

Concept Mastery and Scientific Literacy Capability of Senior High School of 1 Kudus Students

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Article Info

Article History:

Submitted:
June, 28 2018

Accepted:
July, 30 2018

Published:
Julu, 31 2018

Keywords:
Concept mastery,
Scientific literacy, Senior
high school students.

Abstract

The purpose of this study is to identify concept mastery and scientific literacy capability of senior high school students. This study used quantitative-qualitative mix method. This study was conducted at senior high school students of 1 Kudus. The subjects of this study were 12th grade student who have received all the subject matter of physics. The instruments of this study were concept-based and scientific literacy-based multiple choice test accompanied by the reason. The level of concept mastery and scientific literacy capability of students was analyzed through the appropriateness of the choice of answers with the reasons. The results shows that the lowest level of concept mastery and scientific literacy capability of senior high school students is item Graduate Competence Standards (GCS) 3 about heat and thermodynamics. From the results can be conclude that concept mastery influences the students' scientific literacy capability.

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INTRODUCTION

The progress of science and technology in various countries is rapidly increasing on 21st century (Rusilowati et al., 2016). Science became one of foundations of life (Suma et al., 2018). This makes science very important to study in high school level. Science can not be separated from every human activity and various phenomena that occur in the natural environment (Sujana et al., 2014). Specifically, the term “science” is interpreted as Natural Science related to the effort to understand various phenomena of nature systematically (Rahayuni, 2016). Science is one study that seeks to understand something that exists in nature based on empirical data (Glenn & Janusa, 2010: 1). The basic ideas contained in science fit the verifiable facts.

Science education builds students' way of thinking to understand phenomena or natural events by scientific methods such as those conducted by scientists. The main goal of science education is to teach scientific concepts and processes, thereby helping students develop a strong understanding of scientific findings as well as the skills and processes used in science (Sadler & Zeidler, 2009). Science education aims to increase the competence of learners as an effort to meet the needs of life in various situations (Baheivan & Kapueu, 2014). Studies related to science education have been widely developed, one of them through the Program for Intercount Student Assessment (PISA) conducted by the Organization for Economic Co-operation and Development (OECD). Science education develops various abilities in the field of science, one of which is scientific literacy (Sukowati dkk., 2017).

Scientific literacy has become a widespread concern for scientists, lecturers, and public policy holders (Impey, 2013), as it is indispensable for modern societies to cope with the problems of science and technology (Turiman et al., 2011), as well as to support sustainable development (Udompong & Wongmanich, 2014). Scientific literacy is a capacity for using science knowledge, identifying questions and drawing factual inferences to understand the universe and making decisions about changes occurring due to human activities (OECD, 2006). Scientific literacy is an element of life skills that must be key outcome of educational process until the child is 15 years old. For that reason, a 15 years old (end of compulsory education) is deemed necessary to have an adequate level of scientific literacy, whether to pursue science or non-study. Scientific literacy classified into four categories, namely science as a body of knowledge, science as a way of thinking, science as a way of investigating, and the interaction between science, technology, and society (Chiapetta et al., 1991). The development of scientific literacy is needed in order to prepare students who are literate in the field of science (Udompong et al., 2014). Scientific literacy is one of important thing in science education (Sukowati dkk., 2017). Scientific literacy is an important mastered by students about how they perceive the environment, health, economy, and other modern society issues that depend on technology and development of science (Hayat & Yusuf, 2011; Kurniati dkk., 2016). Literate student has knowledge and understanding of science concepts, skills of conducting the scientific inquiry process, applying knowledge, and understanding the skills in various contexts (Hayat & Yusuf, 2011: 49).

Scientific literacy capability of Indonesian student were still low. PISA's study on 2000-2015 indicate that Indonesia on the 10th last rank of other country. One of the factors causing low PISA Indonesia score is caused by the literacy ability possessed by Indonesian students were optimal yet (Ratri, 2015). The results of field observation show that there are still many physics teachers who don't understand or even know about scientific literacy. Learning activity by physics teachers have not been based on scientific literacy. Learning tools such as teaching materials and evaluation instruments are also not based on scientific literacy. This condition made student not familiar about scientific literacy. Physics as a part of science that can explain the natural phenomena in the form of matter and energy (Toharudin et al., 2011; Linuwih, 2014). In studying physics, students not only

recognize and memorize mathematical formulas and concepts (Istiyono et al., 2014; Widowati et al., 2017). Physics contains an understanding of concepts that can be applied to solve problems in daily life like as scientific literacy principle (Widiana, 2016; Parmin dkk., 2017). This condition encourages researchers to conduct preliminary research in order to obtain information about concept mastery and scientific literacy capability of high school students. The results of this study become a consideration to develop science-based literacy learning tools that are valid, practical, and effective to improve students' scientific literacy capability.

