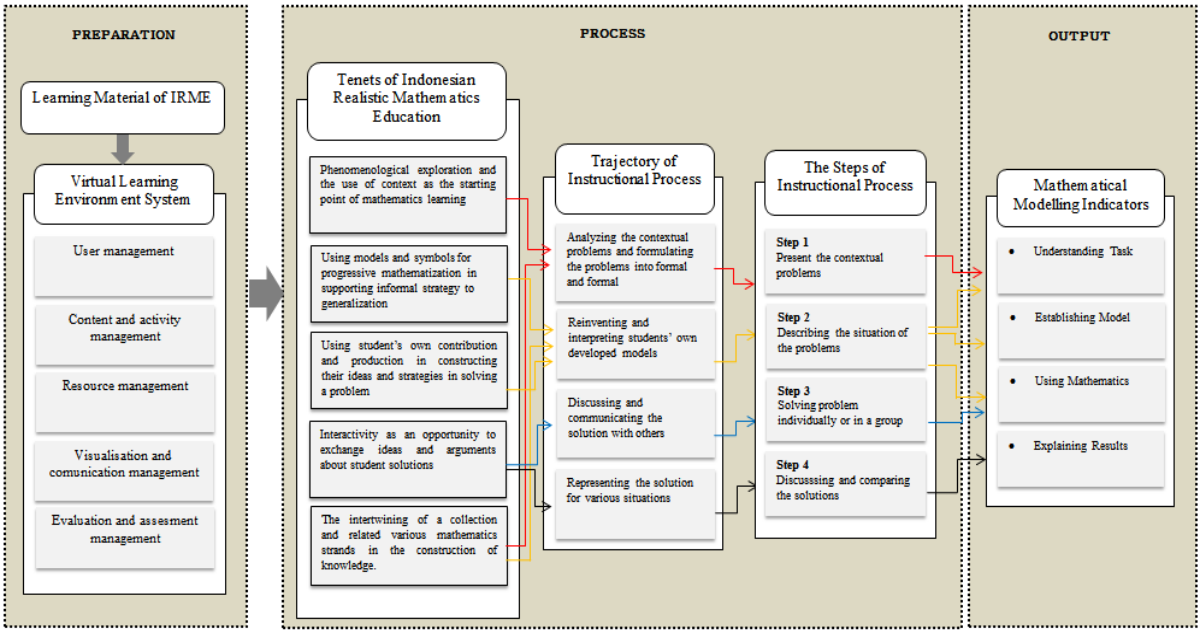


Figure 1. The instructionalprocess of realistic mathematics education in a virtual learning environment

The development of the instructionalprocess of realistic mathematics education via a virtual learning environment is described as follows:

a) Preparation

(1) *Realistic mathematics education learning material*: The learning materials used in this research referred to the theory of realistic mathematics education.Mathematics education should challenge students to stimulate their curiosity. The realistic mathematics education materials are associated with a specific domain of students' real-life situation that is situational strategies applied to the context must be appropriate to the students' situational experience. Interesting contextual problems are attached to student learning activities. The students then solve the problem by exercising various procedures so that their problem-solving ability develops.

(2) *Virtual learning environment management*: The VLE facilities provideonline toolsfor interaction between teachers and students as if learning takes place as usual in the classroom (Information Resources Management Association, 2012). Communication developed is the interaction between students and student interaction with teachers. Components of the learning environment developed in this study are:

(a) User management: A developed user management system manage teacher role and student information such as student profiles and student achievement reports. Web applications used in this study is LMS Moodle developed on computer and smartphone devices. Smartphones become one of the device options made use of in the learning process because most students tend to use this device as information and communication access. the smartphone will form a mobile learning process (Phungsuk et al., 2017).

(b) Content and activity management: This management provides multiform information such as instructional documents (e-books) and web pages (URLs) that serves as a means of information transformation between teachers

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and students. It also supports teacher and student access to various web resources through various communication channels. Interactive feedback on student performance is also provided inthis section.

(c) Resource management: This management promotes materials that can be uploaded, downloaded and printed from either a virtual learning environment designed or from other web resources containing content related to realistic mathematics education materials.

(d) *Visualisation and communication management:* This component creates tools of collaboration, communication, discussion, and sharing information. The function of communication applications such as chat rooms allows students to collaborate with others in the discussions group.

