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Effectiveness of Multiple Representation-Based Mechanics Lectures Using YouTube Video Content on Concept Mastery

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Abstract. In mechanics lectures there are many abstract concepts. The existence of abstract concepts creates misperceptions among students. This research aims to determine the effectiveness of Multiple Representation-based mechanics lectures using YouTube video content on concept mastery. This research was conducted at the Physics Education Study Program, FKIP UHAMKA. The respondents in this study were 3rd semester students who were taking a mechanics course. This research uses a pre-experimental design method with a one group pretest-posttest research design. The results of the research show that the use of YouTube video content in multiple representation-based mechanics lectures is quite effective in increasing respondents' mastery of concepts. This can be seen from the post-test results of respondents, the majority of whom experienced an increase with an average score of 63 with the N - Gain score obtained having an average increase of 46.78% or in the medium category. The benefit of this research is knowing the respondent's level of concept mastery.

Keywords: mechanics, multiple representation, mastery of concepts

1. Introduction

In mechanics courses, there are many abstract concepts. Mechanics is the science that studies the motion of an object and the effect of force on motion so that students need to master the concepts of these loads [1]. Lecturers as facilitators are responsible for ensuring that students have three basic abilities in learning physics concepts, namely conceptual, analytical, and numerical. For this reason, lecturers must prepare teaching materials before lectures, including preparing relevant approaches, models, methods, and learning media. The use of media and teaching materials in learning activities aims to facilitate understanding of the content and concepts presented [2].

From the results of a preliminary study in the form of interviews with students, it was found that there were problems experienced by students in lectures. First, students have the perception that mechanics is difficult, has lots of pictures, graphs, formulas, complicated and abstract calculations. Second, students' reading interest in mechanics is lacking because the source of the book is in a foreign language so that insight into mechanics can only be obtained from the lecturer. Third, basic mathematical skills (calculus in number systems, inequalities, Cartesian coordinates, and functions to draw graphs of equations and volumes of rotating objects using the disc method, and volumes of rotating objects using the ring method) and basic physics of students are lacking. This is also the reason why students experience difficulties when understanding the concept of mechanics.

Etkina in [3] stated that physics learning needs to develop scientific abilities and critical thinking skills, communicate external processes in detail, and be able to apply these skills to other content outside of physics. In this case, educators must use different strategies and representations, justify solutions, relate to previous knowledge and conceptual understanding, and connect representations to other core ideas [4]. Representations are divided into four types, namely verbal, pictorial, mathematical, and

graphic representations [5]. This is in line with the opinion of Wu & Puntambekar in [6] that representations can be divided into four categories, namely oral text (metaphor, oral, written), symbolic mathematics (equations, formulas, structures), visual graphics (animation, simulation, diagrams, graphs, tables), and action operations (demonstrations, movements, manipulations, physical models).

One of the representation models that can be used in mechanics courses is Multiple Representation. Multiple Representation (MR) is an explanation of a concept that is applied in different ways [7]. Multiple Representation is very effective in improving students' conceptual understanding of the physics concepts taught, such as optics, heat, and mechanics. Several representations such as tables, data, conceptual change texts, concept maps, and analogies can also improve students' conceptual understanding. The inferential conception seems to be a philosophical theory that results in scientific representation in science learning.

Ainsworth in [8] explains that conceptual analysis of the learning environment and the three main levels of MR functions are to obtain complementary information, interpret constraints, and build a deep understanding of the topic being studied. The use of multiple representations (MR) in learning will require several student abilities, including learning to communicate, learning to reason, learning to solve problems, learning to connect ideas, and learning to express ideas [9].

Furthermore, Prain & Waldrip in [10] stated that students' scientific abilities depend on their ability to analyze, conceptualize scientific representations, and create representations independently. The use of MR in learning enables students to understand more deeply about scientific concepts and relationships through the process of transduction and transformation of various representations [10]. The application of multiple representations is also supported by teacher training including learning theoretical knowledge through activities on campus and teaching practices in the classroom [11].

Multiple Representations have been shown to improve students' understanding of abstract concepts, facilitate the transfer of knowledge, and improve their problem-solving abilities. According to [12] multiple representations are an effective way to solve problems in mechanics and an important area of research in engineering. This is demonstrated by the many scientists who use multiple representations, such as tables, graphs, models, simulations, formulas, and others in their research to improve personal understanding, communicate their ideas, and advance science [6].

Several studies have shown that representation is a process by which an object is captured by a person's senses, then enters the mind to be processed, the result of which is a concept or idea that will be conveyed or expressed again with language. Representation functions as a process and result for reasoning in topics and conceptual understanding. Representational construction offers certain abilities to learn science in both scientific concepts and scientific knowledge building practices. One of the media that can be used to help the Multiple Representation-based Mechanics lecture process is YouTube content.

