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The Profile of Scientific Literacy and Self-Concept in Learning Physics

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Abstract

Based on the findings of interviews and preliminary observations, there are various issues with learning physics, including the continued use of the expository approach and a reliance on the capacity to recall topics without comprehending their significance. This study aimed to characterize the profile of students' scientific literacy and self-concept. The descriptive research approach was employed in this study, with a single case design. Learning observation sheets, interview sheets, scientific literacy tests, and student self-concept surveys were utilized as study instruments. The quantitative data acquired from questionnaires and tests in this study will be examined descriptively by percentage. Students' scientific literacy abilities are still rather low in general. Competency domain indicators for explaining scientific phenomena are in the medium category, obtaining a percentage of 78%, while competency domain indicators for evaluating and designing scientific investigations are in a low category, obtaining a percentage of 58%, and competency domain indicators for interpreting data and scientific evidence are in the deficient category, obtaining a percentage of only 46%. Students' attitudes toward learning physics are rated as modest. Based on the outcomes of this study, more in-depth research utilizing appropriate learning models is required to monitor success in physics learning and develop students' scientific literacy abilities.

Keywords: Learning Physics; Scientific Literacy; Self-Concept

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INTRODUCTION

Physics is a science that grows out of an interest in the universe and various observed natural phenomena observed. Based on the 2013 curriculum (K-13) there are several objectives to be achieved in learning, namely learning should be linked to providing experiences for students to create knowledge in their cognitive processes, and students must be able to master the principles of physics. Comprehension as one of the cognitive abilities that must be mastered by students to learn the principles of physics. After studying physics, students are expected to understand the material or concept as a whole and comprehensively.

Based on the results of interviews and initial observations at one of the public Islamic senior high schools in Deli

Serdang Regency, various problems in learning physics were encountered, including many students continued to chat with their friends during teaching and learning activities, did not focus when the teacher explained, hesitated to ask questions, the amount of subject matter while the time allocated for teaching and learning is limited, and students' interest in reading is low. Another problem for students is understanding questions in the form of calculations, as well as questions in the form of grouping several assertions during exercises at the end of the lesson.

In line with the results of the latest Program for International Students Assessment (PISA) study, namely in 2018, that of the 80 participating countries in the field of science. Indonesian students are ranked 75th. This study was published by The Organization for Economic Cooperation and Development (OECD). The average math score of Indonesian students is 375, the average reading score is 396, and the average science score is 382. In fact, the average OECD scores are 494, 496, and 501 respectively. According to PISA data, there is a decline in students' ability to have scientific literacy in Indonesia due to low scientific literacy. Regarding scientific literacy, the 2015 PISA evaluation revealed that Indonesian students scored 403 out of an average of 493 (OECD, 2015b). While the results of the PISA test in 2018 showed a decrease in student acquisition scores compared to 2015, in which they obtained a score of 396 from the OECD average of 489 (OECD, 2018).

According to Rusilowati et al. (2019) several factors are causing a decrease in acquisitions in aspects of students' scientific literacy in Indonesia because these aspects have not been fully implemented in the learning process, namely teaching materials or learning resources; the learning design used; media; student worksheet; and evaluation methods (Rusilowati et al., 2019). Scientific literacy is defined as the capacity to utilize scientific knowledge in recognizing problems and drawing conclusions based on available data to understand and make decisions about nature and changes produced by human activities (OECD, 2013). Scientific literacy prepares students to overcome twenty-first-century challenges, such as thinking critically and creatively to solve problems and communicate more effectively. Students must be able to use their scientific knowledge in dealing with science-related challenges through scientific literacy (Setiawan et al., 2021). Therefore, measuring scientific literacy is important for a reference for the government in evaluating and improving the quality of education. Students who are literate in science are expected to be able to become individuals who can innovate and become highly competitive (Saraswati et al., 2021).

In general, learning physics in class still uses explanatory techniques. The ability to memorize concepts without knowing their meaning is more important in learning physics. Many students, unfortunately, are unable to relate scientific knowledge to everyday life, instead most of them are only able to memorize theories. Such practice could be blamed for the failure of objective achievement in science. For this reason, using scientific literacy, students will be able to expand their thinking about concepts and events seen in everyday life. Scientific literacy is very important in studying science, especially nowadays when countries are faced with many everyday problems that require scientific knowledge and scientific thinking methods to make policies and decisions.

