

Enhancing Conceptual Understanding and Critical Thinking Skills Pre-service of Physics Using Mechanics Multi Representation (MMR)

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Abstract: Physics learning based on multiple representations is to association dual or more representations as a method of learning progress that utilized to enhance pre-service teachers' responses after implementing multi representation-based mechanics lectures. In mechanics subject, pre-service physics teachers' have trouble and misconception on some concept such as; gravity and central force (GCF), dynamics system particle (DSP), rigid object rotation (ROR), three-dimensional rigid object rotation (TROR). This study aims to find out that using multiple representations (MR) can enhance conceptual understanding and critical thinking skills (CTS) skills for physics teacher candidates. MR-based modules content and pre-service teachers' worksheets (PTW) with the CTS was utilized to enhance conceptual understanding. Descriptive quantitative and qualitative research methods are carried out to get an evident description of the implementation of MMR to improve conceptual understanding and critical thinking skills. The results found that the level of understanding of MR-based concepts increased for an average N-gain of 0.44% while for the implementation of CTS an average value of 44.9% with quite good criteria. The pre-service teachers' responses to learning of multi-representation-based mechanics are positive. This research is the first study to map a mechanics conceptual understanding and mechanics critical thinking skills based on multiple representations. The results of this research found new discoveries, that all pre-service teachers' have the ability to understand concepts MR-based and using PTW MR-based can enhance the critical thinking skills of pre-service teachers.

Index Terms: multi representation, mechanics, conceptual understanding, critical thinking skills, pre-service teacher

1 INTRODUCTION

Mechanics lectures are connections among pre-service teacher's and lecturers or other education possessions about abstract concepts, natural phenomena, and phenomena in mechanics. Mechanics lectures cover many concepts and principles which generally identical abstract. This abstract concept makes pre-service teachers' frequently find problems and misconceptions in learning mechanics. Problems and misconceptions that are mostly faced by most pre-service teachers' in understanding numerous concepts and principles of mechanics, because they are compulsory to be able to interpret the conceptual understanding of mechanics correctly and not cause meaning misperception. Pre-service teachers' ability to identify and interpret physics concepts is clearly an important requirement to make more multifaceted discovery or for solving physics problems related to these concepts [13]. The initial study shown by our at one of universities in Jakarta using form of a instruments trial to pre-service teachers', as well as an analysis of the trial test results in a mechanics concept for gravity and central force, data analysis result and discussion of concept mastery central force on pre-service teachers' in semester 3 found that concept mastery average pre-service teachers' based on multiple depictions reached the good category, though there were still low pointers of achievement.

Furthermore, from five indicators aspects of conceptual understanding on central force concept showed that the highest pre-service teachers' conceptual understanding is in the classifying indicator with a percentage of 86.65%, while the lowest pre-service teachers' conceptual understanding lies in the comparing indicator that is equivalent to 66.55%, so mechanics learning on the concept of central force through multiple representations-based learning methods are effectively practical to other theme mechanics material for physics learning pre-service teachers' in semester 3. Based on conclusions from the results of study, we suggest that the application of learning a central force material based on multiple representations can be used as an alternative knowledge method to other concept and it is expected that other investigators can deliver a more varied approach to learning mechanics based on multiple representations [5]. The relationship between multi-representation and conceptual understanding concepts by Suhandi and Wibowo [12] stated, "... multi representations are one method that is fairly actual to be used in order to implant physics conceptual understanding between pre-service teachers". The physics concepts utilized in this research are gravity mechanics and central force, particle system dynamics, rigid body rotations and three-dimensional rigid body motion [3]. Multiple representations also affect critical thinking skills. Satria [11] state that "... Pre-service teachers' critical thinking skills after the operation of inquiry-oriented worksheets can enhance critical thinking skills from an average of 10% to 74.6% on Virgin Coconut Oil (VCO)". Another researcher who studied the same question stated that "The results of the advanced sequencer tests presented that the rise in CBC, MR skill, and mastery of concepts was higher in the experimental group than control group. The implementation of PFSdAb-MR in the experimental group can enhance the CTS (N-gain = 60.3% in the medium category. Pre-service teachers' and lecturers respond very well to PFSdAb-MR and their implementation physics teacher"[2]. The results of many researches can prove as empirical facts

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that the use of multiple representations in science learning can help pre-service teacher's better to understand the science concept, help pre-service teacher's to solve difficulties and encourage pre-service teacher's to pose difficulties [1], [4], [6], [8], [9], [10]. The thinking skill at a higher level includes thinking critically skill, and this is the skill to think rationally and reflectively based on what is believed or done [7]. Based on the explanation above, the problematic of the research is how mechanics multi-representation (MMR) can enhance pre-service teachers' conceptual understanding and critical thinking skills (CTS) on gravity and central force (GCF), dynamics system particle (DSP), rigid object rotation (ROR), three-dimensional rigid object rotation (TROR). Therefore, the researcher designed to find out how to enhance pre-service teachers' conceptual understanding and pre-service teachers' critical thinking skills, after getting physics learning using multi representations on a pre-service teacher.