YouTube is an internet application that is frequently visited by users in all circles and ages for various purposes. YouTube also makes it easy to use and capture videos so that they can easily be adapted into a medium for delivering lecture content, especially in Mechanics courses.

Based on the literature study that has been carried out, it turns out that no research has been found using Multiple Representations based on YouTube content to improve mastery of mechanical concepts. So this research aims to determine the effectiveness of Multiple Representation-based Mechanics lectures using YouTube content on students' mastery of concepts.

2. Methods

This research method uses a pre-experimental design (non-design) method. It is said to be pre-experimental design because this method is not yet a real experiment. Pre-experimental design is experimental research that has not been carried out seriously because it is still there are external variables that influence the dependent variable [13]. So, the experimental results which are dependent are not solely influenced by the independent variable. The instrument used in this research is a Multiple Representation-based assessment. The following is flow diagram of the research carried out.

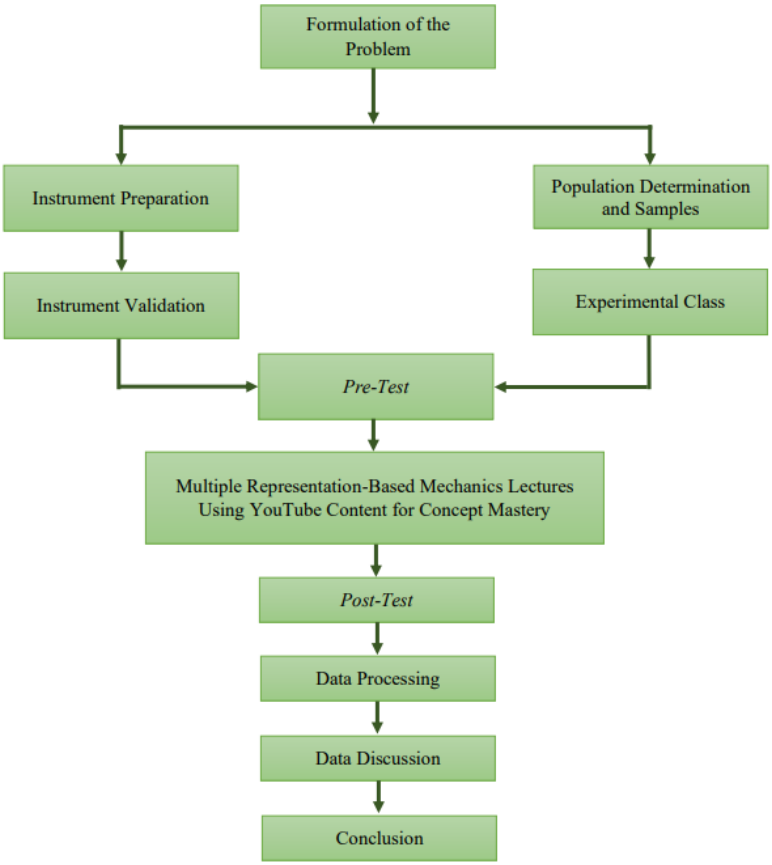

Figure 1. Research flow diagram.

In this research, the author used a one group pretest-posttest research design. In this study, there was only one experimental group that was given treatment in the Multiple Representation-based mechanics lecture process using YouTube content. The test was carried out twice, namely before the experiment and after the experiment. The test before the experiment used by the author was an oral test regarding the respondent's initial conceptual understanding. Meanwhile, the test after the experiment used by the author is a representation of the material concept according to the perception of each respondent. The one group pretest-posttest design research design is shown in the table 1 [14].

Table 1. One group pretest-posttest research design.

Kelompok	*Pretest*	*Treatment*	*Posttest*
Eksperiment	O_1	X	O_2

where O_1 shows the group of respondents who were given the pre-test, X shows the respondents who were given MR learning (treatment), and O_2 shows the group of respondents who were given the post-test.

3. Results and Discussion

The results of this research are that there is an influence on the use of YouTube video content in increasing respondents' mastery of concepts. This is shown by the following table.

Table 2. Respondents concept mastery score.

Score Type	Minimum Score	Maximum Score	Average Score
Pre-test	40	65	52.5
Post-test	46	80	63
Total	86	145	57.75

Table 2 shows that the respondents pre-test results had a minimum score of 40 and a maximum score of 65 with an average score of 52.5. Then, the respondent post-test results showed that the minimum score was 46 and the maximum score was 80 and the average score was 63. Furthermore, the increase in respondents' test results is presented in the diagram below.

