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The effectiveness of physics learning tools based on discovery model with cognitive conflict approach toward student's conceptual mastery

The effectiveness of physics learning tools based on discovery model with cognitive conflict approach toward student's conceptual mastery

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Abstract. The Discovery learning model with the conflict cognitive approach is a teaching model designed to help students develop thinking skills by involving contradictory problems. The combination of the learning model with this approach means that the stages of the discovery learning model are combined with the learning stages of the cognitive conflict approach. This study aims to measure the effectiveness of discovery model learning tools with a cognitive conflict approach to students' mastery of concepts. The research was a quasi-experiment with one group pretest and posttest. The population of the study was the students of class 10th grade high school in the city of Mataram with a sample of 65 students. Data collection using the test method. The test instrument used was a mastery of the concept in the form of 25 multiple-choice questions. The data collected were analyzed using the N-Gain score. The results showed that the use of discovery model physics learning tools with the cognitive conflict approach was effective to improve students' conceptual mastery. The highest increase in concept mastery is in the sub-material of business with the highest cognitive level, namely remembering and understanding.

1. Introduction

Physics learning is learning related to abstract concepts. Physics learning is not only to master several abstract concepts as a product of physics, but also must provide sufficient space for the development of scientific attitudes, and the application of physics in everyday life [1]. Physics learning is part of the science subject which reflects the competence of scientific attitudes, scientific thinking, and scientific work [2]. Physics learning is taught so that students have the knowledge to solve problems and can master concepts. Physics learning is learning related to abstract concepts. Physics learning is not only to master several abstract concepts as a product of physics, but also must provide sufficient space for the development of scientific attitudes, and the application of physics in everyday life [1]. Physics learning is part of the science subject which reflects the competence of scientific attitudes, scientific thinking, and scientific work [2]. Physics learning is taught so that students have the knowledge to solve problems and can master concepts.

According to Hosler & Arends [3], concept mastery is a thought process carried out by individuals to truly understand an object or event. Mastery of concepts is not just understanding in simple terms,

but can also be described as the cognitive abilities of students which include the ability to understand, understand, apply, classify, generalize, synthesize, and conclude objects. Mastering the concept is the most important part of learning physics [4]. Sugiana et al. [5] argued that mastery of physics concepts is one aspect of measuring student learning outcomes obtained to realize learning.

So far, it seems that physics learning in schools emphasizes physics as a product rather than physics as an attitude and process. This causes students to not master the concepts being taught. Gunawan et al. [6] stated that students had not yet obtained optimal concept mastery results. This was also reinforced by Nisrina et al. [7] who stated that the students' mastery of concepts was still low. The students' low mastery of concepts is due to several factors one of which is innovation in learning, especially the use of learning tools. Suranti et al. [8] stated that teachers as facilitators must be able to innovate in learning to make it easier for students to visualize abstract physics concepts. One of the learning innovations that can be used is discovery model-based learning with a cognitive conflict approach.

The Discovery learning model with the conflict cognitive approach is a teaching model designed to help students develop thinking skills by involving contradictory problems. Through the discovery learning model, students can prove the hypothesis independen[17] [9] and play an active role in building their initial knowledge [10]. Discovery learning begins with stimulation by the teacher related to the physics concepts to be studied [11]. The application of this learning model will provide direct experience to students so that the learning process becomes more meaningful [12]. Several studies conclude that the use of discovery learning models has a positive impact on increasing students' mastery of concepts [13, 14, & 15].

The use of cognitive conflict approaches in learning also has a positive impact on increasing students' mastery of concepts. The cognitive conflict approach has been widely applied in science learning [16]. The cognitive conflict approach is part of a psychological theory of conceptual change that helps students reconstruct their knowledge [17]. Through the cognitive conflict approach, learning occurs when students recognize needs and become dissatisfied with existing conceptions [18]. Several studies indicate that the cognitive conflict approach has a positive impact on learning. Kang et al. [19]; Samsudin et al. [20]; and Mufit et al. [21] indicated that the cognitive conflict approach had a positive impact on increasing students' conceptual mastery.

The combination of the discovery learning model with the conflict cognitive approach means that the stages of the discovery learning model will be combined with the learning stages of the conflict cognitive approach. The stages of the discovery model with the cognitive conflict approach are contained in the physics learning device used. Discovery-based physics learning tools with a cognitive conflict approach used consisted of a syllabus, lesson plans, student worksheets, handouts, and evaluation instruments. Based on this description, the use of discovery model learning tools with a cognitive conflict approach is expected to be effective in increasing students' mastery of concepts.

2. Research Method

This research is part of research and development. At the stage of developmental testing using a quasi-experiment with one group pre-test and post-test. The study population was students of class 10th grade high school in the city of Mataram with a research sample of 65 students. The sampling technique used purposive sampling. The sample was given a preliminary test, then taught using a discovery model of physics learning tools with a previously revised cognitive conflict approach. Learning carried out offline and online. Data collection using the test method. The test instrument used was mastery of the concept in the form of 25 multiple-choice questions. The data collected were analysed using the N-Gain score to determine the increase in students' mastery of concepts.