Student learning experiences can be evaluated based on their learning achievements. Therefore, it is necessary to have a positive self-concept towards learning. In line with what is actually in students, which aims to achieve optimal learning achievement. Self-concept broadly refers to students' perceptions of themselves and generally consists of two components: academic and non-academic (Shavelson et al., 1976). While the academic component includes a person's self-concept specifically for general school subjects, the non-academic self-concept includes social, emotional, and physical self-concept (Marsh & Craven, 2006). Students with good self-concepts can overcome obstacles in everyday life, be more confident and independent, and have no negative thoughts such as worry, excessive fear, and feelings of loneliness (Palloan et al., 2021).

A positive self-concept's importance will positively impact one's behavior and attitudes in learning (Astalini et al., 2019). As a result, efforts or interventions to improve students' self-concept towards their lessons need to be pursued. According to Symonds (Hall & Lindzey, 1978), the idea of "concept" in the sense of self-concept includes four aspects: views or opinions about himself, thoughts or speculations about himself, judgments or appreciation about himself, and actions about his growth. Several studies have revealed that self-concept is the main predictor of student achievement (Chao et al., 2018; Chen et al., 2015; Erten & Burden, 2014; Marsh, 1985). In contrast to previous studies, a comprehensive study of students' scientific literacy was carried out by administering tests of scientific literacy abilities by measuring the competency domains of explaining or describing phenomena/symptoms scientifically, evaluating and designing scientific investigations, and scientific interpretation of facts and evidence. As well as a review of students' self-concept regarding the three dimensions of measurement, namely, knowledge, expectations, and assessment. This is done to describe students' scientific literacy and self-concept comprehensively. So, based on this, the current research aims to thoroughly characterize students' profiles and abilities towards scientific literacy and self-concept in physics learning.

METHOD

In conducting this research, a descriptive research approach was used with a single case design. Descriptive research investigates the state of something concerning current or previous conditions. This type of research only covers a group of individuals' achievements, attitudes, habits, or other qualities. Descriptive research describes facts as they are and does not manipulate independent variables (Millan & Schumacher, 2001). Meanwhile, single-case research is research that focuses on one case.

All of the tenth-grade students who took the physics subject on parabolic motion material at one of the Islamic senior high schools in Deli Serdang Regency were included in this study. This research involved 32 class X students from one of the Islamic senior high schools in Deli Serdang Regency. Convenience sampling was used to take samples.

The instruments used consisted of (1) learning observation sheets; (2) scientific literacy test; (3) self-concept questionnaire; and (4) teacher and student interview sheets. Observation sheet instruments are made to find out how far the teacher is in carrying out learning activities. The observation sheets are divided into two sections: one for teachers and one for students. Observation sheets made include teacher learning models/methods as well as observation sheets of students' actions in learning activities. The test to measure scientific literacy consists of multiple-choice questions. The capacity to measure it can be obtained by looking at students' abilities in each aspect (Rusilowati et al., 2016). The competency domain studied in this study is the realm of scientific literacy. Indicators from the domain of competence include understanding phenomena scientifically, assessing and designing scientific research, and analyzing data and evidence scientifically (OECD, 2015a). The test instrument used in this research has been evaluated for validity and reliability so that it can continue to be used in research.

Three aspects of self-concept measurement described by Calhoun are used in this study, including knowledge, expectations, and judgments. The overall score generated from the respondents' responses measures the cognitive aspect, meaning the student's understanding of their situation, and the emotive aspect, namely the student's assessment of himself. The student physics self-concept variable instrument consists of 31 statement items separated into negative and positive statements. The statement includes 4 answer options, namely Disagree; Strongly Disagree; Agree; and Strongly Agree. Each recommended answer choice gets a score ranging from 1 to 4. The sum of all item scores results in a variable score. The self-concept variable instrument applied in this study has been evaluated for its validity and reliability so that it can continue to be used in research. Teacher interview sheets were made with the aim of exploring the learning system carried out by the teacher starting from the opening, core and closing stages of activities. The aspects asked in the interviews were adjusted to the learning aspects contained in the questionnaire, including the clarity of subject matter, the existence of real experiences in learning (demonstrations and experiments), student involvement in learning, practice questions, evaluation and student paradigms about physics subjects. According to Riduan (2004), data obtained from questionnaires and tests in this study will be analyzed descriptively through the following stages: (1) perform calculations on the respondent's scores from each aspect or sub-variable; (2) record value; (3) perform calculations on the average value; and (4) calculate the percentage value and determine student gains, concerning Table 1.