METHOD

Method of this study used qualitative-quantitative mix method. The subject of this study were 12th grade students of senior high school 1 Kudus. This study was conducted in January 2018. The instruments of this study is concept-based and scientific literacy-based multiple choice test accompanied by the reason. Question of test compiled according to Graduate Competence Standards (GCS) of physics in senior high school. Concept-based test and scientific literacy-based test derived from PISA test and scientific literacy-based test that have been developed by previous researchers. The results of students' answers were analyzed to know concept mastery level and scientific literacy capability of students. Based on the results obtained, conducted interviews as a form of confirmation about students' answers. The purposes of interviews is to identify the factors that influence concept mastery level and scientific literacy capability of students.

RESULT AND DISCUSSION

This study is preliminary research to know the level of concept mastery and scientific literacy capability of senior high school students. The percentage of correct answers and correct reasons for concept-based test are presented in Tabel 1.

Tabel 1. Percentage of Correct Answers and Correct Reasons for Concept-Based Test

No	GCS	Correct Answers	Correct Reasons
		(n = 100) (%)	(n = 100) (%)
1	Understanding the principles of physics quantities measurement direct and undirect, carefully, thoroughly, and objectively	92,00	73,00
2	Understanding the natural phenomena and their regularities in point-body mechanics scope, rigid body, work, conservation of energy, elasticity, impulses, momentum and fluids	72,00	42,00
3	Understanding the concept of heat and principles of heat conservation, ideal gas properties, and its changes concerning the laws of thermodynamics in its application on heat engine	36,00	17,00
4	Analyzing concepts and principles of waves, optics and sounds in various problem solving and technology products.	57,00	38,00
5	Understanding concept and principles of electricity and magnetism and its application in various problem solving.	65,00	29,00
6	Understanding concepts and principles of quantum, relativity, core physics and radioactivity in daily life	63,00	33,00

Tabel 1 presents the percentage of correct answers and correct reasons given by students on each GCS. This percentage describes the level concept mastery of senior high school students. Based on all questions tested to the students, the percentage of correct reasons is always less than percentage of correct answers. The lowest percentage of answers and reason is on GCS 3 related to heat and thermodynamic.

On concept-based test of GCS 3, students are given problems about heat. In accordance with indicator test, students are expected to be able to determine the temperature of water mixture using *black principle*. The concept-based test of GCS 3 is presented in Figure 1.

<p>Ferdi menyiapkan 500 mL air panas dan 1 liter air dingin untuk persediaan minum. Suhu masing-masing minuman tersebut adalah 60°C dan 6°C. Ferdi ingin meminum air hangat terlebih dulu karena cuaca sedang hujan. Karena air minumannya terlalu panas, Ferdi mencampurnya dengan 50% air dingin yang dibawanya. Suhu minuman yang diminum oleh Ferdi adalah. . . .</p> <p>a. 6°C b. 24°C c. 33°C d. 36°C</p>

Figure 1. Concept-Based Test of GCS 3

Figure 1 presents concept-based test of GCS 3 about heat. Test assigned to students classified into C3 difficulty level (application) on Bloom taxonomy. Students are expected to be able analyzing and applying *black principle* in water mixture that have different temperatures. Result of student's answers can be seen in Tabel 2.

Tabel 2. Students' Answers Percentage of Concept-Based Test for GCS 3

Answer Choices	Students Answered (%)	Correct Answer
A	13,00	C
B	44,00	
C	36,00	
D	7,00	

Tabel 2 shows that majority of students choose answer B on concept-based test of GCS 3. Question of concept-based test for GCS 3 can be solved using *black principle*. This principle applies when there is mixing of 2 objects that have different temperatures. The amount of heat received by an object 1 is as same as the amount of heat released by the object 2. On the concept-based test of GCS 3, mixing occurs between hot and cold water. In accordance with *black principle*, the mixing causing hot water removing heat to lower temperature. Conversely, cold water receives heat to raise their temperature. Only 36% of students were able to answer concept-based test of GCS 3 correctly. Students who can answer the reason exactly is only 17%. This result indicates that concept mastery of senior high school students on GCS 3 is not good enough.

