

EFFECTIVENESS OF CONCEPT ATTAINMENT MODEL BASED ON MULTIPLE REPRESENTATION TO CONCEPTUAL UNDERSTANDING AND SCIENTIFIC CONSISTENCY OF STUDENT ON WORK AND ENERGY TOPIC

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Abstract

The physics learning systems in most schools are too oriented in mathematical problems solving, this condition make students are weak in conceptual understanding and solved problems which is present in graph, tables, or verbal representation. Thats why the aims of this research was to describe the effectiveness of concept attainment model based on multiple representation for conceptual understanding and scientific consistency of the students. The design of this research is one group pre-test post-test design with two classes of replication. Conceptual understanding and scientific consistency was measured by multiple choiche test based on multiple representation, where there is six indicator and in each indicator were present in three problems with verbal, graph, and mathematics representation. The result of Z test shown that conceptual understanding of experiment, 1st replication, and 2nd replication classes are more than the minimum evaluation score (KKM) which is more than 65. The result of normalized gain analyze show that there is an increase in moderate category both in experiment or replication class. Based on scientific consistency analyse, there is an increase on moderate category of scientific consistency, with the score gain of experiment is 0,60 , 1st replication is 0,56 , and also 2nd replication is 0,57. In the other hand there was a good respons from the student to the learning process, shown by the percentage of the students response questionere which have 77% percentage in strong category. So there is a conclusion that the concept attainment model based on multiple representation was effective for conceptual understanding and scientific consistency of the students. Beside of that from this research we also found that there is a dependency of conceptual understanding and scientific consistency of the students.

Keywords :Concept Attainment, Multiple Representation, Conceptual Understanding, Scientific Concistency

INTRODUCTION

Physics as one of the subjects held in order to develop analytical thinking ability to solve both qualitative and quantitative problems that exist around us. This is in accordance with Ministerial Regulation No. 22 Th.2016 stating that the aimed of learning Physics at school has to make students are able to master the concepts and principles of physics and have the skills to develop knowledge, as well as confidence as a provision to continue education at a higher level. In line with the Sanjaya (2006) opinion which states that the learning process, especially physics must refer to students' thinking skills and conceptual understanding.

Work and Energi topic are one of any kind physics Topics that have many concepts and related to daily life. Work and energy concepts are also fundamental concepts in science, and related to the diverse physical phenomena in everyday experience. Considering the importance of work and energy concepts in the development of other concepts then the students must have a fairly good conceptual understanding in mastering work and energy concepts.

In the other hand students are still having difficulty to master the concept of work and energy. According to

Arslan and Kurnaz (2014), the students' difficulties in understanding the work and energy concepts due to the work and energy concept are abstract. This evidenced by the study of document analysis of the national examination result (UNAS) 2013 which shows that theconceptual understanding in determining one of work and energy scale is still low, that was 50.18 out of 100 (Balitbang, 2015).

Based on preliminary study conducted in SMA Dharma Wanita Surabaya, The learning activity are too oriented to solve the problem exercises contained in textbooks. As a result 94% of students agree that the Physics lesson is a lesson to memorize the formula. In addition, 27 out of 35 students agree that it is rare to find the questions which present in graphical representations or tables. When the students is tested with multiple representation test shown that 80% of students are choose the wrong answer in the graph representation problems .

Based on TIMSS 2011 shows Indonesia have ranks 40 out of 42 countries. In addition, the TIMSS problem is presented in various representations. This is because Indonesian students are weak in the ability to integrate information, draw conclusions, and generalize their knowledge to other things (Rahmawati, 2016). Based on

it, it can be concluded that the students are weak in working on the questions presented in the form of multiple representation.

The multi-representation capabilities of the students show a stronger, solid conceptual understanding. According to Duffreness, et.al (1997), Representation is a configuration (form or arrangement) that can describe, represent or represent something in a way. Multi representation is defined as a way to present various representations to embed a concept in the minds of students.

