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The Profile of Concept Mastery and Scientific Literacy Skills for Senior High School Students in Force Theme

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Abstract

The purpose of this study is to identify concept mastery and scientific literacy skills for senior high school students. This study used quantitative-qualitative mix method. The subjects of this study are 12th grade student in Boyolali Regency. The instruments of this study are concept-based and scientific literacy-based multiple choice test accompanied by the reason of force theme which consist of five competencies. The level of concept mastery and scientific literacy skills of students are analysed through the appropriateness of the choice of answers with reasons. The result shows that that concept mastery influences the students' scientific literacy skills. The lowest of students' concept mastery and scientific literacy skills is on the subject of Impulse and Momentum.

Keywords: Concept mastery, scientific literacy, force theme

1. Introduction

Science has an important role in improving the quality of education through high order thinking skills needed in life in order to realize qualified human resources (Meika & Karyanto, 2016). Science became one of foundations of life (Suma, Sadia & Pujani, 2018). This makes science very important to study in high school level. Science cannot be separated from every human activity and various phenomena that occur in the natural environment (Sujana, Permanasari & Sopandi, 2014). Specifically, the term "science" is interpreted as Natural Science (IPA) related to the effort to understand various phenomena of nature systematically (Rahayuni, 2016). **S**cience is one study that seeks to understand something that exists in nature based on empirical data. The basic ideas contained in science fit the verifiable facts (Glen & Janusa, 2010).

Science education builds students' way of thinking to understand phenomena or natural events by scientific methods such as those conducted by scientists (National Research Council, 1996). 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 (Toharudin, Hendrawati & Rustaman, 2011). 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 science literacy.

Scientific literacy is recognized internationally as a benchmark for the quality of education (Ardianto & Rubini, 2016). Scientific literacy is one of the spheres of PISA (Program for International Student Assessment) study that focuses on students' ability to use science knowledge and skills (Khasanah, Dwiastuti, & Nurmiyati, 2016). 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, Omar & Osman, 2012), 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 (Wardhani & Rumiati, 2011). Scientific literacy

classified in 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, Fillman & Sethna, 1991). The development of scientific literacy is needed in order to prepare students who are literate in the field of science Udompong, Traiwicitkhun & Wongwanich. 2014).

The literate students can apply concepts and facts which getted in learning to solving the problem in daily life (Arief, 2015). The good ability of scientific literacy means to have a good mastery of the concept as well. The results of research shows one dimension of science literacy is still in low percentage due to the mistake of the concept of material received by students in the learning process (Rohman, Rusilowati & Sulhadi, 2017). This condition encourages researchers to conduct preliminary research in order to obtain information about concept mastery and scientific literacy skills of high school students. The results of this study become a consideration to doing further research on the learning approaches in the 2013 curriculum that has been applied in senior high schools.

2. Methods

Method of this study is use qualitative-quantitative mix method. The subject of this study were 12th grade students of senior high school in Boyolali Regency. 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. Problem composed according to Physics Base Competencies of force theme that consists of five subjects, namely Newton's Law, Newton's Law of Gravity, Work and Energy, Momentum and Impulse, and Harmonic Vibration. 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 skills 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 skills of students.

3. Result and Discusions

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

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

No	KD	Correct Answers (N = 100) (%)	Correct Reasons (N = 100) (%)
3.7	Analyzing the interaction of forces as well as the relationship between force, mass, and movement of objects in a straight motion.	72.00	42.00
3.8	Analyzing the orderliness of planetary motion in the solar system according to Newton's laws.	92.00	73.00
3.9	Analyze the concept of energy, work, and energy changes, energy conservation laws, and its application in everyday events.	57.00	38.00
3.10	Applying the concept of momentum and impulse, as well as the law of conservation of momentum in everyday life.	36.00	17.00
3.11	Analyze the relationship between force and vibration in everyday life.	65.00	29.00

Table 1 presents the percentage of correct answers and correct reasons given by students on each KD. This percentage describes the level concept mastery 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 reasons is on KD 3.10 related to impulse and momentum.

On concept-based test of KD 3.10, students are given problems about conservative law of momentum. In accordance with indicator test, students are expected to be able integrating the conservative law of energy and momentum in any collision phenomena. Test assigned to students classified into C5 difficulty level (evaluation) on Bloom taxonomy. Students are expected to be able integrating the conservative law of energy and momentum in any collision phenomena. Result of student's answers can be seen in Table 2.

Table 2. Students' Answers Percentage of Concept-Based Test for KD 3.10

Answer Choices	Students Answered (%)	Correct Answer
A	44.00	B
B	32.00	
C	10.00	
D	7.00	
E	5.00	

Table 2 shows that majority of students choose answer B on concept-based test of KD 3.10. Question of concept-based test for KD 3.10 can be solved using the conservation law of momentum. The kinetic energy of object A decreases as the speed decreases. Conversely, B objects that increase in speed will increase kinetic energy. On the concept-based test of KD 3.10 both objects apply conservation law of momentum, so the momentum before and after the collision is constant. The collision that occurs is elastic because the two objects are in a different system after a collision. Only 36% of students were able to answer concept-based test of 3.10 correctly. Students who can answer the reason exactly is only 17%. This result indicates that concept mastery of senior high school students on KD 3.10 is not good enough. There are still many students who reason that the kinetic energy of object A and object B before and after the collision is the same. Although for the reason of the type of collision occurring most students have correctly answered that since the two objects after colliding separate collisions that occur are elastic.

