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An Analysis of Teacher Candidates Scientific Literacy through Nature of Science (NoS) in Inquiry-Based Learning

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Abstract: The purpose of this study is to determine the scientific literacy of teacher candidates through Nature of Science (NoS) in Inquiry-Based Learning. This research uses descriptive research method with quantitative approach. The subjects in this study were 24 students in the A4 class of Teacher Candidate study program. The researchers used the scientific literacy test, observation, and documentation instruments to analyze students' scientific literacy. The indicators of scientific literacy that are used refer to the scientific literacy according to PISA. The results showed the achievement of scientific literacy of students with a high category of 62.5%, with a moderate category of 25%, and a low category of 12.5%. Meanwhile, the achievement of each indicator in each aspect of scientific literacy shows that student literacy related to the achievement of the scientific context aspect is 84.83%, the aspect of science knowledge is 86.32%, and the aspect of science competence is 81.99%. The mean percentage of students achieving scientific literacy from all aspects is 84.38% with a high category. Thus, it can be concluded that lectures through Nature of Science (NoS) in Inquiry-Based Learning can be used to improve students' scientific literacy.
Keywords: Science Literacy, Nature of Science (NoS), Inquiry-based Learning

1. Introduction

Science is a scientific study that focuses and explains natural phenomena and their interactions (including interactions of matter and energy, and involves biotic and abiotic components) [1]. Entering the 21st century, the key to the success of a country lies in mastering science and technology. Science is used to build the character of society and nation because in science it contains knowledge that continues to grow, science processes that can be applied in other fields, and in science also instill scientific values and scientific attitudes in them [2]. Science exists to shape the behavior and character of a person to care and responsibility towards himself, society, and the universe is what is called scientific literacy [3] .

Science literacy is knowledge and scientific skills that possessed by someone to be able to identify questions, understand the characteristics of science, gain new knowledge, explain scientific phenomena, draw conclusions based on facts, know the relationship of science and technology in shaping the natural, intellectual, and cultural environment, and desires to participate and care about issues related to science [4]. The aspect of scientific literacy refers to the PISA framework (OECD, 2015) including: Context, Knowledge, Competency and Attitude aspects [4].

Science Literacy Assessment according to the Program for International Student Assessment (PISA) not only measures the level of mastery of science in knowledge, but also mastery in aspects of the scientific process, as well as skills in applying science knowledge and processes in students' daily lives, both students in individual situations, in society, as well as citizens of the world. Over the past four years, Indonesia's ranking has dropped in the PISA evaluation. Indonesia's position is declining in all fields, namely reading, mathematics, and science. Based on the results of the 2018 PISA study, Indonesia's ranking dropped compared to the results of the 2015 PISA. In the science level, Indonesia ranked 9th from the bottom of 79 countries [5].

Improving the quality of education in Indonesia is a reflection of the evaluation of the Indonesian people on the results of the PISA assessment. The achievement of the PISA Indonesia assessment in 2018 showed that the education in Indonesia has not been able to increase student scientific literacy. The low yield of students' scientific literacy is predicted to be related to the science learning process that has not provided opportunities for students to develop scientific literacy abilities. This is in line with the study material sought by Indonesian education minister Nadiem Anwar Makarim, namely "improving the quality of learning becomes the main thing". He continued "The government will involve teachers and parents and provide sufficient space for relevant parties to be able to get involved and participate in learning" [5].

Improving the quality of learning can be done by applying creative and innovative learning. Teachers are required to build and improve students' scientific literacy by packaging learning that is able to increase the scientific literacy [6]. One of the lessons deemed appropriate for increasing student scientific literacy is inquiry-based learning. Inquiry learning is one of learning which is in line with 2013 curriculum and fulfills science learning [7]. Inquiry-Based Learning is one of the learning models that plays an important role in constructing constructivist learning paradigms that emphasize student learning activeness. Through inquiry learning models, students are trained to develop fundamental scientific abilities which include observing, classifying, calculating, formulating hypotheses, making space and time relations, measuring, interpreting data, and designing experiments [8]. According to Widowati (2017) inquiry-based learning can be integrated with Nature of Science [9].

The origin of the word Nature of Science is based on the epistemology of science which states that science is a means used to know or judge and trust that is attached to the development of scientific knowledge [10]. Next, Lederman mentioned "NOS refer to epistemological underpinnings of the activities of science and the characterics of the resulting knowledge". It means that NOS epistemologically is a scientific activity and the basic characteristics that result from the formation of knowledge [11]. Correspondingly, Driver et al. (in Lederman) believes in making, managing and processing technology in everyday life, making decisions on social scientific issues, having an attitude of respecting the value of science as a culture, developing an understanding of the norms of scientific activities that are useful in realizing moral beliefs that are common to the community, and facilitating problems in science learning requires a very important role in understanding NOS. So that Nature of Science is very closely related to scientific literacy [11]. Holbrook & Rannikmae (2009: 281) Scientific literacy is closely related to investigation and Nature of Science (NoS) As shows that "Understanding of Nature of Science (NoS) plays an important role in the development of scientific literacy" [12].