The Things that can distinguish a concept with another concept are the critical attributes. Conceptual understanding can not be separated from deductive and inductive thinking strategy. Inductive learning strategies are preferred because the achievement of concepts is based on grouping of things from those specific characteristic to general. So to that why concept attainment model is the best way learn conceptual understanding. This is in line with Arends (2012) which states that the learning concept of attainment is learning by classifying an object simply and form a category of the object.

Trianto (2010) state that learning effectiveness is a scale associated with rate of learning process, while the criteria of effective learning are:

1. Completeness of learning learning. If 75% of the students have scored 60.
2. The learning model is effective if it shows a significant difference between conceptual understanding after and before learning.
3. Learning model is said to be effective if it can increase student interest and motivation

The criteria of effectiveness criteria in this study are more addjusted to the learning instructional objectives. The effectiveness of learning criteria in this research are:

1. Learning process is effective while clasically student achieve minimum score of evaluation (KKM) that is 65.
2. Learning process is effective when there is an signifikan increase in conceptual understanding and scientific consistency after learing process.
3. Learning prosses is effective when there is a good respon from the students. Shown by the good category on students feedback.

Learning using concept attainment model based on multiple representation is a learning process that presents example and non examples of the concept by various type of representation. so that students are able to determine the critical attributes of the concept being studied. Therefore, it is hoped that concept attainment based on multi representationis good for conceptual understanding and scientific consistency of the students.

Concept attainment model based on multiple representation is design to develop the ability of learners t describes the properties of a category already formed and comparing with the categorize of non example group.

Multi representation is the way to re-representation of the same concept with different formats, including verbally, graphically, graphically, and mathematically (Ainsworth, 2007). Multi representation is defined as a way of presenting various representations to deliver a concept in the mind of the student. In accordance with the definition of representation itself is a configuration (form or arrangement) that can describe, represent or represent something in a way (Rosengrant, et al., 2007).

According Dahar (2011), Conceptual understanding is the ability in understanding the scientific meaning both theory and its application in daily life. In line with anderson, et.al (2001) conceptual understanding is the ability to capture the notions such as being able to reveal a material presented into a form that is more comprehensible, able to provide interpretation and able to apply it. it can be concluded conceptual understanding is the ability of students in understanding the meaning of learning and able to apply in solving problems in everyday life.

Pinar, et.al (2016) stating that scientific consistency is the consistency of students in answering questions correctly scientifically. So it can be concluded that scientific consistency is the consistency of students in answering questions and see the truth of the answer in the sense that the concept must be true.

Based on research conducted by Sari, et al (2015) entitled "The use of Multi representation to improve the conceptual understanding of high school student in Newton II law topic" from that research is know that Multi Representation learning approach increase conceptual understanding of the students. On the other hand Septianingrum research (2013) entitled "Application of interactive learning in concept achievement model to improve student learning outcomes on work and energy topic." The results of these studies can improve student learning outcomes. Supported research conducted by Kurnaz & Arslan (2014) entitled "Effectiveness of Multiple Representation for Learning Energy Concept". The result multi-representation is effective in learning work and energy topic. In addition, Nieminen's research, et al., (2010) entitled "F-RCI Multiple-choice test for Investigating students representational consistency." The results of the R-FCI test were able to evaluate the consistency of representation.

Based on the explanation, the problem of this research is how the conceptual understanding, scientific consistency, student response after learning process of concept attainment based on multi representation in work

and energy topic in class X SMA Dharma Wanita Surabaya?, and how the effectiveness of concept attainment model based on multiple representation on work and energi topic in class X SMA Dharma Wanita Surabaya?

Based on that problem then the purpose of this study is to describe the conceptual understanding, scientific consistency, and student response after the learning process of concept attainment based on the multi representation on work and energy topic in class X SMA Dharma Wanita Surabaya?. And describe the effectiveness of concept attainment model based on multi-representation on work and energy topic in class X SMA Dharma Wanita Surabaya?