(e) Evaluation and assessment management: The management focuses on the students' work such as the assignment, quizzes, and the project reports. Students' evaluation and assessment are published both in the printed and the online report.

b) Realistic mathematics education instructional process

(1) The tenets of realistic mathematics education as a guide for the development of instructional system design: The current research refers to five tenets of realistic mathematics education, such as: (a) phenomenological exploration and the use of context as the starting point of mathematics learning; (b) Using models and symbols for progressive mathematization in supporting informal strategy to generalization; (c) Using student's own contribution and production in constructing their ideas and strategies for solving a problem; (d) Interactivity as an opportunity to exchange ideas and arguments about student solutions; (e) The intertwining of a collection and related various mathematics strands in the construction of knowledge.

(2) Application of realistic mathematical education tenets that are integrated into the trajectory of the instructional process. The trajectory of the instructional process used as the basic instructional process consists of four elements, such as (a) Analyzing the contextual problems and formulating the problems into formal and formal; (b) Reinventing and interpreting students' own developed models; (c) Discussing and communicating the solution with others; (d) Representing the solution for various situations.

(3) The trajectory of the instructional process is incorporated into the design of an instructional system called the instructional process steps of realistic mathematics education. The design of instructional process in virtual learning environments to improve mathematical modelling abilities comprises: (a) Present the contextual problems; (b) Describing the situation of the problems; (c) Solving problemindividually or in a group; (d) Discussing and comparing the solutions.

Phase 2 is the experiment of the instructional process via virtual learning environment. The present research organized a pre-test / post-test in 2 groups consisting of the class of virtual learning environment and normal class. It aims to evaluate the experimenting effectiveness of developed realistic mathematics education instructional systems design via VLE in mathematical modelling. 100 seventh graders in Medan, Sumatra Utara were selected as a sample group. The sample group consisted of 50 students from the experimental group and 50 other students for the control group. The teaching experiment was conducted for 2 months.

The results obtained after the instructional process of realistic mathematics

education via VLE were tested in secondary school students in Medan. The recent research found a difference in learning ability between students in realistic mathematics education via VLE class and students in realistic mathematics education via a normal class. The students' ability of mathematical modelling in groups of realistic mathematics education via VLE class was significantly higher than that of Group of realistic mathematics education via a normal class (see **table 1)**. The students' ability of mathematical modelling was significantly higher after learning through the instructional process of realistic mathematics education via VLE than those before learning (see **table 2**).

Table 1: Description of the comparisons of mathematical modeling ability between the experimental group and control group after the experiment

	Group	n	Mean	SD	Variance
Mathematical modelling after the experiment	Group of the RME via VLE class	50	41.37	4.63	21.48
	Group of the RME via normal class	50	36.77	5.14	26.39

Table 2: Description of the comparisons of mathematical modeling ability before and after the experiment

Group	n	Before the experiment				After the experiment		
		Mean	SD	Variance		Mean	SD	Variance
The mathematical modelingfor Group of the RME via VLE class	50	31.37	4.12	17		41.37	4.63	21.48

The findings of the teaching experiment of the group participated in realistic mathematics education via VLE class show that students' performance in mathematical modelling is increasing. The instructional process of realistic mathematics education via VLE was able to stimulate students to be confident in their own ability. When students choose what they want to learn from both the available content and the broad source of information accessible from various URLs, it allows students to think independently with teacher guidance. It means that students get the opportunity to use and develop their own models when solving or interpreting a problem.

CONCLUSION

The virtual learning environment developed can be employed as an alternative to managing the process of realistic mathematics education learning. The integrated instructional design on platform design (web pages) is considered valid in terms of a formative evaluation approach. The integrated instructional design on platform design (web pages) is considered valid in terms of a formative evaluation approach. Advice and opinion of mathematics education experts, web design experts, and competent secondary school mathematics learn mathematics. This outcome is a recommendation for the teacher to apply the developed collaboration of realistic mathematics education and web-based learning as VLE to enhance the mathematical modelling of students in secondary school. A teacher should anatomize the content of realistic mathematics education learning material related to students' backgrounds and socialize the manual operation of VLE patiently. Teachers are considered to revise the practicality of realistic mathematics

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education's instructional design via VLE prototype. The present research shows that instructional design of realistic mathematics education via VLE adequate to improve students' performance in mathematization and to stimulate students' appetency to learn mathematics. This outcome is a recommendation for the teacher to apply the developed collaboration of realistic mathematics education and web-based learning as VLE to enhance the mathematical modelling of students in secondary school. A teacher should anatomize the content of realistic mathematics education learning material related to students' backgrounds and socialize the manual operation of VLE patiently.

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