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Scientific Literacy in Hybrid Learning with the STEM Approach for the Students of Primary School Teacher Education

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Abstract

Scientific literacy is essential in improving students' skills to deal with the rapid development of science and technology. This quantitative descriptive research aims to: obtain information about the scientific literacy skills of prospective elementary school teacher students in hybrid learning with a STEM approach at a university in Indonesia. The sampling technique in this research applied convenience sampling involving 101 students of semester two as the subjects. The scientific literacy of primary school teacher candidates was collected using a self-developed, multiple-choice questionnaire following the scientific literacy competence of PISA, and it has been validated, achieving a score of 3.50 (perfect category). The results of this research show that scientific literacy of the 2nd-semester students of the primary elementary school teacher department is categorized as low with an average value of competency one is 53.96% (low category), competency 2 is 56.19% (low category), and competency 3 of 63.61% (medium category) so that the overall average of the three competencies is 57.92% (low category). Following up on the findings of this research, the scientific literacy of primary school teacher candidates in hybrid learning with a STEM approach can be further optimized by paying attention to the design of lesson plans, learning modules, and the implementation of a STEM-based learning approach.

Keywords Scientific Literacy Competenc; STEM Approach; Hybrid Learning

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1. INTRODUCTION

Literacy is a fundamental thing that must be owned by students of primary school teacher department (Yuyu Yuliati, 2016) in facing the rapid development of science and technology (Setiawan et al., 2017) in order to compete and survive in the 21st century (Limiansih & Susanti, 2021). According to World Economic Forum (WEF) in 2016, to be able to compete and survive in the 21st century, students of primary school teacher department need to learn 16 skills which are categorized into 3, namely basic literacy, competence, and character qualities (Limiansih & Susanti, 2021). One of the essential skills that need to be learned by school teacher candidates is basic scientific literacy (Rini et al., 2021).

Scientific literacy is the ability to develop scientific knowledge, identify questions that acquire new knowledge, and describe evidence that can be concluded (Schleicher, 2019; Pahrudin et al., 2019). That ability can be achieved by every student of primary school teacher education to make a choice or decisions based on scientific information to produce a scientific product and to solve scientific problems in daily life (Fakhriyah et al., 2017). It is further stated that with scientific literacy, primary school teacher students can be more curious to describe scientific phenomena, evaluate scientific problems, design a scientific investigation, and systematically interpret findings, facts, and evidence to conclusions (Ahied et al., 2020). Therefore, primary school teacher students are expected to have reliable scientific literacy skills and become the vanguard in improving the quality of education in Indonesia (Amiruddin et al., 2021).

Primary school teacher candidates need to understand three (3) competencies in scientific literacy. The three competencies are (1) explaining the phenomenon scientifically, (2) evaluating and designing a scientific investigation, and (3) interpreting data and evidence scientifically (OECD, 2015). Training primary school teacher candidates to understand the three competencies needs a learning approach to improve their scientific literacy skills (Amiruddin et al., 2021). The learning approach used is STEM (Amiruddin et al., 2021).

STEM (Science, Technology, Engineering, and Mathematics) is a learning approach that encourages students to compete in the face of complex contexts using knowledge (Rusydiyah et al., 2021) and skills of problem-solving from various disciplines (Afriana et al., 2016). With the STEM approach, it is hoped that lecturers will be able to create meaningful classes (Zaki et al., 2020) that influence the teacher's students to innovate, design new things, have critical thinking skills (Yulianti et al., 2022), collaboration skills and abilities to master technology (Shernoff et al., 2017; Sukmana, 2018). In addition to using the STEM approach and improving the scientific literacy skills of the teacher students during the covid-19 pandemic (Hidayat et al., 2022), lecturers, too, play an essential role in compiling and designing learning that is tailored to a hybrid learning method that is being used (Suebsing & Nuangchalerm, 2021; Aurelia, 2021).

The hybrid learning method is a learning method that combines conventional and virtual classes (Gultom et al., 2022; Riyanda et al., 2022). Learning hybrid in Natural Science (IPA) for primary school physics is taught through a virtual media laboratory, and the STEM approach can improve digital literacy and scientific literacy of primary school teacher students (Muhpriaji & Hidayat, 2022; Rahayu et al., 2019). Therefore, hybrid learning is considered to provide solutions to learning in the new era of the ordinary (Chakim, 2020).

Unfortunately, the use of hybrid learning methods in primary schools is considered not yet adequate because of several factors, including internet connection, lack of student ability to use information technology and communication, and lack of student focus in learning from home as well as some other inhibiting factors (Triyono, 2021). On the side, other hybrid learning in college has several obstacles, including unstable internet connection, the interaction barrier between lecturers and students, and other inhibiting factors (Muhpriaji & Hidayat, 2022). Improving the teacher students' scientific literacy skills needs interaction and an optimal learning approach (Ngabekti et al., 2019). One of the approaches referred to is the STEM approach.