3. Results and Discussion

This study aims to measure the effectiveness of discovery model learning tools with a cognitive conflict approach to students' mastery of concepts. Concept mastery is the student's ability to remember, understand, apply, analyse, evaluate, and create on work and energy material after being taught using physics learning tools based on discovery models with a cognitive conflict approach. Students 'mastery

of concepts can be seen from the results of the students' initial and final tests. The results of the students' initial and final tests are shown in Figure 1 below.

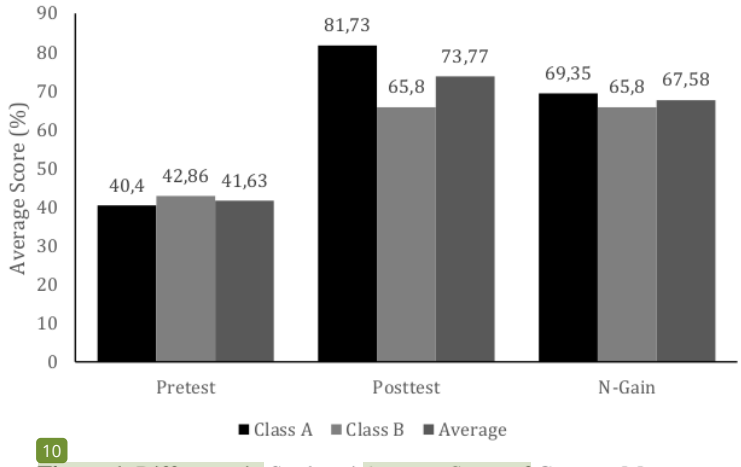

Figure 1. Difference in Students' Average Score of Concept Mastery

Figure 1 shows that the results of the students' pre-test and final test of concept mastery differ. The final test result is higher than the initial test result. This shows that there is an increase in students' mastery of concepts. The increase in students' mastery of concepts can also be seen from the N-Gain score. The average N-Gain score of the two classes is in the medium category where the average N-Gain of the two classes is 67.58%.

The increase in concept mastery occurs because of the application of discovery model physics learning tools with a cognitive conflict approach. Learning using discovery models with a cognitive conflict approach helps students find and find their contradiction problems that are being studied. This finding is reinforced by the results of research conducted by Hendrik & Minarni [22] which showed that there was an effect of the application of the discovery learning model on students' conceptual mastery. Anisa [23] also showed that discovery learning was effective in improving students' mastery of concepts with very high criteria. The results of Larasafitri's research [24] also showed that the cognitive conflict approach influenced students' mastery of physics concepts. The increase in mastery of this concept is still not high. This is because during learning there are several obstacles faced. One of them is that at several meetings, especially in class B, research was carried out during the COVID-19 pandemic, namely social distancing. At this time learning was carried out online. Learning tools that should be implemented offline cannot be implemented. This causes difficulty in controlling students to carry out learning activities.

The results of the concept mastery test were also analysed based on the sub-material. The business and energy material taught has four sub-materials including effort, energy, business relations & energy changes, and the law of conservation of mechanical energy. The increase in concept mastery in each of the two classes is presented in Figure 2 below.

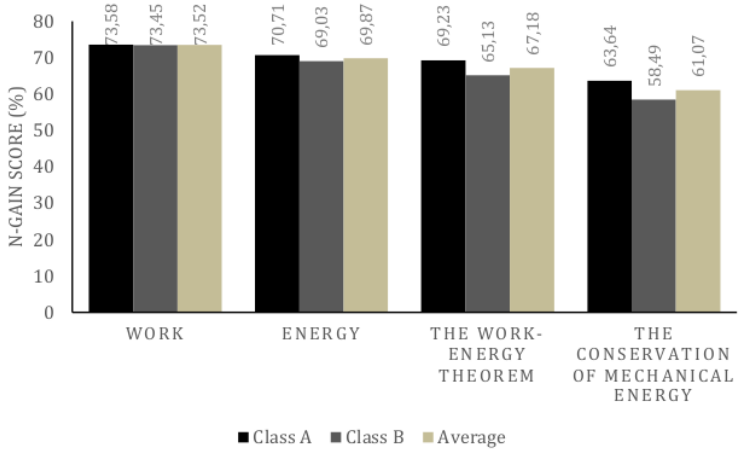

Figure 2. The Difference in Average Score of Concept Mastery of Each Sub Material

