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The Using of Scientific Based Physics Module in Learning to Enhance High School Students' Critical Thinking Skills on Rotation Dynamics and Equilibrium of Rigid Body

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Abstract

The purpose of this study was to determine the effectiveness of using a scientific based physics module to improve high school students' critical thinking skills. This study is a quasi experimental study which uses two classes taken at random experiment consists of one class and the control class. Class experiments using the scientific study using scientific-based modules and classroom experiments using books that have been owned by students. Experimental class numbered 25 students and control class numbered 28 students. The research was conducted in the first half (one) Academic Year 2016/2017. The method used is the test method with a pretest-posttest design. Data were analyzed with quantitative and qualitative methods. Data were analyzed using a pretest form of the homogeneity test to find out that the experimental class and controls used homogeneous. Posttest results were analyzed using normality test to determine the normally distributed data, N-gain to determine the increase critical thinking skills, as well as test two parties not bound to determine whether or not there is a difference in the increase in critical thinking skills. Conclusions and recommendations are the use of scientifically-based modules effectively improve the ability to think critically and use physics-based scientific modules should be adjusted to the prevailing syllabus and curriculum so that learning can take place properly.

Keywords*: Module, Scientific, Critical Thinking Skills*

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Introduction

Physics is a branch of science that is critical studied in primary and secondary school. Learning good physics will train the various components on the students both in terms of knowledge, attitudes, and skills. It fits the purpose of learning physics as a means to train students master the knowledge, concepts, principles of physics, skills, and scientific attitudes (Permendiknas No.22 Tahun 2006). Various aspects are very important in the learning process so that students can improve thinking skills to solve problems in everyday life

Often in physics learning there are various problems. The problems that exist can be a learning process, media, as well as the completeness of supporters. Packaging materials for teaching physics is still linear, ie teaching materials are only present concepts and principles, example problems and workmanship, and exercises (Sujanem, 2012: 105). Analysis of the results of examination by the National Education Standards (2015) 2015 City of Magelang on the material and the rotational dynamics of rigid body equilibrium is still low with 65.08 absorption performance is under provincial and national absorptive capacity which respectively reached 67.13 and 65.24. In addition, the learning material and the rotational dynamics of rigid body equilibrium is almost never done with an experimental method (Zulirfan et.al., 2011).

The scientific approach emphasizes learning by students to get active and concepts through direct contact to the phenomenon in everyday life that can improve student learning outcomes. This is according to a statement (Macaulay, Damme & Walker, 2009) Active student centered learning that encourages a deeper approach to learning and to improve learning outcomes. In addition, learning to use science-based modules developed to optimize student learning outcomes in the form of students' thinking skills (Fitri, et. Al., 2013). Characteristics of learning the scientific approach (Hosnan, 2014: 36), namely: a student-centered; science process skills involved in constructing the concept, law or principle; involves the cognitive processes of potential in stimulating the development of the intellect, especially high-level thinking skills of students; to develop the student's character. Learning step with scientific approach according Hosnan (2014: 39) are listed in Table 1.

Table 1. Measures of learning with the scientific approach

Activity	Learning Activity
Observing	Seeing, observing, reading, listening, listening (without and with the tool)
Questioning	Asking questions from the factual to the hypothetical; preceded by the guidance of the teacher to independently (a habit).
Data collection (Experimenting)	Determining the necessary data from questions, determine the source of the data (objects, documents, books, experiments), collecting data.
Associating	Analyzing the data into categories, determines the relationship data / categories, concluded from data analysis
Communicating	Delivering results conceptualization in the form of oral, written, diagrams, charts, pictures, or other media.

Based on Table 1, learning with a scientific approach is a student-centered activity. Activities undertaken to train the students in the form of knowledge, attitudes, and skills. That is, with a scientific approach to learning can train students to think critically to solve a problem.

Critical thinking skills is the ability of a high level. The essence of critical thinking skills by Brookfield as quoted by Sarwi and Liliasari (2010), namely: (1) critical thinking is the activity of productive and positive, (2) the manifestation of critical thinking depending on the context, (3) critical thinking is an activity of the emotional and rational, It can be concluded that the processes or activities that should be included in any study in a certain level. There are 5 framework of critical thinking in analyzing the concept according to Ennis as quoted Sarwi and Liliasari (2010), namely: (1) give a simple explanation (elementary clasification), (2) build the basic skills (basic support), (3) concluded (inference), (4) makes a further explanation, and (5) implementing strategies and tactics (strategy and tactics).

