Enhancing Understanding Concept and Scientific Attitudes of Students through Phenomenon-based Learning Model

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Abstract: Understanding the concept of physics is very important to be mastered by students in order to learn the phenomena of the universe encountered in everyday life. This study aims to improve the understanding concept and scientific attitude of students after applied the phenomenon-based learning model on the atmosphere concept. The method was used is quasi-experimental with pre-test and post-test design. The instrument used consisted of a test understanding of concepts and The Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS). The subject was students of the sixth semester in Physics Education of UIN Sunan Gunung Djati Bandung, with a number of students 40 people. The sample was selected using simple random sampling technique. The results showed an enhancement of understanding concept by a normalized gain average of 0.61 that is a moderate interpretation, and the student's scientific attitude increase to a positive direction. It can be concluded that the phenomenon-based learning model can improve the understanding concept students on the atmosphere concept and student's scientific attitude.

1 INTRODUCTION

The common phenomenon that science, especially physics, was regarded as a difficult and unpopular subject. Many concepts in physics tend to be abstract and require a high level of thinking ability and good mathematics skill. In addition, the terms used in physics are often interpreted specifically and different from the same terms in everyday life. Based on the above facts, it can be assumed that the traditional learning approaches are considered to be inappropriately used in learning that emphasizes understanding of concepts. The era of the global community has forced each individual to have not only knowledge but also skills in order to compete in the 21st century (Malik, Setiawan, Suhandi, Permanasari, Samsudin, *et al.*, 2018).

Students can figure out the concepts of physics well, and then required a proper and effective learning process. That is, the learning must be precise with the characteristics of the subjects and effective in the learning delivery process so that the defined goal can be achieved. Similarly, the process of learning in atmosphere concept requires an appropriate approach so that students are able to understand the concept and could be applied in life. Students often have difficulty in understanding the concept because they have not linked the concept learned with the contextual phenomenon. Students focus on knowing the law or principles but do not know how they are formulated from the phenomena that occur to everyday life. Mastering physics amounts to not only developing a robust knowledge structure of physics concepts but also developing productive attitudes about the knowledge and learning in physics (Mason and Singh, 2010).

Understanding concepts is defined as an understanding of ideas appropriately both concrete and abstract. This is demonstrated by the ability of students to understand an idea either explicitly or implicitly from various information either in oral, written and symbolic form independently using their own language. Students can be said to understand if they determining the meaning of instructional messages, including oral, written, and graphic communication (Krathwohl, 2002).

There are four main components that must be achieved by students in understanding the: understanding, skills, abilities and scientific attitudes. If the four components are mastered by

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students, it will add insight and knowledge; improve mindset and scientific attitude to be applied in everyday life. The correlation between students' attitudes and their conceptual knowledge also appears to be influenced by students' educational background (Milner-bolotin *et al.*, 2011).

According to educational psychologists the attitude of the student plays an important role in his systematic and scientific training (Trivedi and Sharma, 2013). Effective teachers adapt learners' needs and evaluate how information should be presented. To meet these demands, teachers need to adjust instruction to students' ability levels and background (Chen and Howard, 2010).

Attitudes are related to coping with and management of the emotions occurring during learning process, and they play an important role in directing human behaviour. (Kaya and Böyük, 2011). Researchers have long discussed has accumulated concerning the importance of various attitudes to science and the relationship between these attitudes and science achievement (Papanastasiou and Zembylas, 2004).

Personal attitudes and beliefs about learning can influence students approach in learning the subject, as a result, attitude evaluation and how these changes over time become more commonly encountered (Slaughter, Bates and Galloway, 2011). This is reinforced by the opinion of (Kaya and Böyük, 2011) who said that students should develop research activity, ask questions, think critically, solve the problems, and decision-making skills. Hopefully, they could increase knowledge and curiosity, understanding concepts and scientific attitude throughout their life.

Departing from the thought, this study focuses on implementation phenomenon-based learning model to improve the understanding of the concept and scientific attitude of students. This phenomenon-based learning model is adopted from Problem Based Learning model (PBL) which is part of contextual learning. The atmospheric phenomena (related to the order, characteristics and content of each layer of the atmosphere) used as the basis of the research in the form of physical phenomena that occur in everyday life and phenomena contained in the universe that can be seen by the human senses or visualized with the helped of virtual media and modified with simple tools.