Based on Figure 2, there is a difference in the average N-gain score of the concept mastery of each sub-material. The highest increase occurred in the business sub-material by 73.52%, while the lowest average score was in the mechanical energy conservation law sub-material by 61.07%. In general, the increase in students' mastery of concepts in each sub-material is in the medium-high category. The increase in the average value of conceptual mastery of each sub-material was due to the availability of visualization of the concept of each sub-material in the form of student worksheets and handouts that were presented during the lesson. Student worksheets 01 and material 01 present sub-material about business, student worksheet 02, and material 02 present sub-material on energy, student worksheet 03, and material 03 present sub-material on the law of energy conservation. In student worksheets and handouts, students can easily master each sub-material. This is because the student worksheets and handouts present material descriptions, sample questions, and practice questions based on the discussion model with a cognitive conflict approach that facilitates students to be able to train and master each of these sub-materials. The results of this study are reinforced by research conducted by Gunawan et al. [25] which states that the use of discovery-based learning tools with a cognitive conflict approach is effective in improving conceptual mastery of each sub-material. Ceriasari [26] also stated that discovery learning-based student worksheets had very high effectiveness as indicated by the students' mastery of concepts.

The students' conceptual mastery data were also analysed based on cognitive aspects. The cognitive app used is based on the revised Bloom's taxonomic level, namely remembering (C1), understanding (C2), applying (C3), analysing (C4), evaluating (C5), creating (C6). The data from the analysis of the students' concept mastery in each cognitive aspect is presented in Figure 3 below.

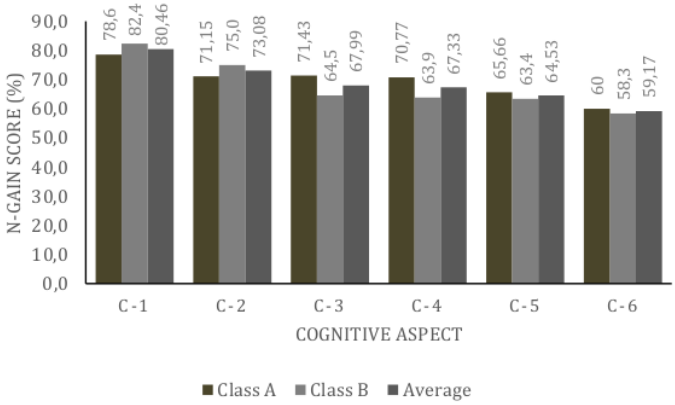

Figure 3. The difference in Average Score of Concept Mastery for Each Cognitive Aspect

Based on Figure 3, there is a difference in the N-gain average score of the conceptual mastery of each cognitive aspect. The highest increase was in the cognitive aspect of remembering (C1) of 80.46%, while the lowest was in the cognitive aspect of creating (C6) of 59.17%. In general, the increase in students' concept mastery in every cognitive aspect is in the medium-high category. In aspects C-1 to C-6, there is no significant difference related to the increase. This shows that the use of discovery model learning tools with cognitive conflict approaches is effective to improve students' conceptual mastery of every cognitive aspect. The results of this study are reinforced by research conducted by Sari et al. [27] which states that classes that are taught using the discovery learning model assisted by virtual laboratories experience an increase in concept mastery for each cognitive aspect, where the highest increase is in the cognitive aspect C1 (remembering). Sirait [28] also supports these results by revealing that the increase in students' mastery of concepts with the cognitive conflict approach is significantly higher than conventional learning. Through the discovery learning model, students can develop their ability to understand the structure of the material being taught [29]. Discovery learning models guide the active role of students and involve the ability of students to find concepts in a structured, sensible, analytical, and critical manner so that students can individually formulate their findings [12-30]. Also, the use of cognitive conflict in learning involves the active role of students in understanding concepts [31].

The Discovery learning model with a cognitive conflict approach is carried out in stages 1) Beginning (stimulation), 2) Cognitive conflict (problem identification), 3) Solution (data collection, data processing, verification, and generalization). Learning begins by providing stimulation which is combined with the initial stages of the cognitive conflict approach. At this stage, the teacher poses problems and anomalous demonstrations to explore the initial concepts that students have. The second stage in the discovery learning model is combined with the cognitive conflict stage. This stage aims to create contradictory problems (conflicts) in the hope that students can identify problems. The creation of contradiction (conflict) problems is expressed by the teacher, then students are allowed to express their opinions. The next stage in the discovery model is data collection, data processing, verification, and generalization combined with the completion stage. This stage is in the form of proof of the problems given in the previous stage.

4. Conclusion

Discovery model physics learning device with a cognitive conflict approach to energy and effort material helps students in mastering the material being taught. The students' mastery of concepts before and after being taught using the physics learning tools discovery model with the cognitive conflict approach has increased. In general, the increase in concept mastery of the two classes was in the medium category,

while the conceptual mastery of each sub-material and cognitive aspects of concept mastery was in the medium-high category. This indicates that the use of discovery model physics learning tools with a cognitive conflict approach is effective to improve students' conceptual mastery.

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