Inquiry-based learning provides understanding of NOS. Wenning gave the following statement about inquiry "inquiry lessons are a great way to teach NOS explicitly" "the best way to explicitly NOS through inquiry learning [13]. Furthermore, Wenning asserted that "Pre and post labs provide opportunities for explicit instruction about NOS" means that activities in the laboratory before and after can provide opportunities for instructions to make explicit NOS in it [13]. Inquiry-based learning can be useful for students when learning and understanding the process of scientific knowledge and scientific skills. Understanding NOS has aspects that contain the understanding that what is called science is temporary (tentative), science is empirical based, empirical knowledge is a product of observation and conclusion (subjective), science is a creative product of thinking (imagination and creativity), science is related to social culture, scientists use many methods to develop science (various research methods), and science is connected between theory and scientific law [9] [14].

Based on this, it is important to apply inquiry-based learning through Nature of Science (NoS) in elementary science education lectures as an effort to improve competitiveness of human resources entering the 21st century. The integration of inquiry-based learning and NoS is believed to optimize the scientific literacy [15]. From the above studies, it is important for the authors to conduct An Analysis of Teacher Candidates Scientific Literacy through Nature of Science (NoS) in Inquiry-Based Learning.

2. Method

This research uses descriptive research method with quantitative approach. Quantitative descriptive research aims to describe, explain, or summarize various situations, conditions, and phenomena as well as various variables in research based on events as they can be extracted and revealed using research tools and documentary materials [16]. The subjects of this study were the 24th grade teacher candidates. Data collection techniques are done through scientific literacy tests, observation, and student documentation. Then, the data are analyzed by calculating the achievement of students' scientific literacy. In this research, the literacy aspects to be analyzed are the context, knowledge and competence aspects.

Research data about students' scientific literacy related to context, knowledge and competence will be analyzed by calculating the percentage. The percentage of students' scientific literacy will then be interpreted descriptively based on the depth categories of scientific literacy, as follows:

Table 1. Categories of Student Science Literacy Depth

Score	Category
<56	Low
56 – 75	Medium
76 – 100	High

PISA (OECD, 2016) [4]

While the acquisition of research data on student scientific literacy in each aspect of scientific literacy is obtained by calculating the percentage of achievement of student scientific literacy test results per indicator. Next, calculate all aspects of scientific literacy by calculating the mean percentage of each indicator in each aspect of student scientific literacy, namely context, knowledge, and competence.

Results and Discussion

This study aims to analyze the scientific literacy of teacher candidates through Nature of Science (NoS) in Inquiry-Based Learning. The implementation of elementary school science education using the inquiry-based learning model and explicitly integrating the NoS in the lecture.

Based on the results of the study, it showed that science literacy scores obtained by students indicate the level of scientific literacy. Achievement of student scientific literacy can be obtained from the calculation of the mean percentage of students in answering questions correctly. Students who reached the high category reached 62.5% as many as 15 students. Students who reached the medium category by 25% were 6 students. Students who reached the low category of 12.5% were 3 students. The graph of students' scientific literacy achievement can be seen in the following figure:

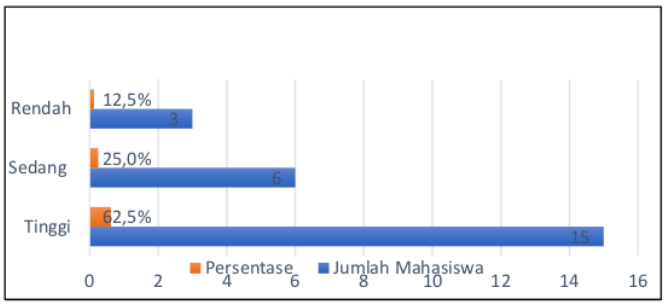

Figure 1. Teacher Candidates Science Literacy Category

The achievement of science literacy ability of teacher candidates in each aspect of scientific literacy can be described as follows:

3.1 Context

The context of science literacy context of students emphasizes the importance of knowing and understanding the context of science applications and being able to apply science in solving real problems both related to personal, social, and global life. Following are the achievements of teacher candidates' scientific literacy in the context aspect.