Identification of students' scientific literacy capability has been done by providing scientific literacy-based test for students. Students' scientific literacy capability analyzed based on each GCS. The percentage of correct answers and correct reasons for scientific literacy-based test are presented in Tabel 3.

Tabel 3. Percentage of Correct Answer and Correct Reasons for Scientific Literacy-Based Test

No	GCS	Correct Answers (n = 100) (%)	Correct Reasons (n = 100) (%)
1	Understanding the principles of physics quantities measurement direct and undirect, carefully, thoroughly, and objectively	83,00	80,00
2	Understanding the natural phenomena and their regularities in point-body mechanics scope, rigid	70,00	22,00

	body, work, conservation of energy, elasticity, impulses, momentum and fluids		
3	Understanding the concept of heat and principles of heat conservation, ideal gas properties, and its changes concerning the laws of thermodynamics in its application on heat engine	40,00	11,00
4	Analyzing concepts and principles of waves, optics and sounds in various problem solving and technology products.	46,00	42,00
5	Understanding concept and principles of electricity and magnetism and its application in various problem solving.	61,00	59,00
6	Understanding concepts and principles of quantum, relativity, core physics and radioactivity in daily life	57,00	33,00

Tabel 3 presents the percentage of correct answers and correct reasons given by students on each GCS. This percentage describes scientific literacy capability of senior high school students. Based on all questions tested to students, the percentage of correct reasons is always less than percentage of correct answers. The lowest percentage of answers and reason is on GCS 3 related to heat and thermodynamic.

On scientific literacy-based test of GCS 3, students are given problems about heat. In accordance with indicator test, students are expected to be able analyzing and classifying the heat transfer process in daily life. Scientific literacy-based test of GCS 3 is presented in Figure 2.

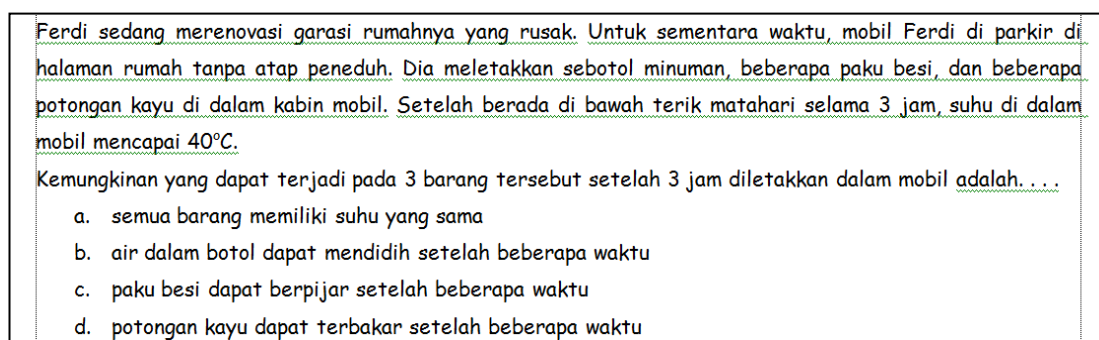


Figure 2. Scientific Literacy-Based Test of GCS 3

Figure 2 presents scientific literacy-based test of GCS 3 about heat. Test assigned to students classified into C4 difficulty level (analyze) on Bloom taxonomy. Students are expected to be able analyzing and classifying heat transfer process in everyday life. Result of student's answers can be seen in Tabel 4.

Tabel 4. Students' Answers Percentage of Scientific Literacy-Based Test for GCS 3

Answer Choices	Students Answered (%)	Correct Answer
A	40,00	A
B	14,00	
C	26,00	
D	20,00	

Tabel 4 shows that majority of students choose answer A on scientific literacy-based test of GCS 3. Scientific literacy-based test of GCS 3 reviews about phenomenon of convection heat transfer in daily life. The convection occurs on the air in car cabin due to warming by solar radiation. The heat from solar radiation will be spread evenly in the car's cabin by the gas substance, ie air. Convection that occurs affects the objects contained in system, in this case is car cabin. All objects in car cabin will have the same temperature after convection process. The majority of students have answered scientific literacy-based test of GCS 3 correctly, by 40%. Only 11% of students are able to

give reason appropriately. Students know that the state of objects in car cabin will have same temperature after 3 hours in car cabin. But students can not explain the heat transfer process that occurred. Based on the percentage of students' answers, it can be concluded that scientific literacy capability of senior high school students is not good enough. Students have not been able to explain the reason for answer the problem well according to the theory.

