

Implementing of science literacy guidelines for primary school teacher students

Ima Wahyu Putri Utami ^{a,1,*}, Arinta Rezty Wijyaningputri ^{a,2}, Nor Hazlina Fazlyn ^{a,3}

^a Department of Primary School Teacher Education, Faculty of Teacher Training and Education, Universitas Muhammadiyah Malang, Jl. Raya Tlogomas No.246, Malang, East Java 65144, Indonesia

¹ imawahyu@umm.ac.id*; ² arinta@umm.ac.id, ³ fazlynnorhazlina@gmail.com

* Corresponding author

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Abstract: Science literacy is an individual's ability to understand, use, and communicate concepts and critical-thinking in a scientific context. Primary school teacher students plays an important role in shaping strong understanding and effective on science literacy skills among elementary school students. This research employs a qualitative descriptive approach. It utilizes both qualitative and quantitative data. The study focuses on the process of data collection and supporting elements of the research obyek. Data collection techniques in this research include in-depth interviews, observation, and document analysis. The results of this study are a description of the implementation of the implementation of science literacy guidelines that have been effective in helping students understand the material, especially the solar system. The science literacy guide has undergone several revisions and has subsequently made it to the ISBN submission stage. In addition, learning objectives have also been maximally achieved with various activities during the implementation of science literacy books. It can be seen from the results of student work on the students' worksheet, each group has answered the questions correctly. In addition, the posters that have been made show that the posters are appropriate according to the material that has been studied related to the solar system. While the essays have also been in accordance with the reading material. The implementation of science literacy guidelines can assist the students in acquiring their knowledge, skills, and strategies needs to effectively teach science in elementary schools.

Keywords: critical thinking skills; primary school teacher students; science literacy

1. Introduction

Science literacy exists to shape the mind-set, behaviour and character of humans to care and be responsible for themselves, society and the universe (Kelp et al., 2023; Ogunkola, 2013). Although science literacy develops in line with the direction of scientific development and social interaction, literacy-based science learning is not easy to do (Novick & Catley, 2016; Odegaard et al., 2015). Valladares (2021) and Virtič (2022) says that science literacy includes many things, such as knowledge of science, in-depth understanding of their applications, freedom to learn, critical thinking skills, problem-solving skills, intelligent involvement in research, traits, appreciation, and the benefits of science. Permanasari (2016) states that one of the indicators that students do not like science literacy is the lack of connection between material content and things that happen in everyday life. It is certainly a challenge for teachers in the future. According to Bybee (2008) and Utami and Dessty (2021), the goal of science education is to make students science literate. In other words, science lessons are given to students with the aim of forming science literate students (Cole, 2019; Glaze, 2018).

The main problems faced in the use of learning guidebooks are limited access, relevance of content, and inadequate quality (Astuti et al., 2020). In many cases, the guidebooks content is not in line with curriculum developments and students' diversity (Andini et al., 2018; Celi et al., 2021). It is actually predictable due to the wide spectrum of textbook users meets the limitations of authors in accommodating them in the learning resources (Rofieq et al., 2021). Thus, the content of the guidebook is often not align with curriculum developments and the diversity of students' needs. The quality of the guidebook is also a concern, with several problems such as non-contextual material,

difficult to understand language, and less-interactive design (Fajri, 2020; Su'udiah et al., 2016). In fact, the students learning, especially in elementary school, requires many attention to details in order to attract students' attention. Somehow, that is related to their psychological learning characteristics (Howard et al., 2021).

The variety of characters that come from various regions with different ethnicities and family backgrounds is an interesting thing in developing learning (Puriasih & Rati, 2022; Ramadannisaa & Hartina, 2021). In addition, students' cognitive abilities also vary from moderate to high abilities. It is a challenge that needs to be faced in teaching prospective teacher students to apply and improve their scientific literacy (Jumriani & Prasetyo, 2017; Yuliana et al., 2021). The problem is, students are often accustomed to only memorizing concepts and formulas rather than analysing, evaluating, and applying scientific knowledge in various contexts (Chiou et al., 2012; Hasanah et al., 2021). This ultimately results in some students having difficulty designing learning that stimulates critical and creative thinking in their students.

