Development Of Interactive Virtual-Based Learning Media Using The Rme Approach On Mathematics Learning Outcomes

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Abstrak. Penelitian ini bertujuan untuk menghasilkan media pembelajaran interaktif berbasis *virtual* dengan pendekatan RME yang berkualitas baik dan layak untuk digunakan dalam pembelajaran. Kriteria kualitas yang digunakan mengacu pada kriteria Nieveen, yaitu valid, praktis dan efektif. Jenis penelitian ini adalah penelitian dan pengembangan yang mengacu pada model yang dikemukaan oleh Borg & Gall yang telah disederhanakan berdasarkan kebutuhan penelitian. Analisis data yang digunakan adalah kevalidan media pembelajaran yang diperoleh dari penilaian ahli materi dan ahli media, kepraktisan media pembelajaran yang diperoleh dari penilaian siswa, dan keefektifan yang diperoleh dari hasil tes belajar siswa. Hasil penelitian menunjukkan bahwa media pembelajaran yang dikembangkan valid, praktis dan efektif.

Kata kunci : Media Pembelajaran Interaktif Berbasis *Virtual*, RME, Hasil Belajar Matematika Siswa.

Abstract. *The research aims to generate the interactive virtual-based learning media through RME. In addition, the research aims to identify the result level of the interactive learning media. The quality criteria used based on the Nieveen criteria, which are valid, practice and effective. The type of this research is based on Borg & Gall's simply model which suitable with the research needs. The analysis data was the validity of learning media which obtained from material experts and media experts, the practically of media learning which obtained from the students 'assessment, and the effectiveness which obtained from the results of students' learning test. The results shows that the developed multimedia in learning mathematics is valid, practical and effective.*

Keywords: *Interactive Based Virtual Learning Media, The Result of Student's Learning Mathematics.*

INTRODUCTION

The NCTM (2000) states that there are six principles of school mathematics: equity, curriculum, teaching, learning, assessment, and technology. Regarding technology, NCTM states that "technology is essential in teaching and learning mathematics, it influences the mathematics that is taught and enhances student's learning." The role of technology in mathematics learning is essential as it affects the mathematics being taught and improves the quality of learning.

According to Sundayana (2013: 3), to achieve a high-quality learning process, teachers often face difficulties in delivering instructional materials. In particular, mathematics teachers still show shortcomings and limitations in implementing learning in schools. Especially in providing concrete illustrations of the materials delivered, which directly results in low and uneven quality of student achievement. One of the Graduates Competency Standards (SKL) for the mathematics subject at junior high schools (SMP/MTs), as stipulated in Permendiknas Number 23 of 2006, is to understand geometric shapes, their elements and properties, as well as measurements. Solid geometry is one of the topics covered in geometry. According to Fiqri (2016: 281), geometric material is easy to illustrate, but in reality, many students still find it difficult to interpret because the concepts remain abstract. This is evidenced by the absorption rate of the 2015/2016 academic year national mathematics examination in the topics of geometry and measurement at SMP Negeri 1 Seyegan, which declined at the school, city/regency, provincial, and national levels compared to the 2014/2015 academic year. It can be said that an effort is needed to improve students' mathematics achievement, particularly in geometry.

According to Zulkardi (Supardi, 2012: 1), low student learning outcomes in mathematics are caused by several factors, such as a dense curriculum, ineffective learning media, inappropriate strategies and teaching methods chosen by teachers, poor evaluation systems, teachers' inability to motivate students to learn, or because of the use of conventional teaching approaches where students are not actively involved in the learning process. Observations

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conducted during mathematics learning at SMP Negeri 1 Seyegan during the field introduction program (PPL) from August 3 to September 19, 2017, showed that teachers often used conventional methods in teaching mathematics. This teaching method is teacher-centered, one-directional, and makes students passive during the lesson. This is evident from students' behavior, which mainly involved listening and taking notes on the material delivered by the teacher. In addition, it was found that learning media were rarely used, even though the school is equipped with facilities such as a computer laboratory that could support the use of interactive learning media. So far, the lab has only been used for ICT (Information and Communication Technology) classes, even though computer labs can also be used for other subjects.