From this research, the researcher hopes this research can be useful as a reference to choose effective learning model to be applied in school according to subject matter taught and students can play an active role during learning and able to build their own concept.

METHODOLOGY

This type of research is pre-experimental with one group pre test post test design with two class of replication. The subjects of this research were experimental class, 1st replication class, and 2nd replication class. This research was conducted in SMA Dharma Wanita Surabaya, on the even semester of the academic year 2016/2017 from January to June 2017.

Initially all students, both experimental and replication classes were given pre test. Then both the experimental class and the replication classes are given the same treatment of concept attainment model based on multi-representation learning. After the learning at the end of the study is given a post test. To determine whether the sample used has been representative of the population then tested the normality and homogeneity in the student's pre test score. After the data tested is normal and homogeneous then the data must be tested by hypothesis test. In this study there are two types of data, the first data that is the conceptual understanding of the students and the second data is the data of scientific consistency of students. The question of post test and pre test is the same problem that is based on multi representation. This problem consists of seven indicators that in each indicator represents the concept of the work and energy. So the concepts tested are about the concept of work, kinetic energy, potential energy, relations between work and kinetic energy, relationships between work and potential energy, energy conservation laws, and power. Each of these indicators is expanded into three questions with different representations such as verbal, mathematical, and diagrams / table representations.

The first hypothesis test for student conceptual understanding data is Z test, this test is used to see statistically the score of students classically meet the specified minimum score of evaluation (KKM). Continued with paired sample t test, the t-test is used to see if there are significant differences in conceptual understanding of students before and after learning. After the t-test is done to determine the value of the increase difference using a normalized gain analysis. Followed by an analysis of one-way variance (anava) to determine the gain consistency of conceptual understanding of the students.

The second hypothesis test was performed on students' scientific consistency data, the scientific consistency value data was initially tested using t-test to know whether there were significant differences before and after learning. Then the data is tested using gain analysis, this analysis is used to find out how much improvement of scientific consistency of student after treatment. To determine the same effect on each class of learning impact, one-way variant analysis was used.

To determine whether there is a relationship between conceptual understanding and scientific consistency is used by chi square test. During the learning process, the teacher is observed by two observers who aim to see the appropriateness between the learning process and the lesson plan. At the end of the meeting given a questionnaire of student responses, this questionnaire aims to see students' responses to concept attainment model based on multi-representation.

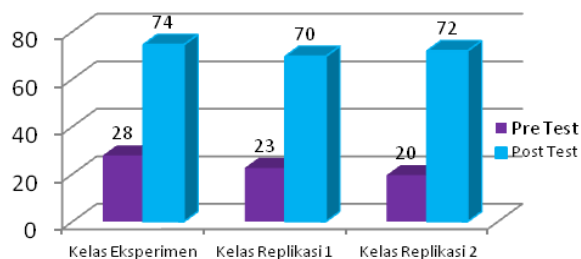
RESULT AND DISCUSSION

In this research there is two variable respon there was conceptual understanding and scintific consistency. Data obtained at the beginning of the study is pre test data in that divided into two conceptual understanding and scientific consintensy. While the data obtained at the end of the study is the post test scores there was conceptual understanding and the scientific consistency of the students, the implementation of learning, and the student's response to the concept attainment model based on multiple representation on work and energy topic.

Based on normality test to conceptual understanding score show that both the experimental, 1st replication, and 2nd replication classes are obtained that the entire concept mastery sample comes from a normally distributed population. Next, the data was tested by homoginity test from that test known that all the sample are homogenous.

The scientific consistency data is also tested using normality and homogenous test. From normality test is know thatt all of the sample are normally distriuted. And from hmogeneity test is know that all of the sample are homogenous.

The average pre test and post test scores of conceptual understanding from experimental class, 1st replication class, 2nd and replication class are presented in Graph 1.