STEM approach has improved students' ability in critical thinking, collaboration, making innovations, solving problems, and mastering new things and technology. Some research has been carried out in various countries, such as the US (Shernoff et al., 2017; Estapa & Tank, 2017; Li et al., 2020; Kelley & Knowles, 2016), Thailand (Sutaphan & Yuenyong, 2019; Suebsing & Nuangchalerm, 2021), Japan (Chen et al., 2019), and Malaysia (Zaki et al., 2020; Sharif et al., 2021; Arshad et al., 2021; Idris et al., 2022). On the other hand, other research on the STEM approach has also been carried out in Indonesia (Sukmana, 2018; Nugroho et al., 2019; Rusydiyah et al., 2021; Rosana et al., 2021; Yulianti et al., 2022).

However, only some still apply the STEM approach in improving primary school teacher students' scientific literacy. In addition, several studies focus on improving scientific literacy skills only (Rokhimawan et al., 2022; Chakim, 2020; Rini et al., 2021; Limiansih & Susanti, 2021; Malina, 2020; Fazilla, 2016). In line with the information, no research examines the scientific literacy skills of primary school teacher students in hybrid learning with the STEM approach. So, this research needs to be done because it can provide information about how to improve the scientific literacy skills of primary school teacher students through a hybrid learning method while applying the STEM approach. Therefore, the research aims to improve the scientific literacy skills of primary school teacher students in hybrid learning using the STEM approach.

2. METHODS

This research applied descriptive-quantitative research using the survey method conducted from February to May 2022. Scientific literacy was the dependent variable (bound), while STEM and hybrid learning were the independent ones (independent). This research involved 2nd-semester students of primary school teacher education students at one university in Indonesia as the research subjects. The total number of 2nd-semester primary school teacher education students involved was as many as 205 students. Therefore, the sampling technique used was convenience sampling. The researcher was free to determine the sample they wanted to use. This method makes it easier for the researcher to take samples because the subjects involved were the students attending the class and students attending virtually, and the class was accessible by the researcher. As a result, 101 students in the 2nd semester of primary school teacher education were selected and in 2 classes. The first class consisted of 48 students, while the second class consisted of as many as 53 students.

This research involved two classes as samples and no treatment, control, or experiment classes. Both classes were taught Natural Science (IPA) Physics for primary school through hybrid learning with a STEM approach on magnetic material. The syntax of the STEM approach was: (1) asking questions and explaining problems;(2) developing and using models; (3) designing and carrying out research, (4) interpreting and analyzing data; (5) using mathematical and computational thinking, (6) explaining and designing solutions; (7)participating in argumentative activities based on existing evidence (8) getting information, evaluating and conveying information (National Research Council, 2012) (Izzati et al., 2019). Both classes received similar treatment in one meeting. The material being taught was also similar; that was a magnet. The data collection on scientific literacy skills was done the next day using a Google form sent via the class Whatsapp group.

The dependent variable in this research was the students' scientific literacy. The student's scientific literacy ability was measured using an instrument consisting of 10 multiple-choice items and two complex multiple-choice items developed from PISA scientific literacy competencies (Schleicher, 2019; OECD, 2015). The formulation of this item was based on the magnet's material. Student answer scoring was adjusted to the Assessment and Learning Center rules, Research and Development Agency, and Books, Ministry of Education and Culture 2020 (Pusmenjar, 2020). Before the instrument was applied, experts validated it. The validation results showed that all items were valid, and the reliability value was 3.50 (perfect category), so the instrument was categorized as reliable.

The survey data from the Google form, downloaded in CSV format, were checked by the researchers before being analyzed. Data analysis involved Microsoft Excel software. Data on the scientific literacy ability profile were in scores ranging from 0-100. The analysis was carried out as follows (Limiansih & Susanti, 2021):

a. Identifying scientific literacy scores of all students from each indicator. Getting the score of all students (101 respondents) of each item (12 questions) used the following formula:

   Scores of all indicators = Σ scores of all subjects

b. Identifying scientific literacy scores of the students in each competency.