According to Rusman et al. (2012: 60), in the learning process, media play a very important role in achieving learning objectives. The communication relationship between teachers and students will be better and more efficient with the use of media. Learning media are tools or forms of stimuli that function to convey learning messages. These stimuli may include human interactions, real objects, moving or still images, recorded texts or sounds. According to Rusman et al. (2012: 65), computers are a type of media that can virtually provide immediate feedback on students' learning outcomes. Moreover, computers have the ability to store and manipulate information according to needs. Technological advancements now allow computers to store and display various forms of media. According to Kristin et al. (Mantasia and Jaya, 2016: 4), virtual learning is essentially a learning process that utilizes information and communication technology. According to Roberck (Ulfa, 2012: 21-22), virtual learning involves several criteria, including the integration of images, photos, videos, animations, activities, simulations, and more. According to Hyder (2007: 4), interaction in virtual learning may include interaction between students and teachers, students and media, student participation in discussion sessions, or student collaboration. Therefore, virtual-based learning media is media that integrates images, photos, videos, animations, activities, and simulations with computer usage, enabling students to actively interact — with teachers, media, during discussion sessions, or through peer collaboration (Adijaya, 2023; Kumala et al., 2021; Salira et al., 2022).

According to Arsyad (2017: 13), one of the most referenced frameworks for the theoretical foundation of media use in learning is Dale's Cone of Experience. In efforts to utilize media in learning processes, individuals' learning outcomes are acquired starting from direct (concrete) experiences, real-life situations, models, and up to abstract verbal symbols. Based on an interview conducted on December 9, 2017, it was found that teachers rarely used instructional media because they felt they lacked the time to create them. As a result, they often resorted to conventional teaching methods. However, teachers also acknowledged that learning would be easier to deliver with the aid of media. Regarding solid geometry, teachers also experienced difficulty in teaching the material due to its abstract nature.

Based on these findings, it is important to consider an appropriate approach in developing instructional media to ensure effective use. From Edgar Dale's Cone of Experience, we can see that the most influential learning media are simulations or models of real experiences, as they enable the highest levels of learning retention, just below actual direct experiences. According to Suharta (Widodo, 2014: 2), RME (Realistic Mathematics Education) is one approach in mathematics learning that is enjoyable and relevant to everyday life. This is supported by Van den Heuvel-Panhuizen (Wijaya, 2012: 20), who states that the use of the term "realistic" does not merely indicate a connection to the real world, but rather emphasizes the use of situations that are imaginable to students. A problem is considered "realistic" if it can be imagined or is real in the students' minds. One solution to the aforementioned problems is the RME approach, which is highly suitable as a foundation for developing mathematics learning media.

The above explanation illustrates the importance of media development in learning. Based on the background described, the researcher adopts the title "Development of Virtual-Based Interactive Learning Media with the RME (Realistic Mathematics Education) Approach on Surface Area and Volume of Solid Geometry in Relation to Mathematics Learning Outcomes of Grade VIII Students at SMP Negeri 1 Seyegan."

METHOD

This study uses a type of research known as Research and Development (R&D). According to Sugiyono (2015: 297), research and development is a research method used to produce a specific product and test its effectiveness. Sukmadinata (2006: 169) defines research and development as a research approach aimed at producing new products or improving existing ones. Therefore, development research is a method for producing specific products or improving existing products and testing their effectiveness.

From the above explanation, development research is an activity that results in a product or improves an existing product and then tests its effectiveness and feasibility. The development research conducted aims to produce a product in the form of interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach on the topic of surface area and volume of solid shapes with flat sides.

Borg & Gall (Emzir, 2013: 271) stated that it is possible to limit the research on a small scale, including limiting the research steps. The media development model used in this study refers to the model proposed by Borg & Gall (Sudarmaji and Khuzaini, 2017: 89), which is simplified into three stages:

1. Preliminary stage, which includes:
   a. Analysis of core competencies (KI), basic competencies (KD), and indicators of competency achievement on the subject matter,
   b. Collecting references related to the material, planning, and selecting the type of learning media to be used;
2. Development stage, which includes:
   a. Preparation of the learning media. Before using Adobe Flash CS5.5, a flowchart is created as a guide to ensure the development stays on track, followed by the creation of a storyboard;
   b. Preparation of a validity questionnaire aimed at assessing the quality of the developed learning media so that it can be declared good;
3. Validation and implementation stage, which includes:
   a. Limited development testing, where the developed media is tested by material experts and media experts to determine the validity of the developed media;
   b. Small group testing. According to Susilana and Riyana (2008: 173), the small group evaluation stage should be tested on 10–20 students. If fewer than 10, the data obtained may not represent the target population well. Conversely, if more than 20, the data collected might exceed the necessary amount and be less useful for small-group evaluation. Based on this suggestion, the researcher selected 10 eighth-grade students from SMP Negeri 1 Seyegan representing high, medium, and low ability groups. This small group test is an initial trial involving 10 students who represent the target population. The test results in a practical design in terms of usability;
   c. Field testing, which is the implementation of the developed learning media in a real classroom setting involving all 33 students of class VIIIF at SMP Negeri 1 Seyegan.
   d. The field test aims to assess the effectiveness and practicality of the product;
   e. Final design, which is the final result of the media development process that has undergone several testing phases.

The instrument used for data collection is a questionnaire. Questionnaires are given to material experts, media experts, and students to test the quality of the learning media. The questionnaire is based on the software evaluation checklist by Kristin Miller and Jacqueline Bach, which was adapted into separate questionnaires for material experts, media experts, and students (Sudarmaji and Khuzaini, 2017: 89–90). The questionnaire for material experts evaluates learning content, curriculum relevance, technical aspects, graphics, interactivity, assessment, and flexibility. Meanwhile, the instrument for media experts assesses the quality of the learning media based on graphics, display, technical aspects, appropriateness, interactivity, and suitability for age. For

classroom implementation, the instrument used is intended for students to evaluate the developed learning media.

RESULTS AND DISCUSSION

The development of the interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach is based on the model proposed by Borg & Gall, which has been simplified according to the needs of the study. This model consists of three main stages:

1. Preliminary Stage
   a. Analyzing the basic competencies of distinguishing and determining the surface area and volume of three-dimensional shapes with flat surfaces (cubes, cuboids, prisms, and pyramids) to be delivered through interactive learning media. This process includes a review of mathematics materials in accordance with the content standards.
   b. Collecting references related to the topic of three-dimensional shapes with flat surfaces. This topic was selected because the national exam (UN) scores at SMP Negeri 1 Seyegan for this material showed a decline in the academic years 2014/2015 and 2015/2016 (according to BSNP reports).
   c. Planning and selecting the type of learning media to be used. The chosen media is an interactive learning CD that can be used with a computer. This format is considered effective due to its large storage capacity and resistance to accidental deletion. Moreover, the interactive learning media was developed using Adobe Flash CS5.5, which requires the use of a computer.
2. Development Stage
   The interactive learning media focuses on the basic competencies of distinguishing and determining the surface area and volume of three-dimensional shapes with flat surfaces (cubes, cuboids, prisms, and pyramids), with the following indicators: (1) students can determine the surface area of cubes and cuboids, and (2) students can determine the volume of cubes and cuboids. This stage involves the initial design of the interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach. The design outlines the page flow of the interactive media, from the opening page to the closing page. The development of the media strictly follows this design.
3. Validation and Implementation Stage
   The interactive learning media was first validated by subject matter experts and media experts. Based on their feedback, the media was revised to produce Revision I. Once deemed feasible for use, the media was tested with a small group of students. Feedback from the small group was used to make further improvements, resulting in Revision II.

Following this, the media was tested in a field trial with a larger group of students. Based on the feedback from this group, another revision was made to produce Revision III. After completing this series of tests and revisions, the final product was achieved: an interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach, focused on the topic of surface area and volume of three-dimensional shapes with flat surfaces.

Discussion

1. Validity Analysis of the Interactive Virtual-Based Learning Media Using the RME (Realistic Mathematics Education) Approach
   To analyze the validity of the product, two sets of data were used: evaluations from subject matter experts and media experts on the interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach.
   Table 6. Validity Score Data of the Interactive Virtual-Based Learning Media Using the RME Approach

No	Expert Evaluation	Score	Category
1	Subject Expert	76	Good
2	Media Expert	59	Very Good

From Table 6 above, the product validity score from the subject matter expert is 76, which falls within the range of 64.602 to 79.806, placing it in the "Good" category. Meanwhile, the evaluation by the media expert resulted in a score of 59, which is above the 54.606 threshold and thus categorized as "Very Good."

