Understanding advanced mechanics concept thought multiple representation and critical thinking for physics education student

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Abstract. An important go a lot of physics education is to help students to learn to interpret and build Multiple Representation. This research focuses on strategies to replace traditional approaches with more dialogical classroom interactions. The mixed method approach of the study requires the collection and analysis of quantitative and qualitative data using an in-depth case study approach, using an interactive classroom environment where students explore topics about advanced mechanics. Creative thinking is to stimulate curiosity and divergent thinking. Creative thinking also belongs to the category of higher order thinking skills. The results showed that carefully designed instruction using a double representation can be successful in promoting and maintaining the concept of students' scientific understanding.

1. Introduction

An important goal of physics education is to help students to learn to interpret and build the Multiple Representation physical process and learn to move in any direction. Physics education can be used to measure students' abilities by using Multiple Representations [1]. Multiple Representations (MR) and use of Interaction Diagram (ID) have beneficial effects on students' conceptual understanding and students' ability to utilize MR. The use of MR has been shown to increase the teaching benefits of teachers and students learning outcomes. REM can be introduced and used to support student involvement in scientific processes and the development to competent scientific practices (e.g. asking, questioning, planning investigations, and analyzing data) [2]. Multiple External Representations (MERs) suggests Multiple Scaffolding which aims to assist learning in various ways/models. How can students learn with MERs supported, especially in classroom situations? The guidance in the science classroom can be built into teaching materials, but the ways teachers facilitate classroom discussions are also important for learning [2]. Various approach such as implicit clue, integrated representations, static linking, dynamic linking, and explicit instruction have been suggested to reduce students difficulties [4]. Educational science and cognitive psychology integrate various perspectives.

This article aims to explore: (1) how MERs can be integrated with science processes due to their different abilities; and (2) how students learning can be linked through MERs, especially in class. We argue that pair so representations and scientific processes in a principle way based on the presentation ability and purpose of the activity are a powerful way to use MERs in science education [2].

The results show that a Multiple Representation (MR) and use of Interaction Diagram (ID) have beneficial effects on students' conceptual understanding. The use of MR has been shown to increase teachers profit in teaching and students' learning outcomes [1]. This suggests that MRs are effective for improving students' conceptual understanding of the physics concepts that being taught. One of the implications in the class of traditional physicist is the need to encourage students to think deeper about the physics concepts [4]. Integrating an epistemic, epistemological, and semiotic perspective is aimed at proposing new insights into the nature of learning quality in science [3]. The findings of the study offer some potential implications for teaching and learning science [5]. Images are the best way to protect against misconceptions and this does not depend on other materials given to students. In teaching science, it should be more emphasizes on procedures in determining the concepts [6]. The general inputs from students are relatively positive, derived from survey questions, interviews with students and discussions with the teacher, and teachers are expected to find the useful simulations in their own classes [7]. In the case of students' representation, there is an increase in almost every category, but mostly different from the students' concept is the students' improvement in identifying body weight and normal force [8]. Double representation can help students construct scientific concepts that are difficult, abstract, and unfamiliar before teaching in a classroom using a double representation [9]. If it are applied properly, explanations can be useful for connecting mathematical representations and can also deepen students' understanding.

2. Methods

This study is a survey focused on describing the mastery of concepts of physics students in one of the private universities in Jakarta. The survey involved 47 students of the third semester. Data were collected through standard test instruments for physics. The test tool consisted of many choices questions. A data analysis technique was done by using descriptive quantitative analysis technique. The evaluation method is used to collect the required data. The research method used the mixed method between quantitative and qualitative approach. Embedded design used in this study is the embedded experimental model.

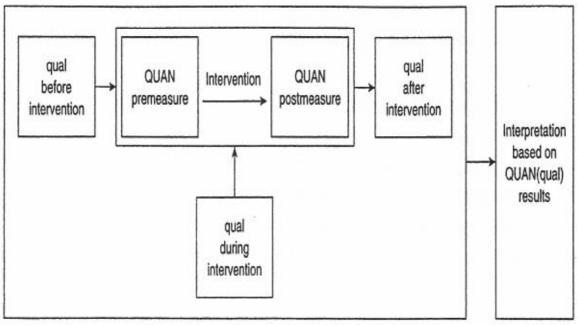

Figure 1. Embedded experimental model [10].