Based on questionnaires and observation sheets prior to the study, the book used by students of class XI IPA SMAN 4 Magelang form of worksheets. Lks used to consist of materials, example problems and workmanship, and exercises. This is in accordance expressed Sujanem (2012: 105) that the packaging material for teaching physics is still linear, ie: teaching materials are only present concepts and principles, examples of problems and solutions, and practice questions. Books used by

students is still a transfer of knowledge and yet engage students actively in contact with the phenomena that occur to get the concept. In addition, the print media in the form of the module is not used in the process of teaching and learning activities in the classroom.

Based on the problems in the above description, learning research conducted with scientific approach to improve students' critical thinking skills. Formulation of the problem in this research is how the effectiveness of the use of scientifically-based physics module to improve high school students' critical thinking skills? The purpose of this study was to determine the effectiveness of the use of scientific-based physics module to improve students' critical thinking skills.

Methods

In this study, using a quasi experimental study design comparing the two groups by using a scientific-based physics module and handbooks that have been owned by the students. Group A by using a scientific-based physics module in the learning consisted of 25 students, whereas group B using a handbook which is owned by the students consisted of 28 students. Both groups were studying for 6 weeks on the material and the rotational dynamics of rigid body equilibrium.

Several studies conducted steps: first, do activities pretest before learning activities. Second, groups A and B is given a scientific approach to learning with group A as an experimental class module using scientific-based physics module and Group B as the control class using the handbook of the students. Learning used to use the scientific approach described by Sani (2014) includes: observe, ask, seek information, analyze, and communicate. The study design can be described in Table 2.

Table 2 Research Design

Group	Treatment		
Group A (Experiment, N=25)	O_1	X_1	O_2
Group B (Control, N=28)	O_1	X_2	O_2

O_1 : Pretest
O_2 : Posttest
X_1 : Using scientific based physics module
X_2 : Using books that have been owned by students

According to the Table 2, the class consist of two groups with 25 students in the experimental class and 28 students in the control class. Class experiments using scientific-based physics module while the control class uses books owned by students in learning on the same topic, namely the rotational dynamics and rigid body equilibrium. Research transactions are carried out for 6 weeks with a summary of activities in Table 3.

Table 3. Summary of Research Activity

Week	Research Activity
1	Pretest
2-7	Treatment (learning module using scientific-based physics in group A and use the handbook of the students in Group B on the same material)
8	Posttest

Based on Table 3, prior to the treatment given pretest activities both in the experimental class and control class. After being given a pretest activities, both classes are given treatment for 6 weeks. After treatment, both the experimental class and control class given activity posttest. Test given using grating aspects of critical thinking skills Ennis.

Differences in learning outcomes and effective use of scientifically-based physics module can be determined using a score Gain normalized (N-Gain) g by Meltzer (2002) in which is determined by the equation:

$$g = \frac{Posttest\ score - Pretest\ score}{Max\ score - Pretest\ score}$$

The criteria used in the N-Gain value according to Hake (1998) is presented in Table 4.

Table 4. N-*Gain* Score Criteria

N-*Gain*	Category
$g < 0,3$	Low
$0,7 > g \geq 0,3$	Medium
$g \geq 0,7$	High

Module-based scientific physics can be said to improve critical thinking skills when the value of N-Gain minimal in the medium category.

Finding and Discussion

On the application of products such as physics module, carried out a pretest beforehand to know the initial conditions of students. Problem pretest used consisted of 12 questions in the form describing the criteria critical thinking Ennis. Problem pretest used, tested first in class XII students who have obtained the material and the rotational dynamics of rigid body equilibrium. Questions have been tested, analyzed using analysis of quest and validated by expert validator.

The data obtained, showed the experimental class and control class normally distributed and homogeneous. N-Gain of the experimental class and control class are normally distributed with a significance level of 0.200 and 0.078, and homogeneous data variance with significance 0.345. Based on the results of the two sample t-test is not related, gained a significance level of 0.024 <0.05. According to the results obtained t test concluded that there are differences in the increase shown N-Gain experimental class and control class. That difference is the N-gain average experimental class is higher than the control class.

