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The Science Literacy Capabilities Profile Using Guided Inquiry Learning Models

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Abstract

This research aims to find out the influence of guided inquiry learning models on the ability of scientific literacy in high school students in the city of Tangerang. This research is a pre-experimental design study that aims to determine the ability of scientific literacy by using a guided inquiry learning model for high school students in the city of Tangerang in Newton's law material. The research design used was One-Group Pretest-Posttest Design with a sample of 32 students of class X MIA 3 of SMAN 11 in Tangerang City. The average N-gain results for students of SMAN 11 Kota Tangerang amounting to 0.4060 are in the medium category. So it was concluded that the ability of scientific literacy by using the guided inquiry learning model of high school students in the Regency and City of Tangerang is in the medium category.

Keywords: science literacy, guided inquiry learning models, Newton's law

INTRODUCTION

Science literacy, according to PISA (Program for International Student Assessment) is the ability to use scientific knowledge, identify questions and draw evidence-based on conclusions to be able to understand and help in making conclusions about nature and changes to nature due to human activities (Udompong et al. 2014). Also, the assessment of scientific literacy in PISA not only consists of measuring the level of understanding of knowledge but also understanding of various aspects of the process, as well as the ability to apply knowledge and science processes in real discussions conducted by students, as individuals and members of the community (Usmaldi 2016). Science literacy is very important to master because of its wide application and almost in all fields (Demirel 2015; Flores 2018), therefore developed countries continue to work to improve the ability of scientific literacy in the younger generation to be able to be more competitive in the global workforce (Berman & Kuden 2017; Dichev 2017).

Science literacy is a person's ability to use scientific knowledge and processes to understand scientific phenomena in solving problems and making decisions (Ridho, Aminah, & Supriyanto 2018; Nikmah & Subali 2019). In other words, someone who is literate in science will be able to creatively utilize scientific knowledge in everyday life to solve problems and make decisions (Udompong et al. 2014; Efrat 2015). The main objective of learning science is to build students' scientific literacy, which is included in scientific literacy is about understanding scientific principles and understanding how these principles can be developed (Demirel 2015; Gurses et al. 2015). PISA is defined as the ability to use scientific knowledge, identify questions, and draw conclusions based on evidence, in order to understand and make decisions regarding nature and changes made to nature through human activities (Sülün, Dilek, & Onur 2009). Science literacy is very important for the understanding of science and its application to people's lives (Drago & Mih 2015).

There are three scientific competencies measured in scientific literacy, namely: a) identifying scientific issues or problems, namely recognizing problems that might be used for scientific inquiry, identifying keywords to find scientific information, and recognizing key features of scientific inquiry; b) explaining scientific phenomena that are applying knowledge in certain situations, describing and providing explaining scientific phenomena, and predicting changes precisely; c) using scientific evidence that is interpreting and identifying scientific evidence, assumptions, and reasons in making conclusions and communicating, this reflects on the social implications of science and technological development (Karimzadegan & Meiboudi 2012; Turiman et al. 2012; Efrat 2015). The ability of students in scientific literacy is closely related to the learning process carried out by teachers in schools (Nussbaum et al. 2012). Several learning models are seen to help and facilitate students to improve their scientific literacy skills (Ozmusul 2012).

The guided inquiry model is a learning model that can facilitate students to arouse curiosity, think scientifically, be able to conduct investigations, and gain knowledge by determining themselves under the guidance of the teacher (Stockdale et al. 2019; Muliwati et al. 2020). In the guided inquiry model, students are faced with searching, exploring, and finding concepts so that students' scientific literacy can increase (Pedaste et al. 2015; Thaiposri & Wannapiroon 2015).

Inquiry-based learning allows students to use science as a tool to find answers to problems related to real phenomena that occur (Suárez et al. 2018). In inquiry activities, students carry out experiments, collect data, identify patterns from the data, and construct explanations for the identified patterns (inductive reasoning) (Schramm 2017). Also, students compare what they think, discuss with others, and express what they get verbally and in writing (Belton 2016). The use of scientific literacy, in this case, is mainly to broaden the knowledge of scientific knowledge so that the ability of scientific reasoning is increasingly tested (Sözen & Sözen 2011). The inquiry learning model is a learning model that involves all students' abilities to search and investigate systematically, critically, logically, analytically so that students can formulate their findings with confidence (Wang 2012). Learning activities through inquiry exposes students to concrete experiences so that students learn actively, where they are encouraged to take initiatives in efforts to solve problems, make decisions and develop research skills, and train students into lifelong learning (Alameddine & Ahwal 2016; Decker-lange 2018).