Table 1 Categories for descriptive analysis in percentage

Percentage	Description
$0 \leq M \leq 55$	Very low
$55 \leq M < 65$	Low
$65 \leq M < 80$	Medium
$80 \leq M < 90$	High
$90 \leq M < 100$	Very high

RESULTS AND DISCUSSION

Based on the results of observations and administration of scientific literacy tests in the field, several things were obtained:

An observation about the learning model/method performed by teachers

During the research, the researcher also observed the teacher in teaching. The teacher generally delivered the material using the lecturing method interspersed with several questions and a discussion of questions. The teacher performed an apperception and encouraged learning motivation. Sometimes, the teacher conducted a demonstration before forming a group but did not analyze some of the student's performance and only evaluated the results of the practicum report completed by the students. The teacher did not ask students to present the results in front of the class, instead, she walked around while justifying student answers in the form of calculation results. Conclusion of the practicum result was not openly delivered in front of the class but only confirmed to each group.

The results of other observations of researchers are: (1) From beginning to end, the teacher implements a lecture technique that is woven with questions and answers and discussion of sample questions; (2) Passive students, just sitting quietly, watching, or talking to other students; (3) Students answered the teacher's questions during the lesson, some were able to answer, but some were silent without answering; (4) Only a few students dared to try in front of the class to answer the exercises given by the teacher, while others did not even do the exercises given by the teacher; and (5) At the end of the lesson the teacher concluded the subject matter that has been studied and sometimes gives assignments at the end of the lesson.

An observation about students' activities

All students paid attention to the apperception and motivation session by the teacher, some students who sat at the back did not listen carefully to the teacher's explanation and only a few students at the front paid attention to the teacher's demonstration. The students were enthusiastic about asking and responding to teacher questions and favored working in groups and sharing their ideas.

Results of the Scientific Literacy Test

One of the main goals of learning physics is to develop scientific literacy, which means recognizing that the content being taught to students is more than rote learning. The nature of physics learning is closely related to processes and products. The process of learning physics aims to train the ability of the scientific method in students. Products in learning physics are in the form of theories, laws, principles and concepts of physics. Students revealed their understanding of the subject matter. The relevance of scientific literacy in the teaching and learning process significantly impacts attitudes, decisions, and problem solving methods. Table 2 below presents the results of an assessment of students' scientific literacy abilities.

Table 2 Student's scientific literacy test results

Indicators	Items	Mean	Categories
Explaining and describing natural phenomena scientifically	1, 2, 10, 14, 19	78	Medium
Evaluating and designing scientific investigation	3, 4, 5, 9, 11, 13, 15, 16, 17, 18, 20, 21, 22, 23, 25	58	Low
Scientific interpretation of facts and evidence	6, 7, 8, 12, 24	46	Very low

Based on Table 2, the competency domain indicators that explain phenomena scientifically are in the medium category, with an acquisition percentage of 78%, the competence domain indicators that assess and design scientific investigations are in a low category, with an acquisition percentage of 58%, and competency domain indicators of interpreting data and scientific evidence are in the very low category, with a percentage gain of only 46%.

Questionnaire of Students' Self-Concept

The results of the self-concept questionnaire obtained by students are presented in Table 3.

Table 3 Result of students' self-concept questionnaire

Competency Domain Indicators	Questionnaire Items	Mean	Categories
What the students know about physics	1, 5, 6, 11, 17, 22, 23, 25	67	Medium
Students' perspectives about learning physics optimally	2, 3, 4, 7, 8, 9, 13, 16, 18, 21, 28, 31	69	Medium
Students' judgment on how much they like physics	10, 12, 14, 15, 19, 20, 24, 26, 27, 29, 30	69	Medium

The results of the scientific literacy test show unfavorably low result. This can be seen from various indicators of competence, including the medium, low and very low categories. Based on Table 2, indicators of the competency domain in explaining phenomena scientifically are in the medium category with an acquisition percentage of 78%. In comparison, the competence domain indicators assess and design scientific investigations are in a low category with an acquisition percentage of 58%. Competence domain indicators interpret data and evidence scientific knowledge in the very low category, with a percentage gain of only 46%.

The ability of students' scientific literacy in the realm of scientifically describing phenomena is in the moderate range because they cannot remember and apply relevant scientific information. This finding is relevant to previous research (Utama et al., 2019). Furthermore, a study by Ning et al. (2020) showed that some students could not predict the events around them and the changes that occurred due to these events. Specific indicators for competency domain indicators "explain or describe phenomena scientifically" include reviewing and implementing relevant scientific knowledge, utilizing, identifying, and producing clear representations, making and justifying predictions appropriately, offering explanatory hypotheses, and explaining potential implications of social science of scientific knowledge (OECD, 2015a).