   After the scores of all students were collected, then the average score for each scientific literacy competence (LS) was calculated using the following formula:

   The average score of the student's scientific literacy = (Σ score of each competence/(Σ indicator)

c. Calculating all scientific literacy skills of the students (subjects)

   The percentage of scientific literacy (LS) competence was obtained from the calculation of students' scientific literacy scores, and the next was calculating the average of all respondents with the following formula:

   Score of the students' scientific literacy = (score of the subject answering correctly)/(the number of the subjects) x 100

   The calculation of the average obtained was classified according to the categories as stated in Table 1 below (Pusmenjar, 2020; Limiansih & Susanti, 2021; Fadlika et al., 2020):

Table 1: Students' Scientific Literacy Categories

No.	Category	Percentage (%)
1	Hight	>75
2	Middle	60-75
3	Low	<60

3. FINDINGS AND DISCUSSIONS

Examining the scientific literacy skill of the primary school teacher education students in the first class was conducted on May 31, 2022, for 60 minutes by applying a hybrid learning method; that is, some students were present in class, and some students joined virtually via Zoom meeting. All students received questions in a Google form link sent to the class's WhatsApp group. The test for the students in the second class was held on June 1, 2022, which coincides with Pancasila Day. Hence, the students in the second class entirely did the test virtually via Zoom meeting for 60 minutes, similar to the first class, and the test items were sent via Zoom chat room and the class' WhatsApp groups. The subjects of the research were 101 students of primary school teacher education. Answers from the subjects were analyzed according to the results obtained from the calculation of the Google form. The score of the correct answer was 1, and the score of the false answer was 0, with a total score of 100.

a. The results of the scientific literacy ability score of the students on each indicator are shown in Figure 1 of the scientific literacy ability scores as follows:

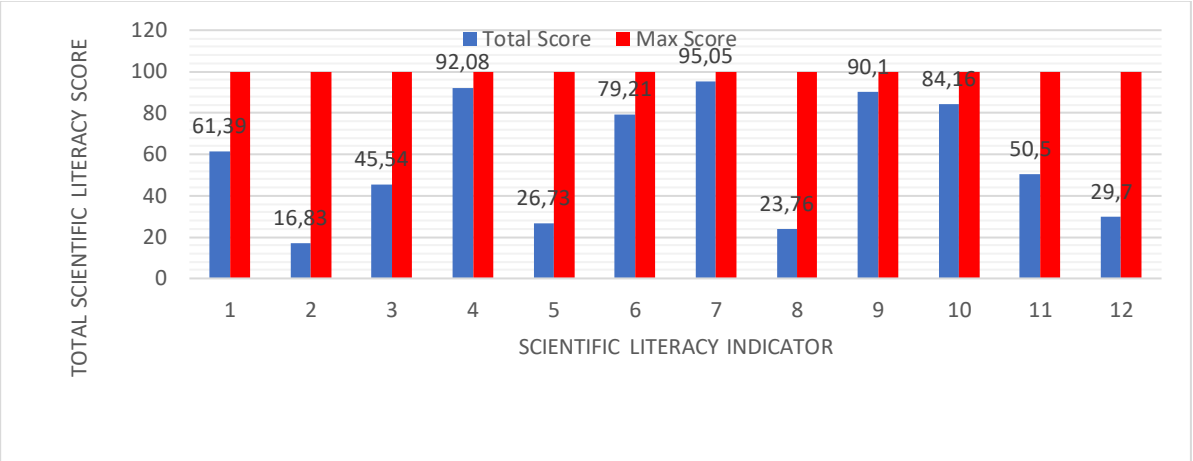

Figure 1. The scientific literacy ability scores

Scientific literacy indicators 1-12, as referred to in the graph above, are as follows:

Table 2. Scientific literacy indicators

No	Competencies	Indicator	Test Items
1	Explaining phenomena scientifically	Identifying model and representation scientifically.	1
		Determining the hypothesis of explanatory questions	2
		Explaining the connection of scientific knowledge to the community	3
		Making proper prediction	4
2	Evaluating and designing a scientific investigation	Designing research scientifically	5
		Differentiating the questions presented scientifically	6
		Proposing questions presented scientifically	7
		Evaluating questions given scientifically	8
3	Interpreting data and evidence scientifically	Analyzing data and drawing proper conclusions	9
		Interpreting data and drawing proper conclusions	10
		Interpreting scientific evidence from letters, news, the internet, and journals	11
		Differentiating arguments with scientific consideration	12

Based on Figure 1 above, it is interpreted that the highest score in the indicator of scientific literacy is found in indicator 7, namely "proposing questions presented scientifically," while the lowest score is in indicator 2, namely "determining the hypothesis of the explanatory question."

b. The results of students' scientific literacy scores on each competence.