Phenomena-based learning is developed or adopted from the problem-based learning model, beginning with the observation of the phenomenon that occurs, described and analysed in accordance with the relevant physics concept. Some characteristics of phenomenon-based learning model such as student-cantered, teacher as facilitator, collaborative system and knowledge construction process by students. The syntax of phenomena-based learning model consists of five stages: student orientation process toward observed phenomena; organize students to learn; guide the student's inquiry both individually and in groups; group discussions to present the results of the investigation; analyse and evaluate the explanation of the phenomena presented in the first stage.

This phenomenon-based learning is used to improve students' understanding of the concept of atmosphere. This learning is done through a contextual learning approach, where students are fully involved in the learning process Contextual learning is not just listening and taking notes, but learning is a process of experience directly. Through the experienced process is expected to develop student scholarship in full, not only developing in the cognitive aspects but also the effective and psychomotor aspects. The phenomenon-based learning is integrated with laboratory activities will offer a context-rich learning experience improve students' conceptual understanding (Setiawan *et al.*, 2018).

Various empirical studies related to the application of phenomena-based learning model to improve various skills have been done previously include the reading skills and on the students motivation to read (Valanne *et al.*, 2012), understanding the concept of disaster (Ningrum, 2017), improving students' critical thinking (Khanasta *et al.*, 2016), enhances critical thinking and physic learning (Pareken, Patandean and Palloan, 2015), improving responsible action (Østergaard, Lieblein and Breland, 2010), the integration of phenomena and practical work in physics (Ng and Nguyen, 2006).

Therefore, research on the influence of phenomenon-based learning models on understanding concept and scientific attitudes of students in universities was still rare. This research used a quasi-experiment method and research question posed by how the impact of phenomenon-based learning model on student understanding concept and scientific attitudes?

2 METHODS

The research method used is pre-experiment with one group pretest-posttest design (Fraenkel, Wallen, and Hyun, 2012). First, students were given a concept comprehension test and a scientific attitude questionnaire to find out the students' initial understanding of their atmospheric concepts and scientific attitudes. Furthermore, students were given treatment of the form of application of phenomenon-based learning model on learning about the concept of atmosphere. Finally, students are given a concept comprehension test and a scientific attitude questionnaire to determine the effect of the application of phenomenon-based learning model to their understanding and scientific attitude.

The subjects of this research were students of Physics Education Program UIN Sunan Gunung Djati Bandung at semester VI academic year 2016/2017. The samples used in this study were 40 students consisting of 18 male and 22 females. The sample was selected using simple random sampling technique.

The research instrument used is: 1) the test in the form of a description to test the level of understanding of student concept with indicator refers to Bloom's Taxonomy which has been revised on the subject matter of atmosphere. Indicators of conceptual understanding in this study refer to Bloom's revised taxonomy consisting of: (1) Interpreting; (2) Exemplifying; (3) Classifying; (4) Summarizing; (5) Inferring; (6) Comparing; (7) Explaining (Krathwohl, 2002). Non-test in the form of checklist from The Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS) to measure students' scientific attitudes covering aspects of (1) Personal application and relation to real world; (2) Problem solving and learning; (3) Effort and sense-making (Zwickl, Finkelstein and Lewandowski, 2013).

Increased understanding of student concept after applied phenomena based learning model is calculated using equation 1 according to Hake formula and criteria (Hake, 1998).

$$< g > = \frac{< S_{pos} > - < S_{pre} >}{100 - < S_{pre} >} \qquad (1)$$

The calculation average normalized gain $<g>$ is furthermore interpreted by the criteria Hake (1998) namely; $<g> < 0.3$ (low); $0.3 \leq <g> \leq 0.7$ (medium); and $<g> > 0.7$ (high). Hypothesis test was done by using SPSS for windows version 19 program.

Scoring of students' scientific attitude using a Likert scale. Student attitudes data were processed by calculating the percentage of respondents that give approval, neutral, and disagreement with each item of the statement submitted. The approval response given by the student is expressed in the responses of SS (Strongly Agree) and S (Agree), neutral response (N), and the response of disagreement expressed in TS responses (Disagree) and STS (Strongly Disagree). Calculation process is done by using equation 2.

$$PTR\ (\%) = \frac{JR}{JSR}\ x\ 100\% \qquad (2)$$

Respectively:

PTR (%) = percentage of respondents to a response
JR = number of respondents in a response
JSR = the total number of respondents

Assessment and processing of scientific attitude using the average scores obtained by students before and after the application of phenomenon-based learning model.