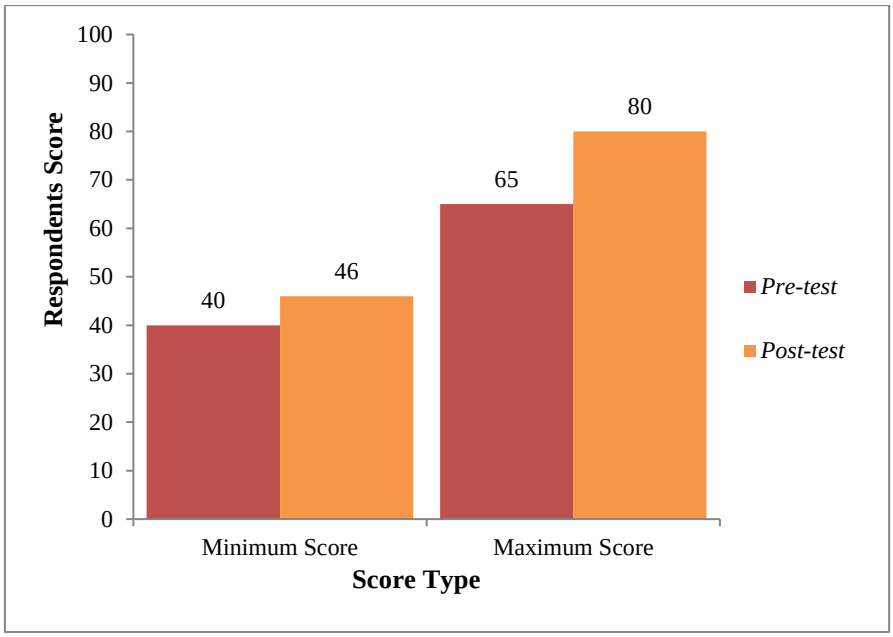

Figure 2. Diagram of respondent concept mastery scores.

Based on the picture above, it can be seen that the minimum score obtained by respondents has a difference that is not too far apart, where both are in the very poor category. Then, the respondents maximum score has a fairly wide range of differences between the score ratios, where the two categories are quite good to good.

Furthermore, all pre-test and post-test scores obtained by respondents were calculated using the normalized Gain equation (N–Gain) in order to determine the magnitude of the increase in concept mastery that occurred. The results of this score calculation is shown in the following table.

Table 3. N-Gain results of respondent concept mastery.

Percentage	Frequency	Explanation
46.78 %	9	Medium
1 %	3	Low
Average	0.36	

Based on the table above, it can be seen that as many as 9 respondents had an increase in mastery of mechanical concepts of 46.78%, which is included in the medium category. Meanwhile, 3 other respondents had an increase in mastery of mechanical concepts by 1% or were in the low category. So the average increase in concept mastery experienced by respondents was 0.36.

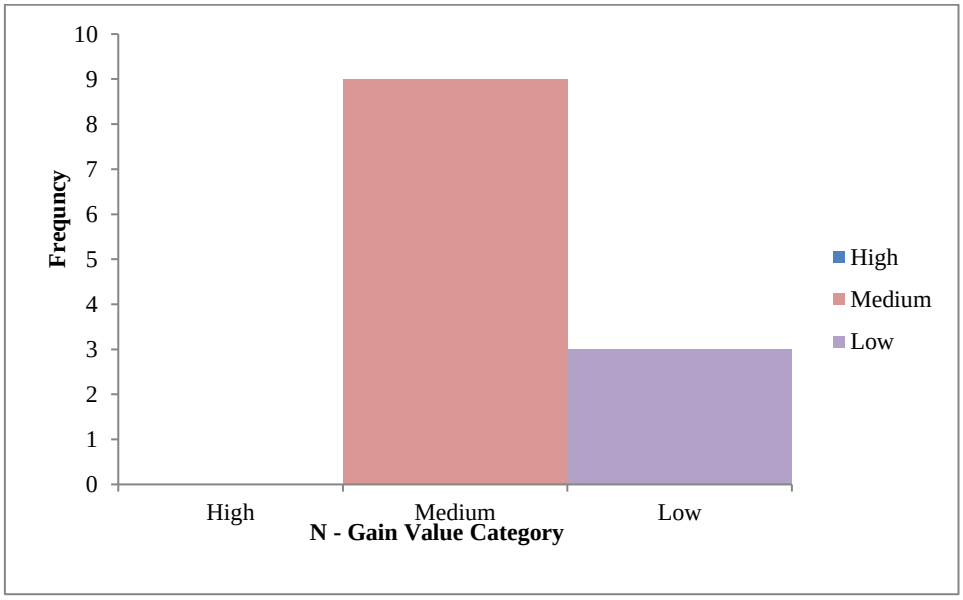

Figure 3. Frequency diagram of respondents N – Gain values.

