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Analysis of students' initial scientific literacy of science in elementary school teacher education student

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Abstract: This study aimed to determine the level of scientific literacy possessed by prospective elementary school teachers. This study used a qualitative method with a descriptive quantitative design. Forty-four students of primary education participate in the subject of study. Data was collected through an online questionnaire survey. The expert reviewed the statement in the questionnaire and declared it could be used for data collection. The data were analyzed descriptively. The results of this study indicate that students' scientific competence is in an excellent category with 66.08% and that identifying scientific problems is in a good category with 58.33%. In addition, the ability to explain scientific phenomena is in a very good category with 71.60%, and the ability of scientific evidence is very good with 69.17%. Generally, student literacy level is in a very good category.

Keywords: scientific literacy, Science Competences

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INTRODUCTION

Scientific literacy is essential in daily life, especially in the digital age. The emergence of various problems related to science and technology requires empowering individuals to decide to participate personally in public policy-making. Scientific literacy can be defined as using scientific knowledge to identify problems and make a conclusion based on evidence (Yuliati, 2017). We believe an effective and efficient framework for scientific literacy is essential, including solutions to minimize the distractions and problems, i.e., in the educational process. However, there is an assumption that promotes unnecessary or irrelevant scientific literacy. The promotion is based on the fact that there is no direct correlation between literacy and daily life. Although literacy cannot solve human life problems, it provides society with tools and a common ground for understanding science and solutions to distractions and problems (McCaffrey & Rosenau, 2012).

Scientific literacy is quite popular in the educational field and gets serious attention from the practicionaire and academia. It is different from the general assumption of literacy. Scientific literacy is essential to learn, especially for primary and secondary level students, because by mastering scientific literacy, they will quickly solve problems (Chusni & Hasanah, 2018). There is an essential and often unquestionable assumption of the importance of achieving higher scientific literacy and increasing the ability to apply deep scientific knowledge in everyday life.

This assumption can be explained as follows: "If someone knows enough about science, he will apply it deeply in his daily life. In other words, there is an assumption that the direct influence of scientific knowledge can influence individual decisions and behaviour (Naila & Khasna, 2021). The development of scientific literacy is essential because it is related to the benefits for society, science, the country, and personal life improvement (Laugksch, 2000).

Scientific literacy has been accommodated in the Indonesian Curriculum since 2006 in the Education Unit Level Curriculum (KTSP) and more clearly in the 2013 Curriculum (K-13). K-13

emphasizes learner-centred learning through the scientific method and the inquiry process through various stages of the scientific method. The scientific method is the starting point or point of view taken by teachers to imitate scientists because this method imitates the scientific method used by scientists to find knowledge (Krogsgaard et al., 2011).

The aspect of scientific competence refers to the psychological processes involved in answering or solving problems. The 2012 PISA scientific literacy assessment focused on several aspects of scientific ability: identifying scientific problems, interpreting scientific phenomena based on scientific knowledge, and drawing conclusions using scientific evidence (Wulandari, 2016). PISA 2012 assessment priorities in scientific literacy focus on several aspects of scientific competence, presented in Table 1 below (OECD, 2017).

Table 1. Aspects of Science Competence PISA 2012

Indicator	Information
Identify scientific problems	Identify issues that may be investigated scientifically
	Identify keywords for scientific information
	Recognize the key features of scientific inquiry
Explain scientific phenomena	Applying scientific knowledge in a given situation
	Describing or interpreting phenomena and predicting change
	Identify appropriate descriptions, explanations, and predictions
Using scientific evidence	Interpret scientific evidence and draw conclusions
	Identify the assumptions, evidence, and reasons behind the conclusions drawn.
	Provide reflection based on the social implications of scientific conclusions.

PISA defined three component aspects as measured in scientific literacy. The three skills are identifying scientific issues, explaining scientific phenomena, and using scientific evidence (Bybee, 2009).

