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Effect of Implementation Interactive Conceptual Instruction with Multi Representation Approach To Improve Levels of Understanding on Work and Energy Subject Matter

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Abstract. This study is a experiment method that purpose to describe increase in the level of understanding of student's senior high school as the effect of implementation's interactive conceptual instruction using multi representation. The research design used one group pretest posttest design. Subjects consisted of 37 students of class X in one of the high schools at Sumedang, West Java. Sampling technique used in this research is purposive sampling. The research instrument used a test understanding of concepts that each item consists of four indicators such as explain phenomenon, define the concepts used in explain the phenomenon, give example another phenomenon which is based on the same concept and define the concepts used in the explanation of the phenomenon. Questions consist of 4 sets that given during the pre-test and post-test. Each of tests has been developed by researchers and validated by experts. The results showed during the pre-test of spring potential energy that highest number at level no response (NR) is 8 students, 14 students at levels not understanding (NU), 5 students at level of incorrect understanding (IU), 3 students at level of partial understanding (PU) and 10 students at level of sound understanding (SU), but after the learning process, the result of post-test shows the changes that the number of students at level of sound understanding (SU) is 32 students, 4 students at level of partial understanding (PU) and 4 students at level of not understanding (NU). The implementation of this learning is considered as effective in facilitate achievement of sound understanding (SU) included in middle criteria.

INTRODUCTION

Physics is one of the main science becomes important to be taught in schools to support the development of science and technology. According to Young & Freedman, Physics is an experimental science where physicists must observe natural phenomena to discover patterns and principles that connect the phenomenas that occur [1]. Physics is also one of the main branches of science were held in order to develop the ability to think analytically to solve the problems associated with the environment both qualitatively and quantitatively and to develop the skills and a confident attitude.

The goal of learning that is listed on the curriculum 2013 is learning must be able to improve and equalize between soft skills and hard skills of learners that includes aspects of attitudes, skills and knowledge. Based on the objectives drafted in curriculum 2013, so the learning must give opportunities and chance for students to construct knowledge in cognitive processes.

The purpose above also explained that students should be able to master the concept of physics. One of the cognitive abilities that must be owned by the students to be able to master the concept of physics is the ability to understand. Students are expected to understand the teaching materials properly and fully after participating in learning physics. Through a fully understanding of the concepts, principles and laws of physics so the students are able to apply it in a real life context and know the technology as applied from physics [2].

But fact in the field show different conditions from ideal conditions that should be achieved. Many students fail to understand the physics as a whole understanding and most of them only have partial understanding. Even, part of them have the wrong understanding. This conditions can be happen because they tend to memorize learning verbal and mathematical formulation in laws of physics [3]. The effect of this conditions is students not able to understand the whole concept can even run into misconceptions.

Results of a previous study conducted by researchers at one of senior high school in West Bandung regency associated with the level of students' understanding of the material Fluid Static shows that of the 15 students surveyed, they generally do not have the understanding as a whole (MSU), Level of understanding sound understanding (SU) only the highest 36,67% on Pascal's Law, the Law Arhimedes lowest at 8.33%. While the largest percentage level is no response (NR) amounted to 48.33% [4].

Research on the level of understanding on the college level is done by Saglam-Arslan and Devecioulu on the levels of understanding and models of understanding shows that students of physics education in regional Black Sea, Turkey have significant weaknesses and understand the basic knowledge of Newton's laws of motion. The college student of physics education has difficulty in explaining Newton's Law. This condition happens because of weakness of physics education students in physics concept of linking knowledge and experience with phenomenon of real life [5].

Referring to generalization of the above problems, it should be applied a conceptual nature of learning for senior high school students. Expected learning is learning physics that give emphasis in depth understanding of the inculcation's concept. Learning with inculcation's concept expected for students to have an understanding of the concept as a whole so as to increase the level of student understanding.

One of the main alternatives that can be emphasized learning is interactive conceptual learning. Interactive conceptual instruction (ICI) or translated as learning conceptual interactive is a lesson that has four characteristics such as conceptual focus, focusing on the classroom interactions, using teaching research-based materials, and use of texts. This was stated by Savinainen and Scott [6].

The first characteristic is conceptual focus. Interactive conceptual instruction approach gives a great attention to developing students' understanding of concepts before they begin to fix the quantitative problem. This component shows that the application of interactive conceptual instruction in learning should strengthen the concept of students at beginning of learning.

The second characteristic is classroom interaction. The classroom interaction is an interaction class that has the form of a discussion between students, collaborative interactions between teachers and students. With the existence of this kind of interaction and students get benefit because students can develop ideas to understand a concept that is being studied.