The teacher's role in creating conditions of inquiry is as a motivator, facilitator, questioner, administrator, director, manager, and rewarder (Kamonratananun, Sujiva, & Tangdhanakanond 2016). This role similar when the teacher has to support students in Project-Based Learning. Teachers may need to change their beliefs about whom they are in the classroom, revising their role from director to facilitator (Morrison 2020). As a motivator, the teacher's role is to provide stimulation so that students are active and passionate in thinking. As a facilitator, the teacher shows a way out if there are obstacles in the student's thought process. As questioners, teachers must awaken students from their own mistakes. As an administrator, the teacher is responsible for all activities in the class. As a director, the teacher leads the flow of students' thinking activities towards the expected goals. As a manager, the teacher manages the learning resources, time, and class organization. As a rewarder, the teacher rewards the achievements achieved in order to increase student morale (Zeki 2013; Ogan-bekiro & Arslan 2014).

There are things that characterize the inquiry learning model. First, inquiry emphasizes student activities as learning subjects. In the learning process, students not only act as recipients of the lesson through verbal explanations by the teacher, but they also have a role in finding their core of the subject matter itself (Sung, Chang & Liu 2016). Second, all activities undertaken by students are directed to search for and find their answers to something that is questioned, so that it is expected to foster an attitude of confidence (Aun & Kaewurai 2017). Third, the purpose of using inquiry learning models is to develop the ability to think systematically, logically, and critically or develop intellectual abilities as part of mental processes (Kõiv 2016). Thus, in the inquiry learning model, students are not only required to master the subject matter but how they can use their potential (Idris 2013).

The superiority of the inquiry learning model is that it allows students to use all mental processes to find scientific concepts or principles. Many of the benefits include improving intelligence, helping students learn to do research, improving memory, avoiding memorizing teaching and learning, developing creativity, increasing aspirations, making the teaching process becomes student-centered

so that it can help better towards the formation of self-concepts, providing more opportunities for students to collect and understand information (Hong et al. 2019).

There are three types of inquiry learning models, including free inquiry, modified free inquiry, and guided inquiry (Pedaste et al. 2015). In this study, researchers used a guided inquiry learning model. The guided inquiry learning model is one of the alternative learning models in learning (Thaiposri & Wannapiroon 2015). The guided inquiry model is a learning model that can facilitate students to arouse curiosity, think scientifically, be able to conduct investigations, and gain knowledge by self-determination under the guidance of the teacher (Suárez et al. 2018). The guided inquiry model allows students to learn and practice in designing and analyzing data and applying the concepts obtained to achieve common goals (Hong et al. 2019).

Some research results show the advantages of inquiry in learning science. Learning with a guided inquiry model can increase student learning activities and creativity, which in turn will have an impact on learning outcomes. Learning with the guided inquiry model can motivate students in the learning process so that they can master the material taught (Decker-lange 2018). Learning based on guided inquiry models enables students to build knowledge in representations and helps students develop a conceptual understanding (Kamonratananun, Sujiva & Tangdhanakanond 2016).

The steps of implementing guided inquiry learning are divided into six, namely orientation, formulating problems, formulating hypotheses, collecting data, testing hypotheses, and formulating conclusions (Ö & Kabap 2010). The advantage in the inquiry learning model is that it allows students to use all mental processes to find scientific concepts or principles and many benefits include improving intelligence, helping students learn to do research, improving memory, avoiding the process of teaching and learning memorizing, developing creativity, improve aspirations, make the teaching process student-centered so that it can help better towards the formation of self-concepts, providing more opportunities for students to accommodate and understand information (Shamsudin, Abdullah, & Yaamat 2013; Vlassi & Karaliota 2013; Calenda & Tammara 2015). The aim of this research is to find out the influence of guided inquiry learning models on the ability of scientific literacy in high school students in the city of Tangerang.