The first aspect is identifying scientific issues. This aspect requires a student to recognize possible problems that can be carried out by scientific investigations, determining and identifying keywords for scientific information, and recognizing the main features of scientific investigations. The second aspect is to explain scientific phenomena that apply science in certain situations, explain phenomena and predict changes, provide appropriate descriptions, provide scientific explanations, and provide predictions. The last aspect is using scientific evidence, namely interpreting scientific evidence and drawing conclusions and communicating, identifying assumptions, evidence, and reasons behind conclusions, and rethinking the social significance of science and the development of science and technology (Winata et al., 2016).

Previous research has highlighted the potential benefits of integrating science literacy teachings, such as identifying elementary school students as scientists, understanding the nature of science, and knowledge of science through programs such as implementing scientific literacy projects (Stefanski et al., 2019). Teachers are expected to adopt the best program given the benefits and importance of teaching scientific literacy. In practice in the classroom, attention to reading and math skills is more important than integrating science into literacy teaching, especially in schools with low Socio-Economic Status (SES) (Diamond et al., 2004; Dooley & Assaf, 2009; Hayes, 2015).

The results of the PISA study, which focused on scientific literacy in 2006, revealed that Indonesian students' scientific literacy rank was 50 out of 57 participating countries, with an average PISA score of 393 (OECD, 2007). In the previous PISA research, in 2000, the scientific literacy of Indonesian students was at an average value of 395 (OECD, 2001). Therefore, in 2006 the scientific literacy of Indonesian students experienced a decline in points compared to 2000. The same applies to the scientific literacy level of PISA 2003 and PISA 2006, which is 393 points (OECD, 2003; OECD, 2006). In PISA 2009, the scientific literacy score of Indonesian students dropped 10 points to 383 compared to PISA data (OECD, 2010) (Rakhmawan et al., 2015).

PISA is a plan organized by the OECD (*Organization for Economic Cooperation and Development*) to evaluate the education system in different countries simultaneously. According to PISA, scientific literacy is a person's scientific knowledge to identify problems, acquire new knowledge, explain scientific phenomena, and draw evidence-based conclusions about scientifically related problems. They understand the characteristics of science as a form of human knowledge and inquiry, how science and technology shape our environment, intellectuals, and culture, and reflect citizens' willingness to participate in issues related to science and scientific ideas (Nurhasanah et al., 2020).

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The PISA research results show why students in Indonesia find it challenging to get meaning from their learning. This problem makes it difficult for them to use science to solve various problems in the surrounding environment related to daily life, health, economics, and various other practical fields that require a good understanding of science. (Rakhmawan et al., 2015).

To be one of the foundations for their future, the crucial scientific literacy for students' lives, especially at the elementary school level, prospective elementary school teachers need to master it very well. According to the data and previous research described above, this study aims to determine the level of scientific literacy of elementary school teacher candidates.

METHOD

The method used in this research is a qualitative description. The research design used is descriptive quantitative research (descriptive-quantitative). The collection and processing of research data are done by presenting it as it is. This research does not provide treatment, manipulation, or change of the independent variable but explains the condition of the data in the field.

The subjects of this study were 44 prospective elementary school teacher students. The subject is taking an elementary science education course. Subjects were chosen because of their suitability to the research criteria needed by the researcher. The subject is a prospective teacher in the population of elementary science education courses requiring many face-to-face activities, discussions, peer reviews, and practicums.

Data was collected through an online questionnaire survey. The research instrument was derived from the indicators of the scientific competence aspect of scientific literacy. The lattice of the instrument and the distribution of questions on the aspects of scientific knowledge and competence in this research are listed in Table 2 below.

Table 2. Distribution of Questions on Aspects of Knowledge and Science Competence

Indicator	Item Number
Identify scientific problems	4, 5, 7
Explain scientific phenomena	1, 2, 3
Using scientific evidence	6, 8, 9, 10, 11, 12

The data collected were analyzed as a descriptive explanation. The analysis was carried out by calculating the student achievement percentage for each scientific competence. The percentage of achievement in science competence is descriptively based on the standard of student learning outcomes listed in table three below (Arikunto, 2013).

Table 3. Student Learning Outcomes Standard

Mark	Criteria
80-100	Excellent
66-79	Very Good
56-65	Good
40-55	Fair
30-39	Poor

RESULTS AND DISCUSSION

The study of scientific literacy is one subject that attracts much attention among academics. Scientific literacy is based on mastering scientific concepts to solve problems (Nurhasanah et al., 2020). This study shows the percentage of primary teacher students' scientific literacy ability, as seen in Table 4.