2 METHODOLOGY

This research utilizes descriptive quantitative and qualitative research methods. The researcher uses this method to get a clear description of MR implementation to improve conceptual understanding and critical thinking skills (CTS), using the design of score assessment in MR-based modules as an achievement of conceptual understanding and assessment using MR-based PTW. In this study, pre-service teachers were given a pretest before implementation. Then pre-service teachers are given implementation using MR-based content modules and answer PTW to enhance critical thinking skills for a certain period of time. After learning is done, a post-test is conducted to know the level of skill conceptual understanding and critical thinking skills. This research was showed at one of the universities in Jakarta, with a sample of 31 pre-service teachers. The sampling technique used is purposive sampling technique. This technique is used on the basis that pre-service teachers' have educated basic physics concepts. MR-based concept instruments and pre-service teacher worksheet (PTW) implementation using CTS by analysis percentage and achievement category as well as instruments for pre-service teachers' responses about the learning using multiple representations. The data analysis technique used by calculating the score of the pre-test and post-test results, then calculated using the N-gain equivalent tion. N-gain defines an improvement in pre-service teachers' learning outcomes between before and after treatment is given. Meanwhile, pre-service teachers' replies were measured by means of a multi-representation Likert scale.

3 RESULTS AND DISCUSSION

3.1 Enhancement of conceptual understanding

The data results of enhancing pre-service teachers' conceptual understanding MR-based can be seen from the N-Gain generated from pre-service teachers' pretest and posttest scores. The calculation results can be shown in Fig 1 as follows:

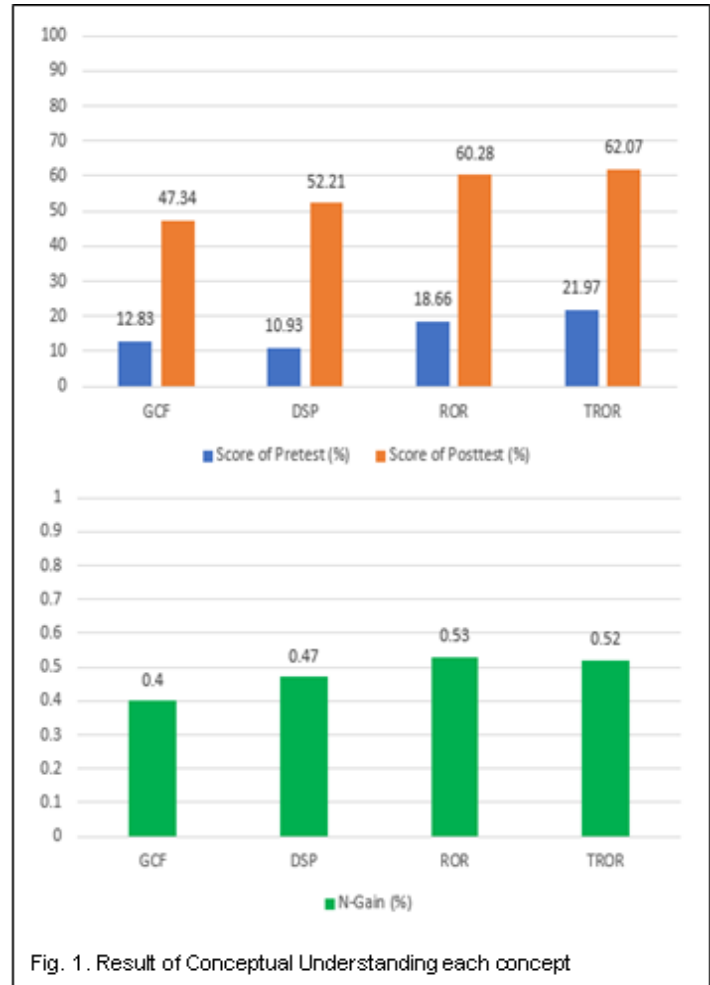


Fig. 1. Result of Conceptual Understanding each concept

Graph 1 showed that there is an enhancement in conceptual understanding after given MR-based lectures on pre-test and post-test. Gravity and Central Force (GCF) concept has enhancement equivalent I to 34,51% with 0,4 N-Gain, Dynamics System Particle (DSP) concept has enhancement equivalent I to 41,28 with 0,47 N-Gain, Rigid Object Rotation (RBT) concept has enhancement equivalent I to 41,62 with 0,53 N-Gain, and three-dimensional rigid object rotation (TRBT) concept has enhancement equivalent I to 40,10 with 0,52 N-Gain. From those concepts that has been taught, RBT has the highest N-Gain while GCF has the lowest N-Gain. The growth in N-Gain value means that there is an influence after being given lectures based on MR. The level of pre-service teachers' conceptual understanding MR-based was in medium criteria.

3.2 Enhancement of Critical Thinking Skills

Data on the results of enhancing pre-service teachers' critical thinking skills can be seen from the percentage value created from the typical pre-service teachers' score. The calculation results can be shown in Table 1 as follows:

TABLE 1
RESULT OF CONCEPTUAL UNDERSTANDING EACH CONCEPT

Responden	Score			
	GGF	DSP	ROR	TROR
R1	92	70	75	70
R2	83	80	80	75
R3	62	55	75	70
R4	80	50	68	75
R5	66	65	75	80
R6	68	65	70	75
R7	69	70	78	75
R8	63	85	85	80
R9	100	100	90	80
R10	88	50	85	70
R11	88	60	86	90
R12	88	70	67	65
R13	72	50	60	66
R14	79	50	65	67
R15	100	95	70	80
R16	78	50	65	60
R17	60	50	70	65
R18	100	90	78	76
R19	65	80	75	70
R20	65	70	75	75
R21	94	100	90	95
R22	72	55	65	60
R23	88	60	70	75
R24	69	75	70	78
R25	72	50	65	68
R26	59	64	60	66
R27	81	70	75	70
R28	66	55	65	70
R29	66	60	75	70
R30	85	70	67	77
R31	66	58	65	75

Table 1 can be depicted as in Fig 2 below as follows:

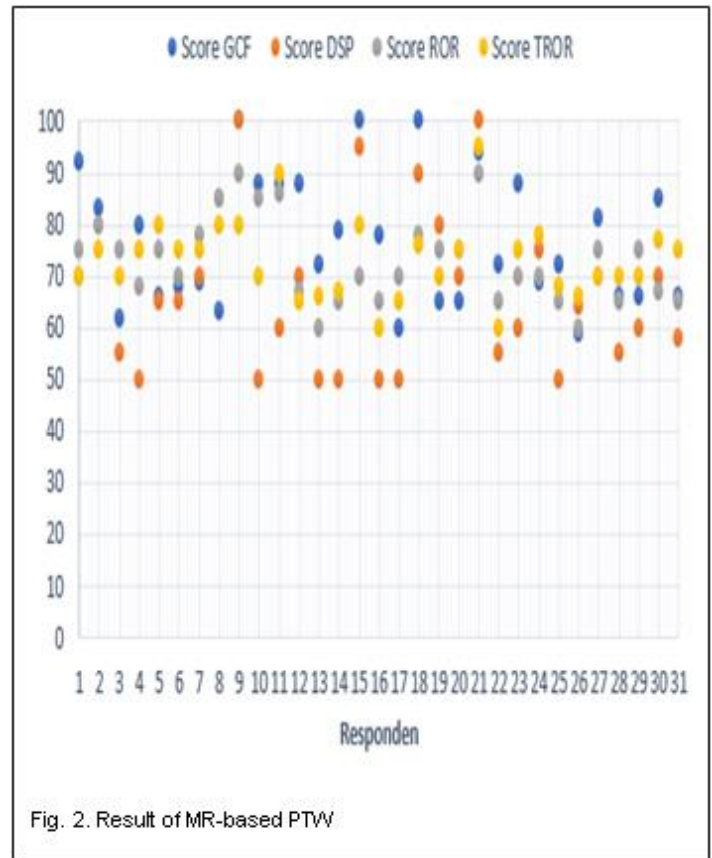


Table 1 and Graph 2 showed that there is an enhancement in pre-service teachers' critical thinking skills in answering using MR-based PTW. A percentage value advances the capability of CTS means that there is an effect of increasing the CTS. Pre-service teacher's Critical Thinking Skills have an enhancement from four concepts that have been taught. Graph 2 shows that all the pre-service teacher after post-test gets an enhancement above score 49. From 31 respondents, 16 pre-service teachers have a score between 59-72 with a percentage of 51,61% which is in a medium category while 15 pre-service teachers have a score between 73-100 with a percentage of 48,39% which is in the advanced category. We obtained a large capacity for the implementation of CTS on MR-based PTW with an average value of 44.9% on quite good criteria.

