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Designing Blended Learning System with Realistic Mathematic Education for Vocational High School Students

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ABSTRACT

Indonesia has entered a new condition in the Covid 19 pandemic, and all activities, including learning activities, need to implement health protocols. Blended learning is an alternative to combined indirect (online) and face-to-face (offline) learning that can reduce group gatherings as one of the health protocols to avoid Covid 19. This study aims to provide alternative learning options with a realistic mathematics education learning design or RME on the subject of area and volume of rotating objects for vocational students. The research used blended learning design with an RME approach to developing a learning model. Learning development is done by analyzing the needs and students. Performance objectives and learning outcomes are discussed and adapted to the instructional objectives. The result of this study indicates that the blended learning design by applying the RME approach is recommended for educators in studying the area and volume of rotating objects. This happens because learning is based on real-life situations that students can imagine according to the characteristics of the RME.

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1. INTRODUCTION

Globalization or currently as kwon the new era of civilization during pandemic requires people to be involved in improving human resources, exploring or collaborating the concept of face-to-face learning into virtual or combining the two, and then direct students to switch to using the basics of Information and Communication Technology (Siswanto et al, 2022). This is understandable because people are now moving towards using various information and communication tools available on various platforms that make people an informative and broad-minded society. Learning with the help of technology or online is a learning update that can visualize media in an interesting, diverse, and dynamic way by utilizing the internet network as a conductor. Learning in this way will greatly increase student enthusiasm.

On Internet, there are various media for delivering information that can be accessed through many channels, such as multimedia. In short, it is a combination of text, charts, images, and video via sound that go a long way in the ability to convey meaningful virtual information. With the development of the internet, learning models have changed with technology-based both information and communication, such as electronic learning models, intelligent classroom technology, virtual classes, and mixed learning. In the literature review, there are a lot of discussions about the effectiveness of blended learning in learning. Blended learning system design is an alternative to better mathematics learning; technology-based education systems are the main choice.

An article written by Rahmi (n.d.) states online learning, or blended learning, must be combined to maintain face-to-face meetings to increase student potential. Therefore, blended learning can be implemented as a learning system design. Then according to (Abarca, 2021), the design of learning systems with mixed learning allows us to design learning activities by paying attention to the parts of the subject that will be studied, rather than focusing on only one part. Furthermore, (Muhtar and Iskdandar, 2019) stated blended learning system is an alternative realized in the form of renewal in learning process that allows social interaction while providing knowledge. It is hoped learning activities will lead to the formation of positive behavior.

Meaningful learning process for students can be done with contextual-based learning activities or by linking realistic problems known to students (Panhuizen, 2014). According to the results of several experts in the matter being studied, it is known that the design of mathematics learning can be developed with the RME approach on several topics, namely building spaces, number patterns, and comparisons can improve students' cognitive abilities (Jamaan, 2018; Rudiono et al., 2015; Fauzan & Diana 2018). Judging from the various things that have been explained previously regarding some problems of curved side space that occur in vocational students and the effectiveness of the RME approach in developing learning designs based on previous studies, to answer these problems, it is necessary to conduct a study on how to teach curved side space in students. Focus on the subject area and volume of rotating objects with blended learning through the RME approach.

Some previous research does not mention how students manage their activities during the class to solve the problem of mathematic manner. It is important to find what is the effective way to understanding of the RME approach. However, this study focused on blended learning design with RME approach to give general understanding for vocational students in volume rotating objects. This approach is used in the mathematics learning process with the hope of making students feel closer to mathematics. Concrete objects taken from objects around us such as objects that we can find in everyday life make students feel easier to understand and can feel direct experience in finding mathematical concepts. This study uses development research methods. An instructional development model is referred to as the Instructional Model for Professional Improvement (MPI). To construct a learning system, the first step is to identify, the second is to develop, and the third is to evaluate and revise (Suparman, 2014). This design of learning mathematics will focus on the area and volume of rotating objects. Learning objectives are incorporated into the design of the learning process because students will use it as a reference for achieving learning objectives and results.

Based on the background, the new thing in this research is to develop a blended learning design with an RME approach for vocational students on the subject of area and volume of rotating objects. This research focuses on the design of learning the subject area of area and volume of rotating objects with mixed learning that applies RME at the Vocational school level. The purpose of compiling articles in this study is to determine how to design mathematics learning activities on volume and rotating objects at the Vocational school level in blended learning by applying RME.