Graph 1. The average score of conceptual understanding

Based on student pre test it is found that the student's score varies from the smallest 5 to the biggest 58 with the average 29 according to Graph 1, based on the result of this test it is found that no one of the students reach the criteria of minimum score evaluation (KKM) that is 65. After the concept attainment based on multi representation learning process oconceptual understanding of students changed ranged from 53 to 91. For the experiment class there are 32 students who reach the minimum completeness criteria, while for the replication class 1 the number of students reaching KKM is 25, on the other side for the replication class 2 there are 28 students who reach KKM.

The Z test is used to determine whether the conceptual understanding classically met minimum Criteria of Completeness (KKM) that has been determined.

After analyzed using the z test it is found that classically either experimental class and replication have classically reached the minimum predefined criteria that have been determined.

The next is used is paired t-test this test is used to know wether there is differences between pre test and post test score. From test it was found that both the experimental, the 1st replication, and 2nd replication class indicate that $t_{hitung} \geq t_{table}$ so that it can be concluded that there is a significant difference between conceptual understanding of students before and after concept attainment based on multiple representation.

To know the increase score then n-gain analysis is used to see how much improvement the conceptual understanding of students after learning.

Table 2 the result of n-gain analysis

Kelas	n-gain	Kategori
Eksperimen	0,64	Sedang
Replikasi 1	0,60	Sedang
Replikasi 2	0,64	Sedang

Based on Table 2 it is found that there is an increase in conceptual understanding of students' after learning process. although all three classes have different n-gain values but all three in one category.

Furthermore, anava test tested the consistency of the improvement of students' conceptual understanding in the three classes after applied concept attainment based on multi-representation. Based on the calculations obtained concept attainment learning based on consistent multi-representation to increase conceptual understanding of students.

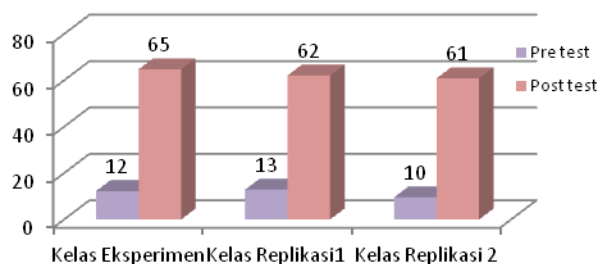
The achievement of the students' conceptual understanding proves that concept attainment based on multiple representation enables students to master work and energy concepts. This is supported by students' response after learning, 79% of students stated that multi-representation concept-based learning attainment makes students easier to understand the material of Physics, especially business work and energy. Easier way students understand the material business and energy because the material work and energy that is abstract can be represented into visual, verbal, and mathematical form that is more easily understood by students so that students better understand.

The ease is due to multi-representation concept-based attainment learning to create abstract concepts that can be visualized and represented in various representations. This is in line with Melter's opinion in Sutopo (2016) which states that multi-representation has a good impact when used in learning a particular concept because it provides a good opportunity to understand the concept and communicate it. Similarly, Arends (2012) which states that visual depiction and graphics are able to help students determine what is important about the critical attributes of the concept and make the concept look more concrete for students.

Kurnaz and Aslan (2013) argue that multi-representation learning is suitable for learning on work and energy subjects, because it is capable of providing meaningful learning so that students are able to more quickly understand the material being studied. The same thing is expressed by Ainswort (2010) which states that multi representation can encourage students to understand the concept of Physics. On the other hand the process of exchanging thoughts runs well so as to trill the ability of high-order students. In accordance with the opinion of Arends (2012) which states that with learning concept model attainment able train students' thinking skills, although basically every human being is able to automatically think but not everyone is an effective thinker. that why concept attainment model is able to train students to become an effective thinker, critical, and creative.