Table 4. Percentage of Correct Answers for Each Item

No. Question	N	%
1	40	100
2	14	35
3	32	80
4	26	65
5	40	100

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No. Question	N	%
6	22	55
7	4	10
8	22	55
9	26	65
10	32	80
11	30	75
12	34	85
Average		66.08

Information: N: The number of students who answered correctly

Table 4 shows that the average achievement of scientific literacy skills in the overall competence aspect is 66.08%, or in the excellent category. From Table 4, it is also obtained information that students answered the question well where five questions are in an excellent category, one item is in a very good category, two questions are in a good category, two questions are in the appropriate category, and one item is in a poor category.

Research data on scientific literacy skills in each aspect of scientific competence was obtained by calculating the percentage of achievement of test results per indicator in the aspect of competence. This percentage is obtained by comparing the score obtained by each student with the maximum value and finding the average value of literacy ability achievement for each indicator in the aspect of scientific competence. The results of the scientific literacy test analyzed per indicator on the aspect of scientific competence are presented in Table 5.

Table 5. Literacy Test Results Per Competency Aspect Indicator

Indicator	Percentage (%)	Category
Identify scientific problems	58.33	Good
Explain scientific phenomena	71.60	Very Good
Using scientific evidence	69.17	Very Good

Based on Table 6, information is obtained that the percentage of achievement of scientific literacy skills on the indicator of identifying scientific problems is 58.33% with the "Good" category. The achievement percentage on the indicator explaining scientific phenomena is 71.60%, with the "very good" category. At the same time, the percentage of scientific literacy achievement on indicators using scientific evidence is 69.17% in the "very good" category.

Based on the results of the student's scientific literacy ability test on the aspect of scientific competence, we can see that the highest competency indicators achieved by students in this study were indicators of identifying scientific phenomena, which were then followed by indicators of identifying scientific evidence and indicators of explaining scientific problems.

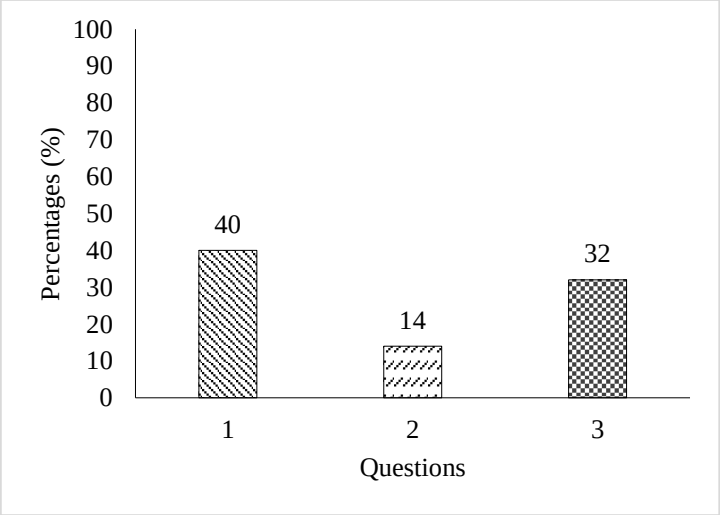

Figure 1. Graph of Correct Answers Indicators Explaining Scientific Phenomena

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Aspects of competence to explain scientific phenomena were achieved by 71.60% with the category of "very good" achievement. The number of questions in the scientific phenomenon indicator is three questions with the numbers 1, 2, and 3. In point 1, questions about the scientific phenomenon of children's growth through unique stages are presented. Students are asked to analyze the growing phenomenon.

In question 1, 40 students succeeded in analyzing existing scientific phenomena. In item number 2, scientific phenomena related to the bobo doll experiment are presented, and students are asked to analyze the effects of aggressive actions on the experiment. A total of 14 students successfully analyzed the actions of children who saw aggressive acts showing the possibility of taking the same action even though they were not treated. In item number 3, the phenomenon of bloom taxonomy used in education in Indonesia is presented. Students are asked to analyze education in Indonesia, which uses learning theory. A total of 32 students answered correctly with the answers to cognitive learning theory.