METHODS

The method used in this study is the pre-experimental design method. This research will be conducted on students of SMAN 11 Kota Tangerang. The research design used in this study is the one-group pretest-posttest design. This design uses only one experimental class and does not use a control class. In simple terms, the research design used can be seen in FIGURE 1 below (Creswell 2013).



FIGURE 1. One group pretest-posttest design

Information:
 O_1 : pre-test
 O_2 : post-test
 X : Treatment

The population in this study was MIA Xth grade students in SMA Negeri 11 Kota Tangerang in the 2018/2019 school year. All students of class X MIA were selected as a sample. The sampling technique in this study uses samples taken at random. One class in the 11th City Public High School uses the guided inquiry learning model. The research instrument was used to measure the value of the variable under study. Thus the number of instruments to be used for research will depend on the number of variables studied. The research instrument is used to make measurements to produce accurate quantitative data, so each instrument must have a scale.

The assessment of scientific literacy ability measured the dimensions of the scientific process by using a description test of 10 items, which are given before the learning activities (pre-test) and after

the learning activities (post-test). The questions given during the pre-test and post-test are the same problem.

Scientific literacy data processing techniques are carried out with the analysis of N-gain to determine the increase in students' scientific literacy after learning (Novili et al. 2016). Before conducting research, students are given a pre-test. The pre-test is given to find out students' scientific literacy skills. Furthermore, after the pre-test, learning is carried out using the guided inquiry learning model. After treatment was given, the class was given a post-test. Post-tests were given to find out the results of students' scientific literacy skills.

RESULT AND DISCUSSION

The following are the results of scientific literacy capabilities that are treated through the guided inquiry learning model that can be seen in TABLE 1 below.

TABLE 1. Science literacy abilities

	N	Min	Max	Mean	Std. Deviation	Variance
Pre-test	32	13	67	41.06	14.569	212.254
Post-test	32	0	97	66.34	25.430	646.684

The results of pre-test data processing in TABLE 1 above, as many as 32 students with a minimum value of 13 and a maximum value of 67, so that the average value of 41.06, the standard deviation of 14.569, and variance of 212.254, while the results of post-test data processing with a minimum value of 0 and the maximum value is 97, so the average value is 66.34, the standard deviation is 25.430, and the variance is 646.684. Based on the data obtained that the ability of scientific literacy by using a guided inquiry learning model for students using essay tests results in an increase in the average value of the class at the pre-test of 41.06 and post-test at 66.34.

The literacy skills of students measured in this study are the dimensions of context, content, process, and attitude. The context dimension of science refers to situations in everyday life that are the land for the application of processes and understanding of scientific concepts. The average pre-test and post-test results in context dimension can be seen in TABLE 2 below

TABLE 2. The data on students' literacy ability in context dimensions.

Relevance	Pre-test	Posttest	N-gain
Science and technology	41.04	66.25	43%

Based on TABLE 2, the ability of scientific literacy dimensions of the context of science increases. This can be seen from the average pre-test value of 41.04, and after being given treatment, the post-test average value increased by 66.25. The increase in students' scientific literacy skills is also seen in the N-gain, where an increase in context dimension scientific literacy abilities becomes 43%. The results of the analysis show that the ability of scientific literacy in the context dimension is in the medium category.

Furthermore, the dimensions of science content refer to the fundamental concepts needed to understand natural phenomena and changes made to nature through human activities. The average results of the pre-test and post-test of students' scientific literacy abilities in the content dimension can be seen in TABLE 3 below.

TABLE 3. The data literacy abilities of students in the dimensions of content.

	Newton's First Law	Newton's Second Law	Newton's Three Laws
Pretest	0	39.43	59.38
Posttest	84.34	61.16	75.00
N-gain	84%	36%	38%

Based on TABLE 3, it is known that all dimensions of the measured scientific literacy content have increased, in Newton’s First Law by 84%, the acquisition of N-gain in Newton’s First Law is in the high category. In Newton’s Second Law, 36% is in a low category. Newton’s Three Law of 38% is in a low category.