3.3 Response Pre-service Teacher

Pre-service teachers' responses after implementing multi-representation-based mechanics lectures were positive. Pre-service teachers are very happy and interested in lecturing mechanics using multiple representations. Data analysis results of pre-service teachers' responses to the MR-based mechanics' lecture process can be shown in Fig 3.

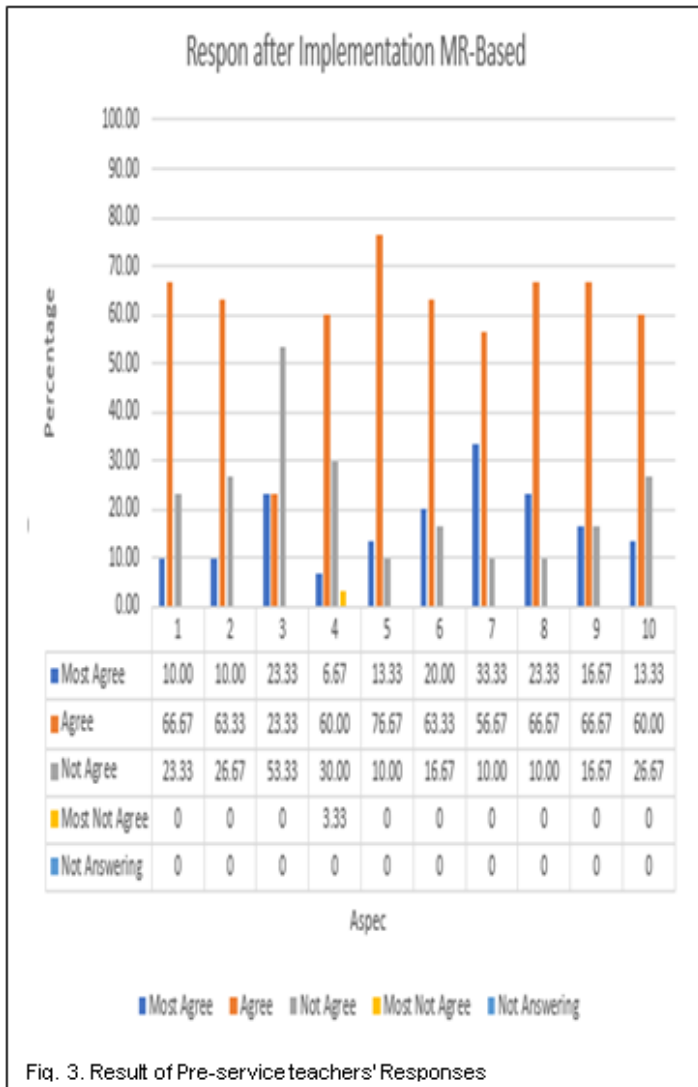


Fig 3 shows that 66,7% in the first aspect, pre-service teachers agree (S) with the concept is interested to learn. The second aspect is about learning sources and media with majority pre-service teachers agree of 66,7%. The third aspect gets 53,3% agree that media learning is not interested to learn by pre-service teachers. The fourth aspect is about understanding the concept and get 60% of agree. The fifth aspect gets 76,7% about 3D media useful to learn. The sixth aspect gets 63,3 agree that should be there is a PTW every lecture. 56,7% of pre-service teachers agree from the seventh aspect that very helpful using software and media learning. 66,7% of pre-service teachers agree from eight aspects that it can be trained to their critical thinking skills. The ninth aspect gets 66,7% agree that this learning makes them arouse curiosity. The last aspect (tenth) is about use language that is easily understood by students and gets 60% of agreement. Pre-service teacher responses are overall is in good. They accepted Mechanics Multi Representation (MMR) as positive learning

4 CONCLUSION

After implementing the mechanics' lectures, student conceptual understanding of MR-based expressions that the majority of students have difficulties and misconception can be overawed with the instruments provided in the form of MR-

based content modules and student worksheets using PTW have enhanced conceptual understanding with average categories and critical thinking skills with categories pretty good. Students' responses after MR-based mechanics lectures can improve general conceptual understanding and critical thinking skills (CTS) are positive.

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