3 RESULT AND DISCUSS

3.1 Understanding the Concept of Students

The average achievement percentage of the pre-test, post-test, and normalized gain (N-gain) scores of student concept comprehension can be seen in Figure 1.

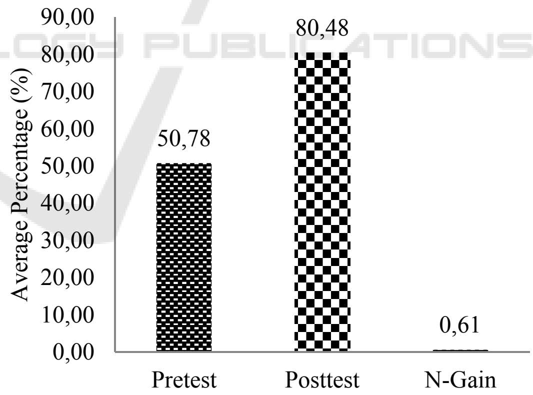


Figure 1: The normalized gain average of understanding of students.

Based on Figure 1, the average pre-test score is 50.78, the average post-test score is 80.48 and the average N-gain score of 0.61 is included in the moderate category. The result of data analysis on pretest scores shows the average of students' understanding before using phenomenon–based learning is low categorized. After the learning with the phenomenon–based learning model, the posttests are applied in order to know the change of student's understanding.

The result of average normalized gain shows improvement in students' understanding after using phenomenon-based learning model including medium category.

The problem-based learning model provides students with the opportunity to collaboratively learn to construct knowledge through their own experience.This model also enables students to learn independently to increase curiosity about things, find concepts through experiments, improve the ability to solve problems, and provide higher motivation. Phenomenon-based learning model as a pedagogical alternative to science education emphasizes three aspects of the learning process: natural phenomena are contextually exposed, students connect the phenomenon with the concept of science being studied, and teachers guide students and reflect upon learning (Østergaard, Dahlin and Hugo, 2008).

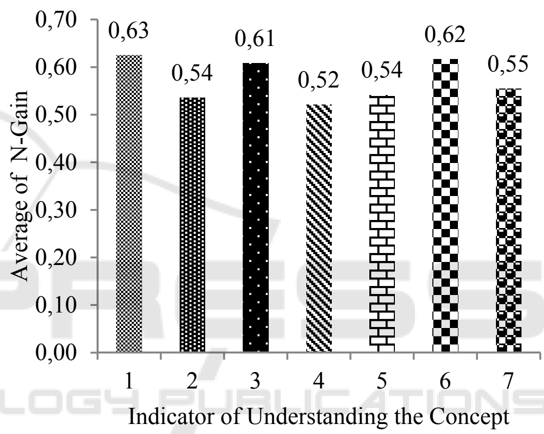
Students learn through natural phenomena that are contextual such as about the atmosphere, the phenomenological perspective has two reasons. First, explicitly train relevant skills and integrate them with ethics and values, thereby complementing student competencies. Second, it relates the theoretical knowledge learned to be applied to action according to real-life situations (Østergaard, Lieblein and Breland, 2010).

This is in accordance with the view expressed by Kaniawati (2010) that the phenomenon-based learning model is a strategy for creating a learning environment that encourages learners to construct knowledge and skills through direct experience. Phase-based learning begins with the learner's orientation to the phenomenon and ends with an analysis and explains the physical phenomena presented. Students are oriented to physical phenomena that often occur in nature as well as on technology products of demonstration or practicum activities. Students will more easily understand complicated and abstract concepts when accompanied by concrete examples, reasonable examples according to the situation and conditions encountered by practicing the concept discovery through the treatment of physic reality, physic treatment and handling the real thing.

Phenomenon-based learning in turn brings students closer to real-world challenges and can better prepare them for college and a career. The benefit of the Phenomenon-based learning is that it offers educators flexibility regarding how and when to implement it. Understanding the concept of students for each indicator can be seen in Figure 2.