Based on Figure 3, the N – Gain value that has the highest frequency is in the medium category with a range of values ranging from 0.40 to 0.63. Then, the N – Gain value in the low category has a frequency of around -0.15 to 0.22. Meanwhile, the N – Gain value in the high category does not have a frequency because the respondents N – Gain score has not reached a range of more than 0.70.

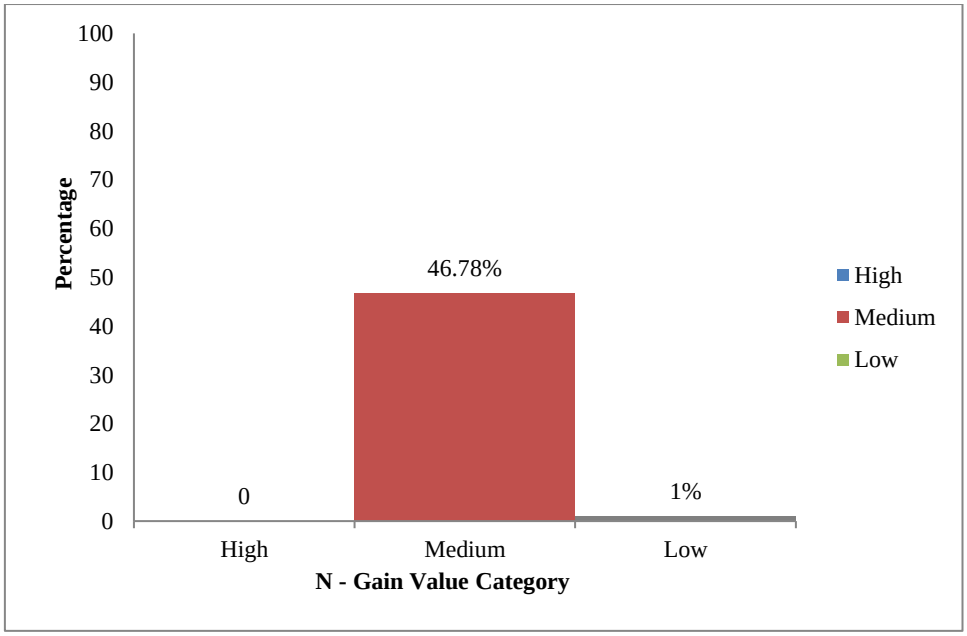

Figure 4. Percentage diagram of respondents N – Gain values.

The picture above shows that the N – Gain value in the medium category has a higher average percentage (46.78%) than the other two categories where the high category has an average percentage of 0% and the low category has an average percentage of 1%. So the overall average percentage is 15.93%.

Thus, the N – Gain score results obtained by 9 respondents had an average increase of 46.78% in the medium category, then 3 other respondents had an average increase of 1% in the low category. However, 1 respondent experienced a decrease in value, which affected the average increase in the N – Gain score

for all respondents. Furthermore, from all respondents the highest N – Gain score was 0.63 and the lowest N – Gain score was -0.15. Therefore, it can be concluded that multiple representation-based mechanics lectures using YouTube video content are able to provide respondents with effectiveness in mastering the concepts.

This is in line with the results of research [15,16] which states that representation means a form that can represent, describe, or symbolize a certain object. Apart from that, research also shows that another function of applying multiple representations is to complement other representations, limit other representations and build deeper understanding. Meanwhile, students still need to be accustomed to and trained in various types of representations because physics learning cannot only use a single model in explaining a concept that is abstract [17].

4. Conclusion

Based on the research that has been conducted, it can be concluded that there is an influence on the use of YouTube video content in increasing respondent mastery of concepts. This is shown by the respondent average pre-test score of 52.5 and the post-test average score of 63. The respondents minimum score was not too far apart, with both being in the very poor category. Meanwhile, the maximum score of respondents has a fairly wide range of differences with the score ratio, where the two categories are quite good to good. Furthermore, there was an increase in mastery of mechanical concepts by 46.78% which was included in the medium category. Meanwhile, 3 other respondents had an increase in mastery of mechanical concepts by 1%, which is in the low category. So the average increase in respondents concept mastery was 0.36. Thus, this research is quite effective in being used to increase respondent mastery of concepts which is in line with the results of the N - Gain value of 46.78% and is in the medium category.

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