Indicators of the competency domain "evaluating and designing scientific investigations" include indicators such as distinguishing questions that are likely to be investigated scientifically, identifying questions to be investigated in a particular scientific study, evaluating how to scientifically investigate a given question, explaining and evaluating the various methods scientists use to ensure data consistency, as well as proposing ways to investigate a given question (OECD, 2015a) scientifically. As seen in the table, this indicator is in the low range.

The indicator with the lowest acquisition is the domain of competence in the scientific interpretation of facts and evidence. These findings are related to previous research (Merta et al., 2020). The decline in students' scientific literacy abilities in aspects of the realm of analysis of facts and scientific evidence is caused by the inability of students to analyze data and draw appropriate conclusions. Specific indicators fall within the domain of "interpreting data and scientific evidence" indicator, which includes transforming data from one representation to another, analyzing and interpreting data and drawing appropriate conclusions, identifying assumptions, evidence, and reasoning in scientific texts, differentiating arguments based on about the scientific proof of theories based on reasoning, and evaluating scientific arguments and evidence from various sources (e.g. newspapers, journals and the internet) (OECD, 2015a).

The explanation strengthens that scientific literacy is in the low category caused by the lack of experience dealing with physics problems based on scientific literacy. This can be seen in teachers who do not assist and support students while studying and working on physics questions (Irwan, 2020). Another cause is learning that relies on memorization and formulas, with the main goal not being processed (Arisman, 2015), and online learning activities that do not involve practicum and experimentation (Farikhatul et al., 2021) are the causes of low scientific literacy in students. The results of students' scientific literacy tests were not optimal, presumably caused by students' lack of familiarity with answering teacher questions, expressing their ideas, and responding to other students' ideas, reporting and comparing group discussion results so that it was recommended to teachers to guide, motivate, and facilitate students to develop students' scientific literacy abilities. This is relevant to the research results, which state that students' low scientific literacy abilities are caused by their inability to solve problems related to scientific literacy that require understanding and problem analysis. Students are more used to solving problems that only require memory of the material they have learned (Sutrisna, 2021). Other research shows that one of the triggering variables for inadequate scientific literacy is that students are not used to working on questions that require in-depth analysis (Huryah et al., 2017).

In addition to scientific literacy, data regarding students' physics self-concept was also obtained. Achievement of self-concept students belong to the medium category. This can be proven by the results of interviews and survey results of questionnaires that students have filled in. From the self-concept questionnaire conducted by the students, it was found that the majority of students still felt less interested and excited about physics lessons. In general, students are less motivated towards physics lessons, several factors that cause this include: (1) Students feel bored with physics lessons because of the teacher excessive use of the lecture method; (2) There are too many formulas that must be understood and memorized; and (3) Students feel they failed in understanding the lesson, this is due to the teacher's incomplete explanation and limited time. The following are the results of exploring what students are looking for when learning physics: (1) Students expect the teachers to apply innovative and creative learning models, so they are not boring; (2) Students want to do physics experiments; and (3) Learning is interspersed with games related to physical phenomena. This is consistent with research findings which state that the causes of low student self-concept are a lack of questions that stimulate brain activity to be more active in thinking, low student interest and motivation, low student creativity, and less varied and less attractive teacher methods (Syah & Busra, 2018). Motivation increases efficiency and causes a person to use his talents and abilities at a higher level and with greater satisfaction. If people are not sufficiently motivated to learn, they will not want to learn, will not get good grades, and will not have a better academic achievement (Rahmanyar et al., 2022). This is consistent with the research findings of Saß and Kampa (2019), which explain that motivational variables such as self-concept are important predictors of student learning success.

CONCLUSION

Based on the research findings, it can be concluded that students' scientific literacy, in general, is still relatively low. Competency domain indicators in explaining or describing phenomena/symptoms scientifically are in the medium category with an acquisition percentage of 78%, while competence domain indicators in evaluating and designing scientific investigations are in a low category with an acquisition percentage of 58%, and competence domain indicators in the category low. Scientific interpretation of facts and evidence is included in the very low category, with a percentage gain of only 46%. It can also be seen that students have moderate self-concept when studying physics. Based on the findings of this study, additional in-depth research is needed to apply appropriate learning models, methods and strategies to observe success in learning physics and increasing students' scientific literacy abilities.

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