Based on PISA (OECD, 2015; Schleicher,2019), there are three (3) scientific competencies in scientific literacy measured in this research, those are, among others:

1) Explaining phenomena scientifically
2) Evaluating and designing a scientific investigation
3) Interpreting data and evidence scientifically

The following is the scientific literacy ability score of the students based on their competence:

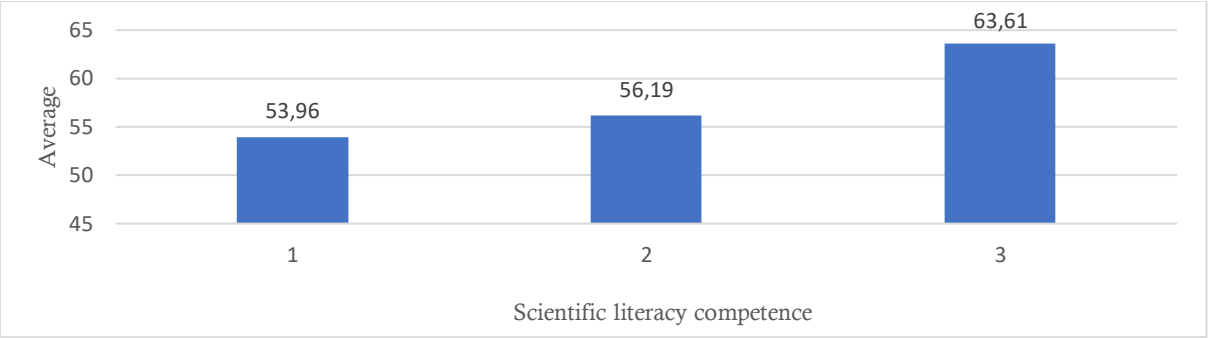

Figure 2. The students' scientific literacy scores for each competency.

Based on Figure. 2 above, the students' scientific literacy ability shows that the highest ability is in Competency 3, which means that the students can interpret data and evidence scientifically. While competency 1 and 2 are low, which means that the students need help to explain phenomena scientifically and evaluate and design scientific investigations.

In connection with these results, no research has examined students' scientific literacy skills with a STEM approach to hybrid learning. Other research with the STEM approach has been reported to increase the ability of scientific literacy compared to the PjBL model (Amiruddin et al., 2021). However, some studies only identify students' scientific literacy skills by giving questions without going through the learning using the STEM approach, and in the research, it is reported that the highest student's scientific literacy ability lies in competence 1 of the scientific literacy, namely: explaining phenomena scientifically (Limiansih & Susanti, 2021; Fakhriyah et al., 2017; Pahrudin et al.,2019).

A series of learning activities with the STEM approach that the subjects in the research have carried out improves the students' scientific literacy skills to interpret data and evidence scientifically, namely competence 3 of scientific literacy. Furthermore, every activity carried out by the students in learning using the STEM approach can improve their ability to solve scientific problems (Sutaphan & Yuenyong, 2019; Sharif et al., 2021). This is also in line with Rokhimawan's statement (Rokhimawan et al., 2022) and (Yulianti et al., 2022), which explain that the STEM approach improves the students' scientific thinking skills and the ability to use scientific knowledge.

The ability to use knowledge, issues, and ideas related to science is the scientific literacy ability (Schleicher, 2019). The results of this research indicate that most students have yet to be able to interpret data and scientific evidence, which lies in the moderate category (Table 1) of 60-75% according to Figure 2, which is 63.61%. While the competence of explaining phenomena scientifically and evaluating and designing scientific investigations are included in the low category (Table 1): <60%; this is in line with the results in Figure 2: 53.96% and 56.19%, respectively. According to Amirrudin (Amiruddin et al., 2021), the STEM approach is a good choice for lecturers to improve the students' scientific literacy skills and prepare them as professional teachers. Therefore, applying the STEM approach to other learning is also very recommended besides hybrid learning.

Apart from the above research results, certain limitations of this research must be considered because the three scientific literacy competencies have yet to reach the high category. This occurs due to several factors of preparation and implementation in learning using the STEM approach, including the readiness of the lesson plans, learning module, and learning implementation, which still need to be optimized. Besides, hybrid learning should consider several factors, such as internet connection and lack of interaction between lecturers and students who are present virtually. They become inhibiting factors in this research. So, it is recommended for further research to pay attention to those factors so that the results of the student's scientific literacy skills become better.

4. CONCLUSION

In this research, the scientific literacy of the students in hybrid learning using the STEM approach results in the low category with an average of 57.92% (Fadlika et al., 2020; Limiansih & Susanti, 2021) among the three scientific literacy competencies according to PISA.

According to the findings in this research, the STEM approach in hybrid learning to improve the scientific literacy skills of primary school teacher education students is recommended, but concerning several factors, especially in the learning preparation and implementation using the STEM approach. The training with the STEM approach for the students who will later become professional teachers of primary school needs to be done so that the future teachers studying in the primary school teacher education department do not feel strange in the application of the STEM approach later in the classroom in improving their students' scientific literacy skills. Besides, further research which examines the improvement of students' scientific literacy skills as prospective primary school teachers needs to be conducted. However, research that provides information about how to improve the scientific literacy skills of the students who will later apply their knowledge to their student's needs also needs to be carried out. However, research that examines the students' scientific literacy skills by applying the STEM approach in other hybrid learning still has to be done so that future primary school teachers know the competencies in scientific literacy and how to apply the STEM approach in their learning.

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