The average pre test and post test categories of students' scientific consistency are shown in Graph 2. Over 21 questions presented consist of 7 pieces of indicator problems, each indicator of the problem consists

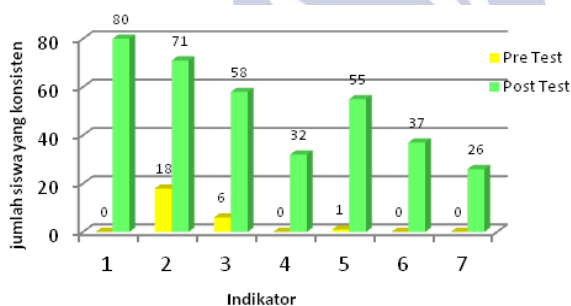
of three questions. Scoring techniques using multi-representation scaling techniques, as contained in the journal "Relations between representational consistency, conceptual understanding of the force concept, and scientific reasoning".



Graph 2 The average score of scientific consistency

From Graph 2 is know that there is increase in scientific consistency of the students after learning process.

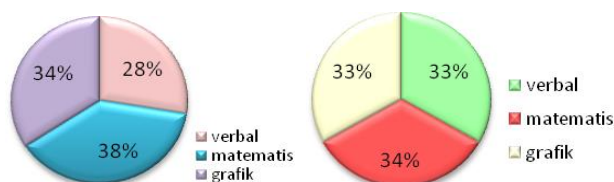
The indicator presented represents every sub-topic contained in business material and energy. The sub-subjects are business, potential energy, business relationships with potential energy, kinetic energy, business relations and kinetic energy, energy conservation laws, and power.



Graph 3 increasing of each sub-topic

Improvement occurs because in the post test most students are only able to answer the problem on mathematical representation only and not able to answer on other representations. However after learning the students have been able to use other representations in problem solving

There is a significant difference between the number of answers in mathematical representation and verbal or graphic representation, the student's tendency is better in mathematical and weak settlement in verbal and graphical representation. The total diffusion of student representation abilities is shown in Graph 4.



Graph 4 representational profile of pre test and post test

Profiles of student representation on pre test and post test have difference in pre test students tend to be able to do the problems in mathematical representation but very weak in verbal representation. This is because the learning patterns that students can use in studying physics is based examples of problems that are discussed in the classroom and then students do the same thing.

After learning there is a student improvement either on graphical representation, mathematically, or verbally. On the other hand the percentage of the distribution of the correct number of students answered from the three representations is presented in Graph 3. On the graph it is seen that the spread of students who are able to answer correctly on the three representations presented equally.

After the paired t-test, there was a difference of scientific consistency between the students before and after the learning process. The multi-representation concept-based learning attainment can improve students' scientific consistency as indicated by the increase of gain in medium category for both experimental and replication classes as shown in Table 3.

Tabel 3 The result of n-gain

Kelas	n-gain	Kategori
Eksperimen	0,60	Sedang
Replikasi 1	0,56	Sedang
Replikasi 2	0,57	Sedang

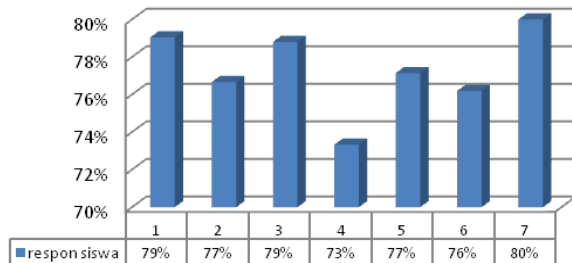
The increase is because students on student learning process embedded the use of multiple representations so that students are accustomed to using different representations. The statement is in accordance with the opinion Kohl (2007) which states that the ability of student representation is influenced by the learning done in the classroom. Classroom learning is able to make students recognize multi representation, but lack of home exercise is the reason why students' scientific consistency does not reach their maximum value. On the other hand with the parties in accordance with multi-representation-based learning can improve the weak student's ability on one of the representations through other representations, and hence the ability of good representation. This is in accordance with the opinion of Ainsworth (2006) which states that through multi-representation is able to complement other representations.

After the one-way anova test to see the consistency of the impact of learning, it was found that multi-representation concept-based learning attachments had a consistent impact on the mastery of student concepts. Overall, it was found that learning attainment concept had a positive impact on students' concept mastery.