Comparison the percentage of students' correct answers between concept-based test and scientific literacy-based test is presented in Figure 3.

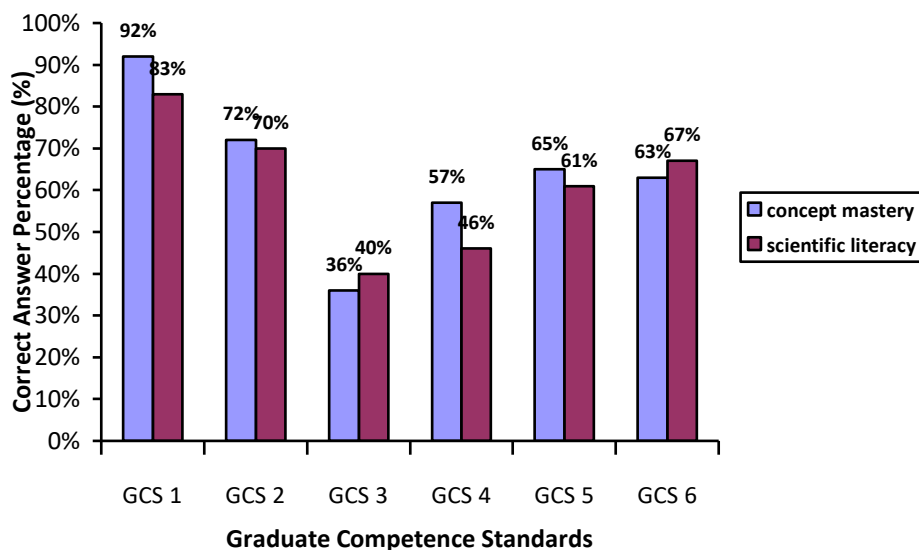


Figure 3. Comparison of Correct Answers Percentage

Figure 3 shows that the percentage of correct answers in concept-based test is higher than scientific literacy-based test in all GCS except GCS 3. In GCS 3, the percentage of correct answers in scientific literacy-based test is higher than concept-based test. Scientific literacy-based test on GCS 3 has simpler question than concept-based test. Question of scientific literacy-based test haven't any number and formula to solve it. In other side, question of concept-based test using any formula to solve. Some student has problem to remember the formula which used to solve it. Nevertheless, based on interviews with students, it found the fact that learning carried out by teacher refers to concept and calculation only. Teachers provide physics material based on books and worksheets without develop it in the other strategies like experiment or discussion. Students only accept simple concept and mathematical calculation without being explained about physical meaning. Students' habits in learning concepts make students' thinking levels more likely to know and apply in simple conditions (Sunarti, 2015). Science education curriculum must be according to students' condition and environment (Darner, 2014). Science should be taught based on students' experiences, attitudes, and self efficacy (Kazempour, 2014). Time limitation is the most popular reason why teachers do not experiment in laboratory. Science education implemented in schools emphasizes abstract conceptualization and less active experimentation, whereas both should be proportionally balanced (Prabowo et al., 2016).

The level of concept mastery and scientific literacy capability of students have same trend. Achievement of students' scientific literacy capability is proportional to level of concept mastery (Munawaroh dkk., 2018). Descriptively, it can be concluded that the level of students' concepts mastery affect the achievement of students' scientific literacy capability. Scientific literacy of students can grows supported by reading interest and learning concept mastery (Diana et al., 2015).

CONCLUSION

Concepts mastery and scientific literacy capability of senior high school students is not good enough. The average of correct answer percentage on concept-based test and scientific literacy-based test at the most 70%. The lowest students' concepts mastery level and scientific literacy capability is

on GCS 3 about heat and thermodynamics. Students' concepts mastery influences their scientific literacy capability. Trends of research results show that both have a relationship and influence each other. This research results could be a base for development of scientific literacy instrument evaluation for senior high school students.

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