2. METHODS

This study uses development research methods. The development model refers to the Instructional Development Model (MPI). The procedure in compiling a learning system is first to identify, second to develop, and third to evaluate and revise (Suparman, 2014). The design of learning mathematics that

will be developed focuses on the subject of the area and volume of rotating objects. The learning design is adapted to the learning objectives because students will use it as a reference in realizing the mathematics learning process so that learning objectives and results are achieved. The subject of the this reseach is vocational students grade 12. The data collected by random sampling according to the need analysis and student analysis.

3. FINDINGS AND DISCUSSION

As a result of a pandemic, we need to adapt to a new, more effective way of life during and after the crisis. In schools, blended learning is a method for reducing the number of mass gatherings and the physical distance between the teacher and the student. Mixed learning does not destroy the essence of the training objectives but instead improves students' skills. Blended Learning aims to provide choices and provide learning facilities with various learning media, focusing on student characteristics and continuing to apply health protocols. This model can also encourage participants to use online communication to develop their knowledge. Based on the research result and analysis it can be differentiate as follow:

1. Participant (Student) Analysis

Student analysis: This learning design was developed for class XII Vocational school students using Blended Learning through the RME approach on the area and volume of rotating objects. The application of blended learning with the RME approach in learning the size and volume of rotating objects is suitable for vocational students. This is in line with the current COVID-19 pandemic, limiting face-to-face learning in schools. Thus, education is carried out by combining online and offline knowledge simultaneously by utilizing technology adapted to the conditions of students and schools. With this strategy, it is hoped that all students can participate in maximum and meaningful learning. With blended learning, students are also seeking to understand the area and volume of rotating objects through the activities in the composite learning design. In addition, the learning process in this theory is concrete and closely related to nature and the surrounding environment (Pribadi, 2009). So that it can be said that the RME approach is closely related to constructivism theory, wherein its learning emphasizes the importance of real contexts that are close to students' everyday lives or can be imagined by students (imageable). In this way, students are expected to understand the shape of space by constructing concrete and abstract things in learning activities for the area and volume of rotating objects in Vocational school because of their relationship to the real world.

2. Needs Analysis

The topic of discussion on the area and volume of rotating objects is one of the materials that class XII SMK students in mathematics must study because it is under the Ministry of Education and Culture (2019) listed in the syllabus (table 1). After reviewing the area and volume of rotating objects, students are expected to understand what they have learned so that the quality of mathematics learning becomes better (Masitoh & Prabawanto, 2016). Understanding the concept of rotating objects in vocational students is very important, but it is not optimal in reality. The actual conditions in learning activities still describe the opposite of what is expected. Students can memorize formulas that already exist but are less able to master the properties of curved side spaces from the concepts they have and learn.

Table 1. Core Competencies and Basic Competencies

Core Competencies	Basic Competencies
3. Acknowledge facts, concepts, procedures, and metacognition following the field and scope of mathematical research at the technical, concrete, detailed, and complex levels related to science, technology, art, culture, and humanities. Apply, analyze, and evaluate the context of self-development as part of the elements involved in learning activities	3.13 Determine the surface area and volume of a rotating object using certain integral concepts.
4. Perform specific tasks using media, information, and common learning paths and solve problems that are relevant to the field of mathematics. Demonstrate skills in reasoning, processing, and presenting effectively, productively, creatively, critically, collaboratively, communicatively, independently, and directedly in the field of abstraction relevant to developing what students learn in school and can perform specific tasks under direct supervision. Demonstrate skills of perception, preparation, imitation, adaptation, mastery of movement, perform natural movements in specific areas related to the development of what has been learned in school, and perform specific tasks under direct supervision.	4.13 Solve problems concerning the surface area and volume of a rotating body by applying certain integrals

The importance of learning the area and volume of rotating objects; therefore, during the COVID-19 pandemic, the selection of learning media and appropriate strategies will help students solve their math problems. So that the alternative chosen is the blended learning design with the RME approach because, in it, there is a combination of online and face-to-face learning activities which are expected to maximize students' learning so that learning becomes maximal and meaningful. Then the RME approach was chosen because it is one of the learning approaches that can carry out an effective teaching and learning process, especially in learning the area and volume of rotating objects in Vocational school. The material chosen is the area and volume of a rotating object because the material requires a broad and in-depth understanding of the concept of integral and curved side space studied in the previous material. Students need to relate it in a natural context. After all, it leads to the explanations associated with real things.