The third characteristic of ICI learning approach is research-based materials. This characteristic has a function to enhance the students' understanding of concepts and overcome the difficulties students in learning concepts by doing the exercises frequently asked questions conceptually developed by teachers to get feedback which showed growth in understanding the concept of students constantly.

The fourth characteristic of this approach is use of texts. During learning, students usually has its own busy to write some important notes or mark important parts of a text book. This activity is sometimes a barrier for students to understand the concepts being taught because students do not really participate in learning. However, students may be asked to read the textbook before attending lessons. The use of this traditional text can be replaced with use of text that can help to improve the understanding of the student's concept.

The reason why interactive conceptual learning is choosed because inspired by the research conducted by Rusdiana and Tayubi, Tayubi and Feranie, and Savinainen and Scott becomes empirical evidence that conceptual learning interactive was able to significantly increase the concept of students' understanding. The application of this study is expected to increase the concept of students' understanding so that understanding can be categorized in level of understanding [7], [8], [9].

To deepen and enrich the understanding of the concept, various other forms of representation in accordance with the characteristics of the concept, especially for some the phenomenon of physics concepts in daily life. So we need an approach that is able to assist in the inculcation's concept for students to represent concepts in different representations. The approach in question is multirepresentasi approach. Learning to use multirepresentasi is a learning approach that utilizes various representations such as verbal, pictorial, charts, graphs, mathematical, and interactive to support the planting of concepts and problem solving [10]. The mode of representation that are diverse in learning a particular concept provides considerable opportunities both in understanding the concepts and communicate them and how they work with the system and the process of a particular physics concept [11].

This approach will be integrated multi representation on the establishment and strengthening of the concept of learning interactive conceptual. At the inculcation's concept, students are given the opportunity to build their own understanding using multi representation. While in the strengthening of the concept, students must solve problems in varying contexts also use multirepresentasi. The use of multi representation in inculcation's concept

at the same time can help overcome misconceptions. This is because qualitative reasoning are emphasized in multi representation approach to establish a logical relationship between the scientific facts with conceptions of the students, thus favoring conceptual change [12].

Interactive conceptual instruction with multi representation approach assumed to be the right choice for use. Multi representation utilization will be very useful for trained students to communicate or represent a concept through diagrams, drawings, sketches and other forms of representation. The purpose of this study was to determine the effect of the application of conceptual learning multirepresentasi interactive approach to improve students' understanding on the material level of effort and energy.

EXPERIMENTAL

The method used in this study is experimental method. Experimental method have been selected with the purpose of research only want to see the impact of a treatment on the dependent variable, not a comparison to other treatment [13], [14]. The independent variable in this study is interactive conceptual instruction using multi representation approach, while the dependent variable in this study is level of understanding. The study design used is one group pretest-posttest design.

The study population was all students of class X in one of senior high school is located in Sumedang, West Java. Samples are 37 students who get a second semester of learning physics class in school year 2016/2017. The sampling technique that research using random sampling method. The research instrument used a test understanding of concepts that each item consists of four indicators such as explain phenomenon, define the concepts used in explain the phenomenon, give example another phenomenon which is based on the same concept and define the concepts used in the explanation of the phenomenon. Questions consist of 8 sets that given during the pre-test and post-test. Each of tests has been developed by researchers and validated by experts.

Instruments in this research are a set of conceptual test of subject matter of work and energy to evaluate student conceptions before and after learning, a set of ALPS (Active Learning Problem Sheet) with multi representation kits to observe understanding of concepts during the learning process and simulation media virtual. The interactive physics simulations used are kinetic dan potential energy, elastic potential energy in spring phenomena. Students are given 2 questions in the form of spring potential energy phenomena, 2 questions about the form of the phenomenon of mechanical energy (total potential and kinetic energy). The phenomenon is equipped with 4 questions such as: 1) Explain the image that rellevant with phenomenon, 2) The concept of physics that explains the phenomenon, 3) Provide examples of physics phenomena that also is based on the same concept, and 4) Defining the concept of using the other word.

Data analysis was performed by categorizing the answers to each question on each student both in the pre-test and post-test. Then calculate the percentage of the number of students for each levels of understanding so it can be seen an increase in the level of students' understanding of work and energy matter through an assessment rubric as shown in Table 1.

TABEL 1. Categories Used toDetermine Student Level of Understanding and Their Characteristics

Levels of understanding Category	Answer Criteria
[0] No Response (NR)	• Leaving blank • Answering “I don’t know” • Answering “I don’t understand”
[1] No Understanding (NU)	• Complete repetition • Irrelevant answer • Vague answer
[2] Incorrect Understanding (IU)	• Insesible information • Inccorect information
[3] Partial Understanding (PU)	• Answer that include only one aspect but not all aspects of a valid answer • Answers that include some aspects of a valid answer and some misunderstandings
[4] Sound Understanding (SU)	• Answers that include all aspects of a valid answer

The next step analysis is performed to determine the percentage of applied learning effectiveness in facilitating the inculcation’s concept, based on the percentage of the number of students who reach a level of understanding to fully comprehend category. Table 2 is the categories for the learning effectiveness in facilitating achievement of sound level of understanding.