This is in accordance with the opinion of Arends (2012) which states the learning of concept attainment with assisted drawings or graphs ease in the learning process. This is also supported by the theory of cognitive

learning by Jerome Brunner (1966) which states that for children at the formal operational stage (11-15 years) began to learn abstract symbols although still using the iconic model. This proves by multi representation in concept learning able to make students more understanding about learned concept.

The students response to learning is shown as graph 5.



Graph 5 percentage result students response

Keterangan

- 1 : interesting and non-boring learning
- 2 : keep students active
- 3 : make students more easily understand the material
- 4 : make it easier for students to complete the task from the teacher
- 5 : make students dare to express an opinion
- 6 : make students better understand the concept

Interesting and not boring learning has a percentage of 79% this is because during the learning took place students feel the new learning atmosphere and new learning patterns is the multi-representation concept based learning attainment. With multi-representation concept-based learning attainment able to train students thinking skill and inductive thinking ability. When given an example the student will think and analyze the critical attributes of the concept. While the lowest student response is about learning to make students more easily complete the task that is equal to 73%. The low response of students in this aspect due to the lack of time to discuss the problem together due to limitations.

Based on the above description on the average return of the total percentage obtained and the percentage results show the student's response to the overall well this is indicated by the average percentage of 77%. So it can be concluded that concept attainment based multiple representation learning has good response in very strong category.

The criteria of the effectiveness of learning based on the mastery of students' concepts in a classical way to achieve the KKM that is determined, both the mastery of the concept and the scientific consistency of students increased significantly and the third student response to good learning.

Based on the result of research, it is found that firstly, through Z test classically mastery of student concept reaching KKM determined that is 65. Secondly there is improvement of mastery concept of student equal to, for experiment class 0,64 with medium category, for class of

replication 1 equal to 0,60 in the medium category, and 0.64 with the medium category for replication class 2. On the other hand the scientific consistency aspect also experienced an increase in the gain category being both experimental class and replication class 1 and replication 2. Results of student response after the average found that 77% or in the strong category.

The above exposure shows the effective learning criteria can be achieved, so that it can be concluded the learning of conceptual attainment based on effective multi representation to the mastery of the concept and the scientific consistency of the students on business material and energy.

On the other hand there are findings in this study students who have good conceptual understanding tend to have a good scientific consistency, this is evidenced by the independence test. Based on the independence test obtained there is a correlation between the mastery of the concept and the scientific consistency of the students, but it is not known how big the correlation of both. So it takes further research to know the correlation between mastery of concepts and students' scientific consistency.

CLOSURE

Conclusion

Based on analysis and discussion described above, the conclusion of this research is:

1. Conceptual understanding of the students after learning both for experimental, 1st replication, and 2nd replication class classically able to reach criterion minimum evaluation (KKM). There is increasing of n-gain score with medium category, with details for experiment class the gain is 0,64 , for 1st replication class the gain is 0.60, and for 2nd replication class with gain score of 0.64.
2. There was an increase in scientific consistency of the students in moderate category of n-gain. He details is 0,60 for experiment class, 0,56 for 1st replication, 0,57 for 2nd replication.
3. There is a good response from the students, shown by the average percentage result of student questionnaire responses with strong categories.
4. In terms of the results conceptual understanding of students, increasing the value of mastery of concepts and scientific consistency, and student response learning concept attainment model based multi representation effective for conceptual understanding and scientific consistency of students on work and energy topic.

Suggestion

From this research researcher hoping that there is further research in this field. Here some suggestion for better research

1. This learning model focuses on students' inductive thinking patterns, therefore this learning model is less suitable for laboratory-based activities.
2. To make students really scientifically consistent it is necessary to do additional tasks or additional exercises to elicit student representation skills.
3. Need further research to know the correlation between the mastery of concepts and scientific consistency. It should be continued research first to know the relationship of multiple intelligence with multi representation ability of students.

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