3. Task analysis

Tasks analysis involved in this research is to design the flow of teaching and learning activities in mathematics on material area and volume of rotating objects for class XII Vocational school students by applying a blended learning strategy. This learning aims for students to understand the size and importance of rotating objects so that they can solve related problems. According to Brown & Green (2011), task analysis aims to assess and overcome the differences between the initial information received by students and their need to learn to achieve the expected goals.

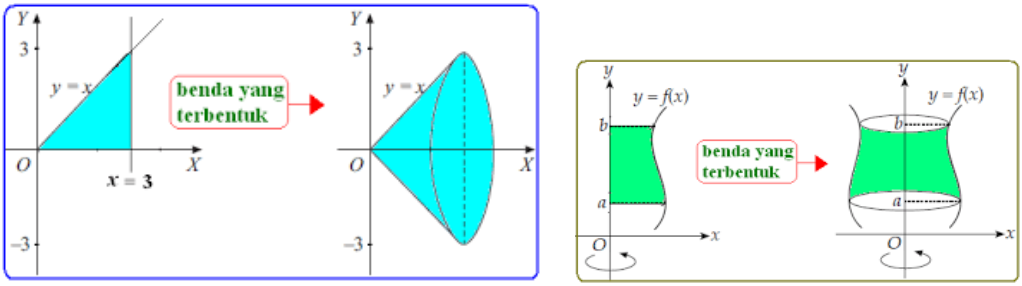

Figure 1. Examples of visual images to help students understand the concept of rotating objects on the x and y axes

The outline of the planned activities by applying blended learning strategy to design learning on the material area and volume of rotating objects for class XII Vocational school is as follows:

Table 2. Learning Design Area and Volume of Rotating Objects with Blended Learning

Learning Activities Area and Volume of Rotary Objects	Blended Learning and RME Characteristics
1. Prerequisite Knowledge. Before discussing the area and volume of rotating objects, students must master the prerequisite material, by reviewed following material: a. definite integral b. indefinite integral	Classroom Learning (Teacher) ***related***
2. Observing objects around rotating objects (such as balls, drinking bottles, gallons, etc.)	Classroom Learning (individual) ***Context use***
3. Observing the shape of the rotating object shown in the illustration (ball, tube, and cone)	*Blended Learning (teacher)*
4. Introducing the shape of a curve on the x and y axes that are rotated and form a circular object that includes a sphere	***Context use***
5. Introducing the shape of a curve on the x and y axes that are rotated and form a circular object that includes a cone	*Online learning (small grup) The teacher divides a small group on a virtual meeting platform*
6. Introducing the shape of a curve on the x and y axes that are rotated and form a circular object that includes a tube	***Context use***
7. Generalize the observation of the rotating object context so that an understanding of the area and volume of the rotating object is obtained.	*Blended Learning (collaboration)* ***Context use***
8. Determine the area and volume of rotating objects and evaluate them by discussion.	Classroom learning student contribution **Interactivity**
9. Indicate available learning resources for the topic. This research uses virtual reality media and virtual meetings and worksheets under realistic mathematics as visual aids.	
10. Distribute student activity sheets to groups accustomed to applying concepts, using realistic problems, and making decisions requiring many answers and many ways to solve problems.	
11. Giving questions or feedback from students to other	*Blended Learning (teacher)*

students regarding other students' presentations.
12. Summarize what was learned during the lesson.
13. Reflect on the activities that have been learned.
14. Giving homework with different questions, the purpose of giving homework is to improve students' abilities with the material that has been given.
15. Deliver the topic assessor for the next day's lesson

4. Performance Objectives and Learning Outcomes

Learning outcomes and objectives are two essential terms used by instructional design to describe changes in knowledge, behavior, and performance achieved through an instructional activity. Brown and Green (2011) show that results are skills acquired through instruction, while goals are measurable actions that aim to achieve broader results. Learning objectives are also interpreted as performance goals because various types of performance or competency standards are strived to be completed.

5. Lesson Objectives

The following describes the learning objectives of discussing the subject area and volume of rotating objects. Students can explain and apply this knowledge using several steps, namely:

1) Students can mention the properties of each rotating object and the basic properties of integrals.
2) Students can find the formula for the area of each rotating object from the integral properties and the concept of curved side objects.
3) Students can find the formula for the volume of each rotating object from integral properties and the concept of curved side objects
4) Students can solve problems in real life by applying the area of the rotating object and the volume of the rotating object

6. Learning Outcomes for Each Goal

After participating in learning with a blended learning strategy, students are expected to be able to:

1) State the properties of each rotating body and the basic properties of integrals.
2) Determine the formula for the area of each rotating body from the integral properties and the concept of curved side objects
3) Determine the volume formula for each rotating body from integral properties and the concept of curved side objects
4) Solve problems in real life by applying the area of the rotating object and the volume of the rotating object

7. How the learning outcomes support each goal

The following explains the relationship between learning outcomes and objectives based on blended learning activities by applying the RME characteristics shown below:

1) Students can mention the properties of each rotating object and the basic properties of integrals.