Based on Figure 2, the lowest average normalized gain was obtained in the summarized indicator of 0.52 in the medium and highest category in the interpreting indicator of 0.63 in the medium category.

The increased of student understanding of atmosphere concept on interpreting indicator is in highest category. Due to students have been accustomed to study and interpret the various natural phenomena occurs in daily life. The results of this study reinforce previous research, interpretation indicators experienced the highest increase compared to other indicators of conceptual understanding (Malik, 2015). The lowest increase in on summarizes indicator. Due to in this indicator, students find difficult to summarize important concept related to natural phenomena.



Respectively:
1. Interpreting; 2. Exemplifying; 3. Classifying;
4. Summarizing; 5. Inferring; 6. Comparing; 7. Explaining

Figure 2: The normalized gain average of indicator understanding the concept.

Different hypothesis test using Paired Samples Test formula obtained t count for post- test and pre-test is 23.953 with significance value equal to 0.000. Since the post-test pre-test significance value of student concept comprehension is 0.000 smaller than the real level of 0.05 then H_0 is rejected as a consequence H_1 is accepted. Thus, it can be concluded that there is an increased understanding of student concepts after applied phenomenon-based learning model on the concept of the atmosphere.

The result of hypothesis testing shows that implementation of phenomenon-based learning model can improve the students understanding significantly. The model involves students to be trained in formulate hypotheses through experimental activities and direct observation which base of science. Besides that, students trained indirect experiences to interpret data to make conclusion in order to proof their hypothesis. Based on indirect experiences will guide the students to learn to think of deductive hypothesis so student can understand the concept they learned. Activities student of based troubleshooting with their own experience example laboratory activities can train and improve students' higher-order thinking skills (Malik, *et al*., 2018).

The results of this study are in line with research (Ardiyanti and Winarti, 2013) which shows that the phenomenon-based learning model can significantly improve students' critical thinking skills. It is also supported by (Hotang, L. Br; Rusdiana, D; Hamidah, 2010) that the application of phenomenon-based learning model significantly can be more effective against improving students' comprehension of concept.

3.2 Student Scientific Attitudes

The scientific attitude of students before and after learning by applying phenomena-based models was measured using a standardized checklist that is The Colorado Learning Attitudes about Science Survey for Experimental Physics (E-CLASS). Data on changes in students' scientific attitudes can be seen in Table 1 and Table 2.

Based on Table 1 and Table 2 it can be seen that after the application of phenomenon-based learning model, there has been a change in students' scientific attitude to be more positive about answering the statement by of the match list.

Table 1: Scientific attitudes of students before the implementation of phenomenon-based learning models.

No	Statement	Answer Options				
		STS (%)	TS (%)	N (%)	S (%)	SS (%)
	Aspect 1: Personal Application and Relation to Real World					
1	I think about physics in the experience of everyday life.	0	8	12	48	32
2	I am not satisfied until I can understand why something works well according to its function.	0	4	12	20	64
3	I studied physics to examine the knowledge that would be useful for my life outside school.	2	0	14	68	16
4	I like to solve physics problems.	2	10	28	48	12
5	Learning physics changed my ideas about how the earth works.	0	6	10	64	20
6	The thinking ability used to understand physics can be useful in my daily life.	2	6	8	52	32
7	To understand physics, I sometimes think of my personal experiences and relate them to the topics being analysed.	2	2	20	60	16
	Aspect 2: Problem Solving and Learning					
1	After I studied the topic of physics and felt understood, I still have difficulty solving problems in the same topic.	4	16	12	52	16
2	If I cannot remember the specific equations needed to solve a test problem, then there is nothing more I can do.	8	30	28	28	6
3	If I want to apply one method to solve one physics problem and another, the questions must have the same situation.	4	32	28	32	4
4	I can usually find a way to solve physics problems.	2	10	36	36	16
5	If I dwell on a matter of physics, then there is no chance for me to find the answer myself.	2	24	36	24	14
	Aspect 3: Effort and Sense Making					
1	In solving the matter of physics, if my calculations show far different results than the expected results, then I choose to remain confident in my calculations.	4	32	32	28	4
2	In physics, it is important for me to reason a formula before I can use it properly.	6	26	44	16	8
3	To study physics, I just need to memorize the solution in the sample questions.	2	34	28	28	8
4	Spending a lot of time understanding the origin of a formula is a waste of time.	8	32	28	20	12
5	Subjects in physics have little relevance to my experience in the real world.	10	34	32	20	4

Table 2: Scientific attitudes of students after the implementation of phenomenon-based learning models.