This result can be proven by students applying the scientific knowledge they have understood in solving scientific literacy problems in this research instrument. The concept of knowledge possessed by students affects their ability to describe or interpret scientific phenomena (Wulandari, 2016). In item number 2, quite a few students can answer correctly. This data shows that analytical skills are more difficult for students than the skills to understand a subject (Agustina & Rahmawati, 2021). Scientific literacy requires skills, including a scientific cognitive understanding of research, design, and communication.

Norris and Phillips describe scientific literacy, emphasizing that reading and writing are fundamental. They believe that "scientific literacy includes concepts, skills, understanding, and universal values of all reading and understanding of the substance of science." This definition of scientific literacy collectively emphasizes various knowledge and abilities based on the profession (Klucevsek et al., 2017).

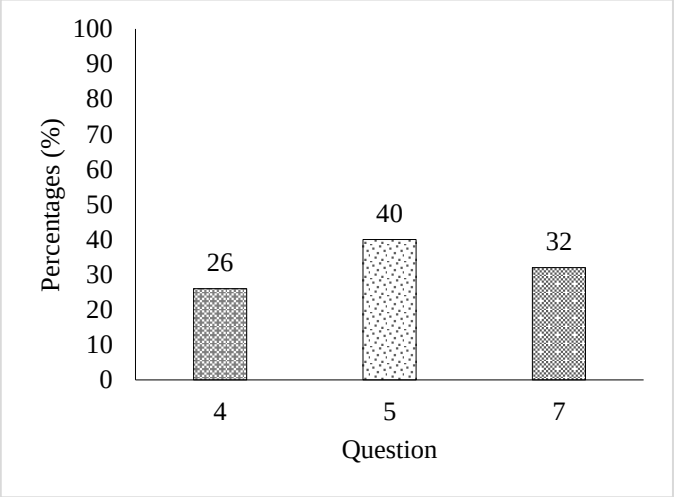

Figure 2. Indicator Correct Answer Chart Using Scientific Evidence

The percentage of scientific literacy achievement on indicators using scientific evidence is 69.17% in the "excellent" category. In using scientific evidence, students are asked to read and interpret graphical representations of the data, i.e., interpret the data presented to make conclusions about the findings of the research, provide generalizations to conclusions, predict, and make conclusions based on quantitative data, namely interpreting data and criticizing experimental designs for evaluating hypotheses and identifying weaknesses in arguments. Based on the analysis of the items on the indicators, item number 4 discusses the discovery of knowledge using intuition. The questions presented evidence of the discovery of knowledge, and students were asked to find methods used by scientists based on existing scientific evidence.

Twenty-six students answered correctly by answering the shortcomings of using intuition to find knowledge. In item number 5, discussing the growth of green lacing, a table of mung bean growth is presented within seven days. Based on the growth table data, students were asked to analyze the differences in the growth of green beans based on the water used for watering.

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A total of 40 students identified the following green bean plant data with the correct variables. Item number 7 discusses observational evidence regarding the student learning process, which starts from general and straightforward things to more complex learning. Students are asked to analyze the learning activities carried out by these students to implement what theory. Of 44 students, 32 answered correctly that the learning activity implemented behavioristic learning theory.

The achievement of literacy skills on indicators using scientific evidence can be seen in the ability of students to interpret evidence of scientific phenomena and then conclude by interpreting the data contained in several tables on the scientific literacy test instrument used in this study. Students still lack interest in reading, and understanding of scientific evidence in scientific literacy is still lacking, so it is less supportive in building the concept of scientific literacy in the learning process through scientific evidence (Sujudi et al., 2020).

Science learning must be designed as a meaningful process and build a coherent conceptual model. Students ask questions, research to find answers, construct new understanding, meaning and knowledge, communicate their learning with others, and effectively apply their learning in abnormal situations (Beernaert et al., 2015).