TABEL 2. Categories for learning effectively to facilitate achievement of sound understanding levels.

The amount of students that achieve sound understanding (SU) levels (%)	Categories of learning effectiveness
> 75 %	High of learning effectiveness
50 % - 75 %	Middle of learning effectiveness
< 50 %	Low of learning effectiveness

RESULTS AND DISCUSSION

Based on the results of reseacrh, Table 3 below represents the average percentage of students' levels of understanding on the concept of spring potential energy and mechanical energy (kinetic and potential energy in total) at the time before implementation of interactive conceptual instruction with multi representation approach (pre-test).

TABLE 3. Levels of understanding on *pre-test* dan *post-test* Submatter elastic Potential Energy

Levels of understanding	The amount of students			
	Quest. 1		Quest. 4	
	Pre	Post	Pre	Post
[0] No Response (NR)	10	1	8	0
[1] No understanding (NU)	7	2	14	4
[2] Incorrect Understanding (IU)	5	1	5	0
[3] Partial Understanding (PU)	10	7	5	1
[4] Sound Understanding (SU)	5	26	8	32
The amount of students	37	37	37	37

Table 3 shows the results of the pre-test and post-test on each submatter elastic potential energy. Before students get implementation of interactive conceptual learning, students totally didn't understand about elastic potential energy submatter. This fact showed in table 3. Question 1 about pre and post test result. Pre-test result of this question is 27.02% students in no response (NR) level. Students who answered but didn't understand about concept is 18.9% at no understanding (NU) level. Students who answered question but misconception is 13.5 % at partial understanding (PU) level.

Students who do not answer at all, generally do not have the understanding of the problem to give the desired answer the question so they decide not to answer the question. Some students can not answer the question about the explanation of the process of throwing a toy bullet out of toy pistol until it pushed out of the gun. Student who are at no understanding (NU) level can't explain more about the physics phenomena in toy pistol. They have a relatively limited understanding such as explaining how to get a toy bullet out of the gun simply and wrongly in putting any energy contained in the process of launching a toy bullet. Students who understand some, generally only bring up one true concept that is the existence of spring energy that existed at the spring in a toy gun compressed while the kinetic energy contained at the time of the bullet out of the gun gun is not mentioned.

Post-test result show percentage increasing of sound understanding (SU) level. The percentage increase indicates an increase in the number of students who provide the complete and correct answer to the related question. The other side, post-test result show percentage decreasing of NR, NU, IU, and PU level. This result indicates decrease in the number of students who not answered, answered but misconception, answered but didn't understanding and partially answered.

Based on tabel 2 about categories for learning effectively to facilitate achievement of sound understanding levels, achievement learning effectiveness percentage based on the increase in amount of students on pre-test and post-test are categorized in medium category. While the difference in the percentage of the number of students is the lower contained in Question 1 which is a physics phenomenon of toy pistol is 19 (51.35%). On the results of the above table have been presented there is a reduction in the number of students at the level of no response (NR), no understanding (NU), incorrect understanding (IU) and partial understanding.

An significant increasing number of students contained in Question 4. The problem number 4 is part of the physics phenomena elastic potential energy of a slingshot. Increasing the number of students in Question 4 to the level of sound understanding (SU) is 64.86%. achievement learning effectiveness percentage based on the increase in amount of students on pre-test and post-test are categorized in medium category. These results indicate that there are significant interactive conceptual instruction implementation using multi representation approach to improve students level's understanding on work and energy subject matter.

The test results on the concept of mechanical energy are presented in Table 4. The increase in the number of students can we see in question number 2 and 3. Pre-test result showed that most of students have no understanding (NU) level in pole vaulting athletes phenomenon. In question number 2, pre-test result is 12 students (21.43%). Most of them give vague answer to explain a physical phenomenon on pole vaulting athletes. Some of them give blank answer or answering "i don't know". Students who answered but didn't understand

about concept is 32.4% at no understanding (NU) level. Students who answered question but misconception is 10.8 % at partial understanding (PU) level.

TABLE 4. Levels of understanding on *pre-test* dan *post-test* Submatter mechanical energy

Level Pemahaman	The amount of students			
	Quest. 2		Quest. 3	
	Pre	Post	Pre	Post
[0] No Response (NR)	10	1	7	0
[1] No understanding (NU)	12	2	8	1
[2] Incorrect Understanding (IU)	4	1	5	0
[3] Partial Understanding (PU)	5	7	7	4
[4] Sound Understanding (SU)	9	26	10	32
The amount of students	37	37	37	37

Some students can not answer question about how a skateboarder can cross a curved skateboard path without falling over. Some students understand that there is a mechanical energy conservation that there is a skateboarder but does not explain in full how value of kinetic energy and potential energy on skateboarder as it crosses curved skateboard path.