No	Statement	Answer Options				
		STS (%)	TS (%)	N (%)	S (%)	SS (%)
Aspect 1: Personal Application and Relation to Real World						
1	I think about physics in the experience of everyday life.	0	4	10	52	34
2	I am not satisfied until I can understand why something works well according to its function.	0	2	14	20	64
3	I studied physics to examine the knowledge that would be useful for my life outside school.	0	0	12	70	18
4	I like to solve physics problems.	0	2	28	58	12
5	Learning physics changed my ideas about how the earth works.	0	2	12	64	22
6	The thinking ability used to understand physics can be useful in my daily life.	0	4	8	56	32
7	To understand physics, I sometimes think of my personal experiences and relate them to the topics being analysed.	0	2	20	60	18
Aspect 2: Problem Solving and Learning						
1	After I studied the topic of physics and felt understood, I still have difficulty solving problems in the same topic.	18	60	20	2	0
2	If I cannot remember the specific equations needed to solve a test problem, then there is nothing more I can do.	10	56	24	6	4
3	If I want to apply one method to solve one physics problem and another, the questions must have the same situation.	22	54	20	2	2
4	I can usually find a way to solve physics problems.	2	4	18	58	18
5	If I dwell on a matter of physics, then there is no chance for me to find the answer myself.	20	50	22	6	2
Aspect 3: Effort and Sense Making						
1	In solving the matter of physics, if my calculations show far different results than the expected results, then I choose to remain confident in my calculations.	4	52	24	18	2
2	In physics, it is important for me to reason a formula before I can use it properly.	2	4	24	48	22
3	To study physics, I just need to memorize the solution in the sample questions.	22	44	26	6	2
4	Spending a lot of time understanding the origin of a formula is a waste of time.	20	54	18	6	2
5	Subjects in physics have little relevance to my experience in the real world.	2	4	28	46	20

Based on the answers given by the students to The Colorado Learning Attitudes About Science Survey for Experimental Physics (E-CLASS), the students' scientific attitudes to physics and physics learning experienced positive changes between before and after applied phenomena-based learning model. Students 'attitudes toward learning applied by teachers can have a significant impact on students' ability to form concepts change (Pyatt and Sims, 2012). If ownership were contrived, one would expect it to be quickly identified as such by students. If ownership equates to student autonomy, it may be an important factor in students' own initiative and control over their practical work with associated positive attitudes (Toplis, 2012).

Students generally exhibit a positive scientific attitude and are in agreement with the opinions of researchers that have previously been tested using E-CLASS instruments. Students can only develop positive attitudes if they are motivated (Zezekwa, 2011). Students' motivation to achieve in science is connected to the combination of expectancies and values they hold about science (Sandoval and Harven, 2011). In the study of physics, there are four main components that must be achieved by students. The four components are understanding, skill, ability, and scientific attitude. Hopefully, when all components are mastered by students, can provide benefits to students to add insight improve the mind-set and attitude of the students to stock in the community and continue further education.

Personal attitudes and beliefs about learning can influence how students approach students in learning the subject; as a result, evaluation of attitudes and how such changes over time become more common (Slaughter, Bates and Galloway, 2011) (Trivedi and Sharma, 2013). In order for students to develop research, questioning, critical thinking, problem-solving, and decision-making skills, so that they become lifelong learning individuals, they must be improved on knowledge, understanding, and attitudes toward science. The factors that influence the formation of attitudes are the personal experience, culture, other important people, mass media, institutions or educational institutions and religious institutions, as well as emotional factors within the individual (Azwar, 2007).

4 CONCLUSIONS

In general, the researchers have successfully conducted research on enhancing understanding concept and scientific attitudes of students through phenomenon-based learning model. The results showed enhancing of students' understanding of the concept of students after applied phenomena-based learning model on the concept of the atmosphere obtained an average value of N-gain of 0.61 overall, including enough category. The students' scientific attitude has improved in a positive direction. Therefore, the application of this phenomenon-based learning model should be considered using to improving the conceptual understanding of other topics.

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