Science as a scientific process means that science is a deterministic step to research problems, such as observations, hypotheses, experiments' design, execution, data interpretation, and measurements. Science as a scientific product can be explained as facts, principles, laws, and theories that have been accepted as accurate in science. The values and ethics of science as a scientific attitude include high curiosity, criticality, creativity, humility, and open-mindedness (Narut & Supradi, 2019).

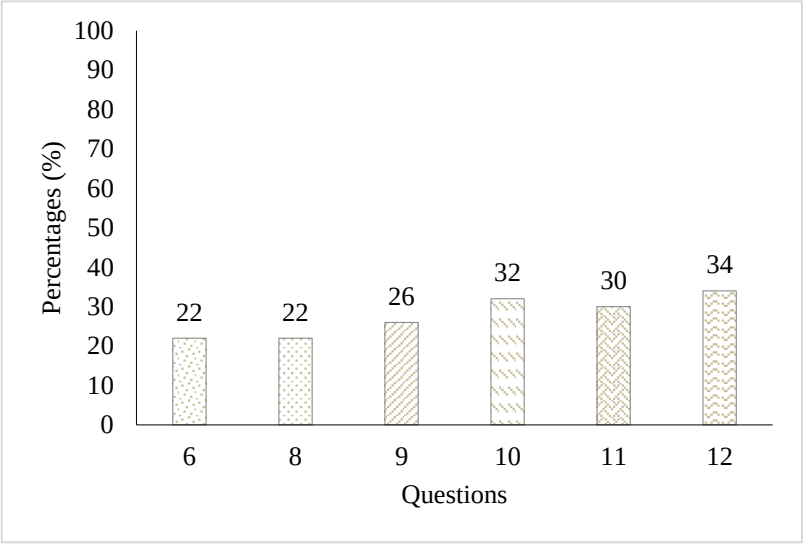

Figure 3. Graph of Correct Answers Indicators of Identifying Scientific Problems

Students showed the ability to identify scientific problems achieved by 58.33%, with the ability to recognize critical issues and characteristics of the phenomena in literacy questions that might be investigated scientifically. Based on the analysis of the items on the indicators, item number 6 presented various kinds of data such as answers to student questionnaires, interviews with school principals, literacy reviews, and field observations obtained from a study. Students were asked to identify the types of secondary data from all these data.

Twenty-two students identified that review literacy was secondary data in this study. Item number 8 discusses inquiry learning problems that do not yield good results. Students are asked to identify these problems and provide suggestions to the teacher. A total of 22 students answered correctly, advising the teacher to replace the learning media because it was not under learning with heat material. In item 9, discussing the results of the PISA study related to scientific literacy carried out in Indonesia, students are asked to provide conclusions on the results of the PISA study. A total of 26 students concluded the results of the PISA study and stated that Indonesia's PISA score never reached 400 in each period. In item number 10, we discussed what hypothesis testing a researcher needs. As many as 32 students answered that researchers need data and facts from the field in research hypothesis testing.

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Item number 11 discusses the researcher who wants to solve a problem he encounters, then the first thing that the researcher must do is start his research. As many as 30 students managed to answer. The first thing the researcher had to do was correctly identified the problem and tried to dig into the depth of the problem he found. The last item, number 12, discusses the teacher who uses a learning theory to teach swimming material to students. It is conveyed in teachers teaching with direct practice and providing swimming training for students to get used to it. Students are asked to identify what learning theory is used by the teacher. As many as 34 students answered correctly with the behaviourism learning theory answer. Learning using behaviourism theory emphasizes learning by training and habituation to achieve learning goals. In this case, scientific literacy is as crucial as using scientific knowledge, identifying problems, and drawing evidence-based conclusions to correctly understand and make natural decisions through human activities (Yuliati, 2017). The ability of students to identify scientific issues is closely related to aspects of scientific knowledge they understand during learning.