The literacy ability of the dimensions of the content analyzed is the knowledge of Newton’s First Law, Newton’s Second Law, and Newton’s Three Law in the 2012 PISA framework (Sülün, Dilek and Onur 2009), included in the scope of physical system material related to motion and force (speed and friction). On this content dimension, in the material of Newton’s First Law, students already have high knowledge. In Newton’s Second Law, and Newton’s Three Law students have low knowledge. However, all students can solve problems related to the application of science in real life.

Furthermore, the scientific literacy ability of students measured in this study is the dimension of the scientific process, which includes three indicators, including the ability of students to identify scientific questions, explain scientific phenomena, and use scientific evidence. The average results of the pre-test and post-test scores per indicator of students’ scientific literacy ability can be seen in TABLE 4 below.

TABLE 4. The data on students’ literacy abilities in the process dimension.

No	Indicator	Pre-test	Posttest	N-gain
1.	Identifying scientific questions	41.67	46.88	9%
2.	Explain scientific phenomena	39.73	72.77	55%
3.	Using scientific evidence	48.96	59.34	20%

Based on TABLE 4, it is known that the N-gain results on indicator 1 (identifying scientific questions) obtain a value of 9% in the low category. The results of N-gain in indicator 2 (explaining scientific phenomena) obtained a value of 55% in the medium category. Furthermore, the results of the N-gain on indicator 3 (using scientific evidence) obtained a value of 20% in the low category.

The scientific literacy ability of the process dimension analyzed consists of three indicators, namely identifying scientific questions, explaining scientific phenomena, and using scientific evidence. In indicators identifying scientific questions, students are required to be able to recognize questions that might be scientifically investigated in a given situation, search for information, and identify keywords. In this indicator, students have not been able to investigate scientifically about the questions in the problem, so students have not been able to provide relevant answers. Therefore, the ability of scientific literacy on indicators to identify scientific questions is still low.

In indicators explaining scientific phenomena, students are asked to be able to explain and predict scientific phenomena, apply scientific knowledge in a given situation, and be able to identify descriptions, expansion, and predictions accordingly. On this indicator, students have been able to solve problems based on existing scientific phenomena and can connect science applications quite well or moderately.

In indicators using scientific evidence, students are required to be able to interpret scientific evidence and make conclusions. On this indicator, students have not been able to interpret scientific evidence and make conclusions. Therefore, students’ scientific literacy ability on indicators using scientific evidence is still low. The low factor of students in identifying scientific questions and using scientific evidence is that students spend more time with knowledge using memorization.

Furthermore, the ability of scientific literacy in the dimensions of attitude analyzed supports scientific inquiry and responsibility for natural resources and the environment. The results can be seen in TABLE 5 below.

TABLE 5. The data on scientific literacy abilities of students of attitude dimensions.

No.	Dimensions	Pretest	Posttest	N-gain
1.	Supports Scientific Investigations	35.83	72.5	57%
2.	Responsibility for Human Resources and the Environment	46.25	60.0	26%

Based on TABLE 5, the scientific literacy ability of attitudes toward indicators supporting scientific inquiry has increased, this can be seen from the average pre-test score of 35.83, and after treatment, the post-test average value increased by 72.5. An increase in students' scientific literacy skills can also be seen in the N-gain, where there is an increase in the ability of scientific literacy in the attitude dimension indicators to support scientific inquiry by 57%. The results show that the analysis of the ability of scientific literacy on the indicators of attitudes towards supporting scientific inquiry is in the moderate category. The ability of scientific literacy dimensions of attitudes towards responsibility for natural resources and the environment increases. This can be seen from the average pre-test score of 46.25, and after being given treatment, the average value of the post-test increased by 60. Increased students' scientific literacy ability can also be seen in N-gain, where there is an increase in the ability of scientific literacy in the indicator dimensions of attitude towards responsibility towards natural resources and the environment to 26%. The results show that the analysis of scientific literacy ability is in a low category.

CONCLUSION

Based on research that has been done, it can be concluded that the increase in student scientific literacy is based on the acquisition value of N-gain. The N-gain value obtained is 0.4046. This shows that the increase in scientific literacy is included in the moderate category. As a follow-up to this study, we provide suggestions for conducting research on scientific literacy using guided inquiry learning models in other materials and can manage time so that students' scientific literacy skills can be improved and the guided inquiry learning models can be implemented better. It can also use a module based on scientific literacy so that it can be used by teachers in learning.

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