3. Results and Discussion

The findings derive preliminary information about the ability of multiple representations of physics education students. Rubric is used as a scoring guide that shows the performance of a learning process or learning outcomes.

Table 1 shows that the students who get a score of 60-64 as many as 12 people or 25.53% are still low on the results of their midterm test scores. Tthis is due to a lack of understanding of the concept of material that has been studied. This condition is in accordance with the research results of Kodjo Donkor Taale [11] which found that this shows the effectiveness of MRs (Multiple Representations of Science) aimed to improve students' conceptual understanding of physics concepts being taught. One of the implications in the traditional physics class is the need to encourage students to think deeper about the physics concepts. In this study, the average value of semester tested by students is low (25.35%). A study by Kok-Sing Tang, Cesar Delgado, Elizabeth Birr Moje [12] found that students who develop better scientific understanding engage more actively in the development of representation.

Table 1. Scoring guide of midterm result of 47 students.

Very Less	Less	Fair	Good
0-1	2-3	4-5	9-10
0-3	3-5	6-9	14-15
< 20	21-40	41-60	> 81

Table 2. Percentage on midterm result of 47 students.

Range Scores	Number of Students	%
40-49	7	14.89
50-59	10	21.27
60-64	12	25.35
65-69	10	21.27
70-75	8	17.02
Total	**47**	**100**

Table 2 shows that in a matter of questionnaire responses (question 1), students responded "agree" that the midterm questions are in accordance with the RPS (*Rencana Pembelajaran Semester*).

Table 3. Students' response data of experiment class.

Answers/Response of Questions	1	2	3	4	5	6	7	8	9	10
S	14	15	11	5	12	10	4	7	4	7
SS	1	2	1	1	3	-	-	-	-	2
TS	2	-	5	9	2	7	13	10	10	8
STS	-	-	-	2	-	-	-	-	3	-

Question Number	S (%)	SS (%)	TS (%)	STS (%)	Total (%)
1	82.35	5.88	11.77	0	100
2	88.24	11.76	0	0	
3	64.71	5.88	29.41	0	
4	29.41	5.88	52.94	11.77	
5	70.59	17.65	11.76	0	
6	58.82	0	41.18	0	
7	23.53	0	76.47	0	
8	41.18	0	58.82	0	
9	23.53	0	58.82	58.82	
10	41.18	11.76	11.76	0	

Table 3 shows the students' response in the experiment class. It is seen from the Table 3, about 2 students responded "agree" that the midterm exam was in accordance with the indicators. While 88.24% of them agree that the given material problems are difficult though the problems still can be done, 52.94% did not agree that the given material problems are easy and workable. The results also indicated that 70.5% agree that the subject of vector material is easy to do, 58.82% agree that the subject of Newton mechanics is easy to do, 76.47% disagree that the harmonic oscillator material is easy to do, and 58.82% disagree that particle motion is easy to work on. Most of the students, about 82%, disagree about the statement that the images and graphs on the subjects are legible and understandable. About 47.06% disagree on the statement that all questions are difficult to understand and confusing to do.

4. Conclusion

On the average, the midterm examination scores obtained by students are low, namely 25.35%. in the result of the questionnaires, it is found that the students have difficulty in solving the given problems, therefore students find them difficult to solve. The harmonic oscillator material, particle motion, drawing, and graph on the given problems are difficult to be read and understood, also confusing to do. In general, it is illustrated that students of S1 Physics Education are still low in multiple representation abilities, designing, developing, and understanding the concept of analytical mechanics material.

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The author realize that this article is far from perfect, therefore constructive criticism and suggestions are desirable for the perfection of this article. Hopefully, this research is useful for the readers.

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