The teacher explores students' understanding of the properties of the two forms through observation and asking questions. They first presented information by displaying an example of an object whose surface is curved on a projector screen with VR media (figure 1b). At this stage, the characteristics of the RME that are applied are Intertwinment or linking knowledge and interactivity, namely questions and answers between teachers and students. So that students can mention the

properties of each rotating object.

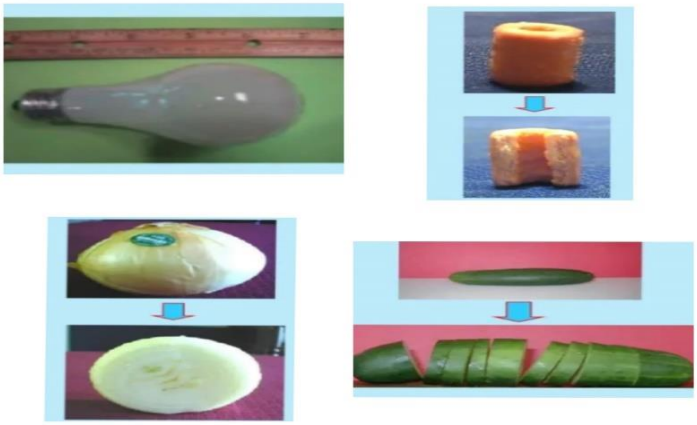

Figure 2. An example of using a realistic model to state the properties of each rotating object

2) Students can find the formula for the area of each rotating object from integral properties and the concept of curved side objects.

In determining the area of an area with a limit on the number, it can be illustrated by the figure below with the main steps taken are partitioning the value, approximating the limit value by adding up and calculating the limit value in these steps:

a) First, divide the interval into intervals of equal length
b) Second, make sure to partition the area
c) Third, Make a rectangle on each rectangle
d) Fourth, Make sure the rectangle on the interval ($x_{i,1}$, x_i)
e) Fifth, Determine the area of the rectangle I (L_I)
f) Sixth, do the sum of the areas of all rectangles
g) Finally, the limit value is calculated

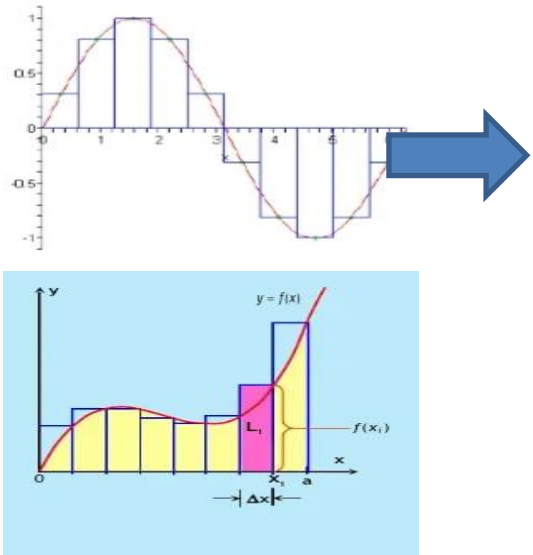

Figure 3. The concept of finding the formula for the area of a rotating object

3) Students can find the formula for the volume of each rotating object from integral properties and the concept of curved side objects.

In finding the concept of the volume of a rotating object is to pay attention to how the shape of the partition if it is rotated.

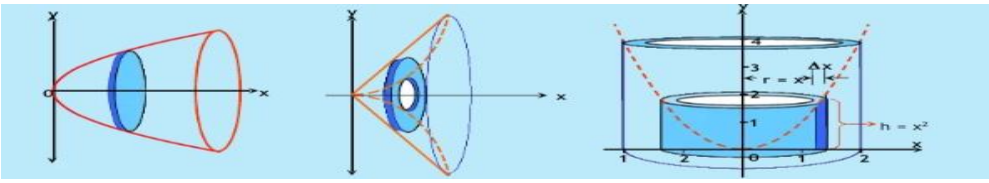

Figure 4. The shape of the partition being rotated

4) Students are expected to be able to solve problems related to the area and volume of rotating objects

After students understand the concept of area and volume of a rotating object by looking for the formula. Furthermore, students are expected to be able to apply their knowledge to related problems. Some worksheets/questions that can be used include the following questions, which can be seen in the learning evaluation subtitle.