The average yield of the value pretest and posttest of the experimental and control classes are presented in Table 5.

Table 5. Analysis of Critical Thinking Ability Assessment

Average	Experiment Group	Control Group
Pretest	46,33	41,29
Posttest	75,42	68,38
N-Gain Score	0,50	0,46

In Table 5, show that the N-Score Gain class experiment that uses physics-based scientific module with category gained 0.50 greater than the N-Gain control class Score of 0.46 with the medium category. Results Analysis of pretest-posttest critical thinking skills at the table, showed an increase in critical thinking skills students experiment class is greater than the control class.

Based on the results of pretest-posttest assessment conducted, the results obtained N-gain score in the experimental class of 0.50. The results showed that there was an increase categorized according to the criteria Hake. Improved criteria is happening on some aspects of critical thinking. Improved aspect of critical thinking in the category is going to almost all aspects of critical thinking. While improving critical thinking skills at a grade of 0.46 with the control medium category. Recent gains in accordance with Naval Research (2014) that the use of physics in the learning modules have positive impact on student learning outcomes.

Differences increase critical thinking skills of students during learning using modules and without using modules answered questions effectiveness of scientific module to the students' critical thinking skills. The use of physics module with step scientific approach included in learning has conditioned constructively active learning of students find themselves. Existing activities on the module that is observed the phenomenon of everyday life presented in pictures and narratives in the module, and then the students were asked to answer questions, make inquiries about the phenomenon, searching for information with experiments, analyze and make conclusions to the results obtained with the discussions and communicating these results. Students at the end of active learning in accordance with step scientific approach. According Sukardiyono and Wardani, (2013) the use of modules with

experimental activities have a positive impact on learning outcomes. According to Thompson (2011) centered learning students can develop students' critical thinking skills.

The initial step of observing the activities of the scientific approach to the phenomenon. The phenomenon that is served there in everyday life. The phenomenon is presented in the form of images with narration that raises questions for the students why the incident occurred. The curiosity of students to the causes of the phenomenon makes the students think to solve the existing problems so as to make students think critically. This is in accordance with the statement of Duron, et al. (2006) stated that through questions can help students develop critical thinking skills.

The next activity is to seek information through experimentation. In this activity students conducted a series of experiments to get the facts to answer the questions that appear on the stage of observing. Experimental activities to assist students in improving the quality of students' critical thinking skills for this activity encourages students mengonstruk knowledge through experience gained. Ausubel accordance with the opinion quoted in Dahar (2011) that one way of meaningful learning is the finding that the student is able to build a knowledge base to new knowledge gained. Rahmawati, et al. (2014) states that the activities of the experiment served to increase students' critical thinking skills.

Analyze and conclude the activities carried out after the experiment. In this activity, students discuss with a group of friends to relate the results obtained in conducting experiments on prior knowledge. In this activity the interaction occurs in the framework of the exchange of information among members of the group occurred. It fits opinion of Piaget (Depdiknas, 2004) that the interaction between friends will overcome self-centeredness. High ability students can share their knowledge and understanding of the low-ability students who pose self-confidence and social skills. In addition, strengthened by Sarwi and Liliasari statement (2010) that the cooperative learning and problem solving to develop students' critical thinking skills.

The last step in the scientific approach is to communicate. The conclusions are communicated with other friends. The process of information exchange and interaction of the class occurs. Questions and responses between the groups made the students can develop critical thinking skills. This is consistent with the proposed Hosnan (2014) that the scientific character is a cognitive process that involves potential in stimulating the development of the intellect, especially high-level thinking.

Conclusion

Based on the analysis and discussion of the results showed that the use of scientifically-based physics modules in learning effective at improving students' critical thinking skills corresponding N-gain calculations score in the experimental class of 0.50 with the category being greater than N-gain score in the control class that uses the book belongs 0,46 students being categorized. The assessment in this study is limited to aspects of critical thinking skills, so there are suggestions as follows:

(i) Assessment in the learning process in addition to assessing critical thinking skills are included in this aspect of the skills (psychomotor) should also be made an assessment of the aspects of knowledge (cognitive) and attitude (affective).
(ii) The use of scientifically-based physics module should be adjusted to the prevailing syllabus and curriculum so that learning can take place properly.

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