The results from both the subject and media experts indicate that the interactive virtual-based learning media using the RME approach is categorized as "Good" and "Very Good," respectively. Therefore, it can be concluded that the developed media is valid and suitable for use.

2. Practicality Analysis of the Interactive Virtual-Based Learning Media Using the RME Approach

   To assess the practicality of the developed product, data was gathered from student evaluations of the media. Based on questionnaires distributed to 33 eighth-grade students at SMP Negeri 1 Seyegan, data regarding student perceptions of the media was collected. The practicality score obtained from student evaluations was 1437, which falls within the range above 1366, placing it in the "Very Good" category. From this data, it can be concluded that the developed product—an interactive virtual-based learning media using the RME approach—is practical and therefore feasible for use.

3. Effectiveness Analysis of the Interactive Virtual-Based Learning Media Using the RME Approach

   To evaluate the effectiveness of the developed interactive media, the data used was based on students' learning outcomes. The analysis of test results showed that the student mastery level reached 100%, indicating that all students met the minimum mastery criterion of 75%. Thus, it can be concluded that the developed product is effective in terms of students' learning outcomes. Based on this data—where more than 75% of students achieved the minimum mastery criterion (KKM)—it can be concluded that the developed product is effective for use in mathematics learning.

Final Product Review

The result of this research is the creation of an interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach developed with Adobe Flash CS5.5. It was designed for use by eighth-grade students at SMP Negeri 1 Seyegan under the 2013 Curriculum and is presented in an executable (.exe) file format. This learning media can be used both in classroom settings and for independent study. The media includes seven main menus: user guide, core/basic competencies (KI/KD), apperception, key figures, materials, evaluation, and profile.

1. User Guide: Instructions on how to use the media.
2. KI/KD: Lists the core competencies, basic competencies, and indicators targeted by the media content.
3. Apperception: Introduction to the lesson material.
4. Key Figures: Information about the mathematicians who developed formulas for three-dimensional shapes.
5. Materials: Contains the learning content, specifically on surface area and volume of three-dimensional shapes with flat surfaces. This section is divided into two parts: the first part explains surface area, and the second part explains volume. Each material section includes practice questions for students.
6. Evaluation: Contains quiz questions for students to complete.
7. Profile: Information about the media creator and thesis supervisor.

After completing a series of development stages, the final product emerged as an interactive virtual-based learning media using the RME approach. It covers the basic competencies of distinguishing and determining the surface area and volume of three-dimensional shapes (cube, cuboid, prism, and pyramid), with indicators:

1. Students can determine the surface area of cubes and cuboids.
2. Students can determine the volume of cubes and cuboids.

This product went through a validation and evaluation process, involving three rounds of revision. The interactive virtual-based learning media using the RME approach positively impacted

students' learning outcomes. The quality of the product is deemed valid, practical, and effective, based on data analysis from expert and student evaluations. Therefore, it is considered suitable for wider implementation.

CONCLUSSION

The interactive virtual-based learning media using the RME (Realistic Mathematics Education) approach was developed through the following steps: (1) Preliminary Stage, which involved analyzing the core competencies (KI), basic competencies (KD), and indicators of competency achievement related to the topic of surface area and volume of three-dimensional shapes with flat surfaces, collecting references related to the material, and planning and selecting the type of learning media to be used; (2) Development Stage, which included the creation of the learning media using Adobe Flash CS5.5, adjusted to the topic of three-dimensional shapes with flat surfaces, and the development of a media evaluation questionnaire. Before using Adobe Flash CS5.5, a flowchart was created first, followed by the development of a storyboard; (3) Validation and Implementation Stage, which involved product feasibility testing by expert lecturers and making revisions based on assessments, feedback, and suggestions from those experts. The data analysis used in this study consisted of the validity of the learning media as assessed by subject matter and media experts, the practicality of the media as evaluated by students (through field testing), and the effectiveness of the media as determined by the results of students' mathematics learning tests.

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