8. Instruction Sequencing Event

Brown and Green (2011) explain the importance of sequencing instructional events to create effective teaching, as Gagné (Nine Gagné events) proposed. Gagne's proposed instruction framework offers a well-organized and sequential set of procedures and supports the possibility of good processes in instruction. So that learning activities are successful and effective. Here are nine steps of Gagné's education that the authors have modified to be more towards a student-centered approach that supports a cognitive constructivist approach to learning and teaching. An adaptation of Gagné's original nine-step instructions as described below:

a) Attract students' attention at the beginning of the lesson, ensure students are ready to learn and motivate them to participate in the learning process.
b) Informing the learning objectives and involving them in thinking about how they can achieve these learning objectives.
c) Exploring prior knowledge/remembering lessons. In the following way:
   (1) Ask students to relate new information to previously learned knowledge;
   (2) Asking previous questions about the experience or the concept/content of learning;
   (3) Accompanying and encouraging students to conclude their prerequisite knowledge and skills.
d) d) Discuss the subject matter; information presented and discussed
e) e) Facilitate student learning by enabling self-discovery and improving students' metacognitive skills, which are indispensable for effective transfer of learning from the classroom to the outside world.
f) f) Provide opportunities to practice the concepts and skills learned to ensure the implementation of adequate learning.
g) g) Provide specific, precise, and constructive feedback.
h) h) Assessing student performance; this is usually a requirement and can be done in various ways, such as group or individual exams or portfolio assessments.
i) i) Increasing reinforcement (retention) and transfer of knowledge (transfer) is the

ultimate goal of instructional activities, i.e., concepts and skills learned can be applied to similar situations outside the classroom.

9. Evaluating Learning

Formative and summative assessments are instruments used in evaluating instruction. Such assessments can be formal or informal and can be very important in meeting the needs of students and guiding them. Summative assessment measures students' abilities, such as holding quizzes about specific lesson objectives and seeing whether students have achieved these goals. Each step of Gagné's modified nine-step education can provide opportunities for formative assessment (Roubides, 2015).

a) Formative evaluation

Formative assessment is collecting data and information to improve teaching effectiveness. Formative assessment is carried out as a constructive process without decision-making. With formative evaluation, teachers can see how far their students have mastered the teaching materials taught (Aji, 2016). However, at some point, we must know whether the teaching is successful or not. To arrive at this decision, it is necessary to carry out a summative assessment.

b) Summative Evaluation

Summative assessment collects data and information in designing decisions about obtaining the planned learning outcomes. Through a comprehensive evaluation, learning designs that provide the basis for assessment decisions based on the effectiveness and efficiency of teaching and learning activities can be identified and evaluated (Aji, 2016). The comprehensive assessment is based on achieving the goals set initially, reflected in the student's grades. When all objectives have been completed, the effectiveness of implementing learning activities related to specific subjects is considered successful. If learning success is achieved relatively quickly, it can also be achieved in terms of learning efficiency.

4. CONCLUSION

Choosing blended learning as an alternative to learning mathematics has the benefit of combining learning activities in conventional classes with face-to-face learning activities. This is a way to achieve independence in learning so that learning becomes more meaningful. Through this research, it is known that learning the area and volume of rotating objects is very important to be taught to vocational students—learning and goals to be achieved so that students must possess the expected results or mathematical abilities. The importance of learning the area and volume of rotating objects is one approach that recommends achieving this ability by applying RME. The characteristics of RME play a role in developing the mathematical understanding of class XII students in learning activities of the area and volume of rotating objects. Following are the results of the development of learning designs for the area and volume of rotating objects, namely the use of contexts or realistic problems as a starting point for learning mathematics. In the first activity, the context compares the surrounding objects to determine the shape properties. The context in the second activity finds the concept of the area and volume of rotating objects with real-world applications. The third activity uses student sheets of each activity and the visual context of the VR media to help students develop the models (use of models) they use to solve specific problems. Through RME activities obtained by understanding mathematical concepts, students will be able to use the results of learning designs. Communication activities between teachers and students and

between fellow students are well established and can be seen in group and class discussions in learning activities. Connecting several concepts in this study attracts attention and motivates students to solve various problems given.

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