Post-test result show percentage increasing of sound understanding (SU) level. The percentage increase indicates an increase in the number of students who provide the complete and correct answer to the related question. The other side, post-test result show percentage decreasing of NR, NU, IU, and PU level. This result indicates decrease in the number of students who not answered, answered but misconception, answered but didn't understanding and partially answered.

That question which is part of the mechanical energy of the physics phenomena and the swing motion of the roller coaster. Increasing the amount of students in the question number 3 to level of sound understanding is 22 (59.46%). Based on tabel 2 about categories for learning effectively to facilitate achievement of sound understanding levels, achievement percentage based on the increase of pre-test and post-test. Learning effectiveness are categorized in medium category. While the difference in the percentage of the number of students who lower contained in question 4 which is a physics phenomena of skateboarding is 45.94%. So, learning effectiveness are categorized in medium category too.

From the results of the effectiveness of the application of learning that has been gained, along with the research that has been done by previous researchers that Rusdiana and Tayubi who has conducted research on an improved understanding of the concepts of physics through interactive conceptual learning approach. Results obtained from this study indicate that based on comparison of gain's value and quantity of student control group and experimental experience of misconceptions on any concept of physics tested, learning approaches conceptual interactively can significantly improve the understanding of physics concepts among high school students compared to traditional instructional approaches.

Student's levels of understanding of work and energy showed significant weaknesses in fundamental knowledge, particularly in providing scientific explanations. This result consistent with previous research focusing on concept understanding in work and energy of students's senior high school is low [15]. This lack of understanding can be attributed to inability of students to relate scientific knowledge with real life phenomena and experience [16]. It suggests that the lack of real life examples in curricula experienced by students could be a significant factor contributing to their lack of understanding.

Understanding concept is emphasized by using the application of learning characteristic of ICI aided empirically multi representation approach proven to increase significantly. Other studies on the implication of interactive conceptual instruction multi representation approach to improve the scientific consistency and reducing the quantity of student's misconceptions in thermodynamics matter that has been done by syakti (2015) showed that the students' scientific consistency experienced an average increase was 39%, while the quantity of the misconceptions students experienced an average decline varied in the range of 7% to 92% [15]. Decrease misconceptions and increase the scientific consistency is one of main indicators that increases student understanding of concepts.

The effectivity of this learning implementation for elastic potential energy show result achievement percentages based on an increased number of students as sound understanding (SU) is 24 students (64.86%). That result were categorized in the effectiveness of learning is medium category. The effectivity of the mechanical energy of the swing motion of the roller coaster at the level of understanding of the sound understanding (SU) is 22 students (59.46%). That result were categorized in the effectiveness of learning is medium category. This result consistent with other studies about implementation of ICI to increase work and energy concept understanding. The results showed the instruction on improving conceptual understanding is

1.72. The effect category for improving conceptual understanding with interactive conceptual instruction is high category [15].

The results above show role of conceptual interactive learning using multi representation approach in raising the level of student understanding in the matter of work and energy. On the implication of the learning process of interactive conceptual instruction with multi representation approach, students are given a demonstration that shows the physics indication of phenomena of work and energy, but it is not able to show how massive the physical quantities associated phenomena interact to appear physical symptoms as observed.

For example, the demonstration can only show about phenomena of motion roller coaster from when released from a certain height so that it can pass through the roller coaster track until it reaches the end of the track. In using the demonstration, the students would not be able to know the value of potential and kinetic energy in each movement of the roller coaster. To overcome the weakness, researchers can use the media in the form Phet simulation in which there are representations of concepts in various forms of graphs, diagrams, verbal and mathematical. In addition, through the media in the form Phet simulation cholorado facilitate students to see firsthand the movement of objects, the object energy bar charts as well as the value of speed, altitude on the object.

CONCLUSION

Based on the above results, it can be concluded that level of understanding of matter work and energy after implementation interactive conceptual learning with multi representation approach show varying results with the highest percentage at MSU level in the elastic potential energy concepts about physical phenomena of a toy pistol. Achievement percentages based on an increased number of students as sound understanding (SU) is 24 students (64.86%) were categorized in the effectiveness of learning is medium category. As for the physical phenomena and the mechanical energy of the swing motion of the roller coaster at the level of understanding of the sound understanding (SU) is 22 students (59.46%). Achievement percentage based on the increase amount of students based on pre-test and post-test effectiveness learning are categorized in medium category.

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