Table 2. Achievement of Student Context Aspects

Science Literacyaspect	Indicator	Percentage of Depth of Context	Depth Category
Context	Personal	91,54	High
	Social	87,88	High
	Global	75,08	Medium
	Mean	84,83	High

The data in the table above shows that scientific literacy in the context aspects of teacher candidates seem to be the highest personal indicator achieved by students, specifically 91.54% with a high category, social indicators achieved by students namely 87.88% with a high category. Whereas in the global indicator, student achievement was 75.08% in the medium category. The mean students scientific literacy in the context of science is 84.83% with a high category. Thus, it can be interpreted that students are able to deal with scientific problems in a personal, social and global context.

Knowledge

The aspects of scientific knowledge according to PISA (OECD, 2016), there are three competencies that needed for scientific literacy to form knowledge which are content knowledge, procedural knowledge and epistemic knowledge. Following are the achievements of teacher candidates' scientific literacy in knowledge aspects.

Table 3. Achievement of Student Knowledge Aspects

Science Literacy aspect	Indicator	Percentage of Depth of Knowledge	Depth Category
Knowledge	Content knowledge	92,79	High
	Procedural Knowledge	90,75	High
	Epistemic knowledge	75,42	Medium
	Mean	86,32	High

Based on the table above, it shows that teacher candidates' scientific literacy in the science knowledge aspect shows that the highest students' achievement in the content knowledge indicator is 92.79% with a high category, procedural knowledge indicators are in the second rank that is 90.75% with a high category, and epistemic knowledge indicators obtained the lowest achievement of 75.42% in the medium category. The mean student achievement of all indicators in the aspect of knowledge amounted to 86.32. It can be concluded that students are able to handle scientific problems in personal, social, and global contexts with a high category.

3.3 Competency

The competency aspect intended by PISA is to explain scientific phenomena, evaluate and design scientific investigations, and interpret scientific data and evidence. Following are the achievements of teacher candidates' scientific literacy on competency aspects.

Table 4. Achievement of Student Competency Aspects

Science Literacy aspect	Indicator	Percentage of Depth of competency	Depth Category
Competency	Explain scientific phenomena	87,58	High
	Evaluate and design scientific investigations	75,29	Medium

Interpret data and evidence	scientific	83,08	High
Mean		81,99	High

From the data in table 4, it is obtained that in the aspect of scientific competence, the achievement of indicators explaining scientific phenomena is 87.58% with a high category, indicators evaluating and designing scientific investigations are 75.25% with medium categories. Furthermore, the indicators interpreting data and scientific evidence obtained an achievement of 83.08% with a high category. While the mean student achievement on competency aspects is 81.99. So, it can be concluded that teacher candidates are able to master scientific literacy in the competency aspect with a high category.

Based on the data achievement of students scientific literacy on each indicator which is in each aspect obtained that data on the mean percentage of students in one class can be seen as follows:

Table 5. Mean aspects of student scientific literacy

Science Literacy aspect	Percentage of Depth Science Literacy aspect	Depth Category
Context)	84,83	High
Knowledge	86,32	High
Competency	81,99	High
Mean	84,38	High

From the data above, it shows that the mean percentage of students scientific literacy achievement from the context, knowledge, and competence aspects of 84.38% with the category of mastery of the aspect of high scientific literacy aspects. Thus, it can be seen that lectures through Nature of Science (NoS) in inquiry-based learning can be applied well. This is in line with the results of Arika Masruroh's research that integrated inquiry-based learning tools of NOS are very valid, practical, and effective to implement [9] [17]. Whereas according to the results of research, Noer Hardianty said that scientific literacy does not only emphasize the mastery of science concepts, but also emphasizes how science is obtained (NOS) [15]. Next, Mc. Donald & Dominguez (in Salamon) provides the statement that scientific literacy includes the ability to understand Nature of Science (NoS) which is in line with science inquiry-based learning which includes the design of experiments, the collection and analysis of data, and drawing conclusions based on scientific evidence [18].

Conclusion

The results showed that the mean percentage of scientific literacy depth of teacher candidates in the high category was 62.5%, the moderate category was 25%, and the low category was 12.5%. Meanwhile, mastery of aspects of scientific literacy according to the results of the study showed that student scientific literacy related to mastering aspects of the scientific context was 84.83%, aspects of science knowledge amounted to 86.32%, and aspects of scientific competence amounted to 81.99%. While the percentage of scientific literacy of students in the context, knowledge and competence aspects has an mean of 84.38% with a high category. Thus, it can be concluded that the application of Nature of Science (NoS) in Inquiry-Based Learning can be used to improve students' scientific literacy abilities.

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