Students understanding during this learning prefers to remember rather than understand and solve problems. This habit is related to the tendency of students to master knowledge instead of using critical thinking skills but memorization. Another cause is the habit of learning science in schools which emphasizes the cognitive aspect and overrides the development of students' critical thinking skills (Irwan et al., 2020; Chusni et al., 2018). The achievement of cognitive aspects in student memory affects students' ability to identify scientific issues. The "good" category obtained in the indicator explaining scientific phenomena describes the ability of students who have not been optimal in explaining scientific phenomena triggered by several factors that will affect achieving scientific literacy skills (Wulandari, 2016). Following the times, the issue of literacy must be a particular concern for the Indonesian people. Low literacy is one of the effects of Indonesia's low competition against other countries. The results of international research show that the literacy skills of Indonesian students, in general, are still low (Fajar, 2019). With these facts, it is necessary to conduct an initial analysis of the level of scientific literacy of students and prospective teacher students in Indonesia to determine the extent of scientific literacy abilities.

The initial analysis of the scientific literacy level aims to determine how students' scientific literacy skills are. The results obtained can be used as a first step to determine the steps to maintain, improve, or increase students' scientific literacy skills. Based on the research results, it is known that students' scientific literacy skills still need to be improved. One of the reasons for the low scientific literacy of students is that students are not trained in solving questions that follow the characteristics of scientific literacy (Afriana et al., 2016). Students have a different way of thinking in solving the problems they usually do. In learning, students are accustomed to learning methods that do not focus on literacy. The teachers prioritize learning that aims to be proficient in mastering the material (Noviani et al., 2017).

In addition to learning methods and models that focus on mastery of the material, the evaluation instruments do not focus on mastery of literacy. Learning instruments often used are learning evaluation instruments made to measure how much students master the material (Ardianto & Rubini, 2016). Literacy-based evaluation instruments affect students' ability to solve problems. Literacy-based evaluation instruments given in a structured way can improve students' literacy skills (Setyawarno et al., 2021).

Several factors influence mastery of scientific literacy skills. As follows. 1) students have never worked on scientific literacy questions, so students find it challenging to solve these problems, 2) students habits prefer to memorize rather than understand learning material, so students are less able to understand and less skilled in applying the material in everyday life, 3) in the learning activities that students go through, there is less emphasis on reasoning and critical thinking skills, so that when faced with scientific literacy problems that require students to have reasoning and critical thinking skills, they have difficulty, and 4) students have less interest in reading and interpreting a passage so that students not accustomed to answering questions in the form of discourse, graphics, and pictures (Huryah et al., 2017).

Achievement of more optimal scientific literacy skills can be realized with proper handling. One way that can be taken is by paying attention to the characteristics and potential of students, developing teaching materials and preparing instruments that follow the conditions and needs of students, and learning activities that are well managed and follow the characteristics and needs of students, as well as learning strategies that are right on target. (Setiasih & Panjaitan, 2016; Chusni et al., 2019). According

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to this research data, learning should be combined to help students understand science in terms of concepts and procedures for scientific investigation. Mastery of students' initial science concepts is expected to be the first step toward understanding the meaning of and appreciating science and technology related to their daily lives (Wibowo, 2019). One solution to overcome the low level of scientific literacy in Indonesia is to improve the learning process. Educators need to organize an effective learning process. The experimental learning process is expected to attract students' attention to study independently, apply electronic-based media to arouse student activity and behave more maturely, and involve students in authentic problems to increase problem-solving skills (El Islami et al., 2016).

One of the lessons that can improve scientific literacy is using the inquiry learning model. One model that focuses on student development during learning is the inquiry learning model. The inquiry learning model is a learning model that instructs students to be active in carrying out learning activities. In inquiry learning, students must be able to find their concepts or principles, develop a research procedure, analyze results and draw conclusions independently. These learning activities provide students with direct experience (Schroeder et al., 2007).

CONCLUSION

Based on the results of research that has been carried out, it is concluded that the average scientific literacy ability in scientific competence is 66.08%, with the achievement category being "very good" The percentage of scientific literacy skills achievement on the indicator of identifying scientific problems is 58.33% with the "good" category. The achievement percentage on the indicator explaining scientific phenomena is 71.60% with the "excellent" category. In contrast, the percentage of scientific literacy achievement on scientific evidence indicators is 69.17% in the "excellent" category. Achievement of more optimal scientific literacy skills can be realized with appropriate handlings, such as paying attention to student needs and then applying them to learning activities, teaching materials, learning media, and learning strategies that suit student needs.

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