Identification of students' scientific literacy capability has been done by providing scientific literacy-based test for students. The percentage of correct answers and correct reasons for scientific literacy-based test is presented in Table 3.

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

No	KD	Correct Answers (N = 100) (%)	Correct Reasons (N = 100) (%)	
3.7	Analyzing the interaction of forces as well as the relationship between force, mass, and movement of objects in a straight motion.	70.00	22.00	
3.8	Analyzing the orderliness of planetary motion in the solar system according to Newton's laws.	83.00	80.00	
3.9	Analyze the concept of energy, work, and energy changes, energy conservation laws, and its application in everyday events.	42.00	40.00	
3.10	Applying the concept of momentum and impulse, as well as the law of conservation of momentum in everyday life.	46.00	11.00	
3.11	Analyze the relationship between force and vibration in everyday life.	61.00	59.00	

Table 3 presents the percentage of correct answers and correct reasons given by students on each KD. This percentage describes scientific literacy skills 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 KD 3.10 related to impulse and momentum. On scientific literacy-based test of KD 3.10, students are given problems about the conservation law of momentum. In accordance with the indicator problem, students are expected to be able to analyze the momentum changes through experiment.

Test assigned to students classified into C3 difficulty level (application) on Bloom taxonomy. Students are expected to be able analysing the momentum changes by experiment. The result of student's answers can be seen in Table 4.

Table 4. Students' Answers Percentage of Scientific Literacy-Based Test for KD 3.10

Answer Choices	Students Answered (%)	Correct Answer
A	40.00	C
B	26.00	
C	14.00	
D	20.00	

Table 4 shows that the majority of students choose answer A on the science literacy question KD 3.10. The science literacy question KD 3.10 reviews about the concept of impulse especially formulating the concept of impulse and momentum, the linkage between both, and its application in life. The scientific literacy-based test 3.10 presents the results of experiments that students are asked to determine the largest impulse correctly. The impulse experienced by a moving object is proportional to momentum change of the object.

The majority of students have correctly answered the science literacy of KD 3.10, which is 46%. Only 11% of students are able to answer the reason appropriately. Students know the correct answer is greatest multiplication of mass and speed. But students cannot explain the concept of impulse as a change of momentum. Based on the percentage of students' answers, it can be concluded that the scientific literacy skills of high school students is good enough. It's just that the students have not been able to explain the reason for answer of problem well according to the theory.

In this case most students have not understood the interrelationship between impulse and momentum, they are still fixated on impulses as multiplication of styles and time intervals. They are confused to choose the correct answer, so there are still many students who are guessing and not biased to write the reason they choose the answer.

Comparison the percentage of students' correct answers between concept-based scientific literacy-based test is presented in Figure 1.

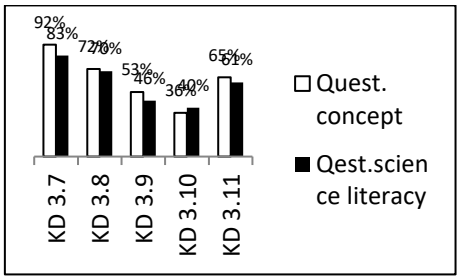

Figure 1. Comparison of Correct Answers Percentage

Figure 1 shows that the percentage of correct answers in concept-based test is higher than scientific literacy-based test in all KD. Based on interviews with students, it found the fact that learning carried out by teacher refers to concept and calculation only. The ability of students to understand the concepts and laws in physics and not yet optimal, especially on the material impulse and momentum. One of the contributing factors is that teachers more often teach practical formulas. Teachers provide physics material based on books and worksheets without developing 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. The ability of students in experimental and scientific work to be a factor in the mastery of science literacy, especially in the category of science as a way to investigate. Science education implemented in schools emphasizes abstract conceptualization and less active experimentation, whereas both should be proportionally balanced (Prabowo, Rusilowati & Nugroho, 2016). Thus, the development of the 2013 curriculum emphasizes scientific approaching learning by involving the active role of the students. the learning paradigm of teacher centered has been transformed into student centered, such as peer teaching, PBL, and inqury-based learning (Gormally, 2009).

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. 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, Rachmatulloh & Rahmawati, 2015).

4. Conclusions

Identification of concept mastery of concept and scientific literacy skills of senior high school students has been done. The results showed that concepts mastery and scientific literacy skills of senior high school students is good enough. The lowest students' concepts mastery level and scientific literacy skills is on KD 3.10 about impulse and momentum. Students' concepts mastery influences their scientific literacy skills. Trends of research results show both have a relationship and influence each other.

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