Several studies have shown that student teachers are agents of change who have a major impact on changing the face of education in the future (Dani, 2009; Mabsutsah et al., 2023). Therefore, strengthening their professional capacity and competence is very substantial and fundamental, including their scientific literacy (Arends, 2012). Therefore, the limitations they face need to be identified and solutions found. Furthermore, researchers reported that students' difficulties in conveying ideas need to be supported by comprehensive literature and adaptive learning spaces to stimulate scientific literacy so that they can optimize their capacity and competence as prospective teachers (Kozikoğlu, 2019; Syofyan & Amir, 2019).

Based on the problems above, in order to understand, communicate, and apply science in solving everyday problems, guidelines for the application of science literacy are needed, including basic science concepts, effective teaching methods, develop teaching materials that are appropriate for students, and relevant evaluation strategies. This study aims to describe, explain, and interpret current conditions that are relevant to the application of science literacy guidelines among primary school teacher students.

2. Materials and Methods

2.1 Types of research

This research uses a qualitative descriptive approach. This research uses qualitative data and quantitative data. Research refers to the process of data collection and supporting elements of the research object (Edgar & Manz, 2017). According to Bogdan and Biklen (1998) descriptive qualitative research methods involve collecting data in the form of pictures or words rather than emphasizing numbers. After being analyzed, this data is then described so that others can understand it easily. Meanwhile, the quantitative data is a research approach to research data in the form of numbers measured by statistics as a calculating test tool in concluding the subject matter under study.

2.2 Research subjects and objects

The research subjects in this study were primary school teacher students at University of Muhammadiyah Malang. As many as 54 of students were involved as research subject while the object of this research was the application of the science literacy guidebook implementation.

2.3 Data types and sources

The types of data used in this study are primary data and secondary data. Primary data comes from the application of science literacy guidelines to elementary school teacher students. While secondary data are in the form of interview results, observations and documentation of research results and indicators of elementary school teacher

student science literacy ability tests. Measurement of science literacy indicators is carried out by (1) explaining scientifically about the solar system, especially the differences between planets and their effects on the solar system, (2) carrying out creative activities to make solar system posters, (3) conducting information searches and reflections about the solar system (Table 1).

Table 1. Science literacy indicators

No	Competency Measured	Indicators
1	Writing explanation	a) Explaining of three differences between the outer and inner planet. b) Describing the solar system influence on life comprehensively, including on earth and other planets. c) Describing the difference between asteroids and comets.
2	Creative activities	Ability to create a solar system poster
3	Information search and reflection	a) Explaining the purpose and findings of space missions. b) Writing the reflections and conclusions precisely.

2.4 Data collection technique

In-depth interviews, observations, and documentation studies are the instruments of this research. Observations were carried out systematically using observation guidelines and non-systematically without instruments. data collection results from observation sheets which are from simulations that have been carried out in the stages of science literacy-based learning which consists of six stages, namely the contact phase, the curiosity phase, the concept formation phase, the elaboration phase, the decision making phase, the concept development phase, the nexus phase and the evaluation phase (Syofyan & Amir, 2019). Non-systematic observations observed student and teacher activities in the application of the science literacy guide. The observation guideline was used as a record of things that happened during the activity, and then the results were interpreted.

2.5 Data analysis techniques

The process of analyzing and interpreting qualitative research data is as follows (1) prepare and organize data; (2) explore and code the database; (3) describe the results and form themes; (4) represent and report the results; (5) interpret the meaning of the results; and (6) evaluate the validity of the results (Denzin, 2017). The data analysis techniques use qualitative descriptive indicators to describe the data that has been collected as it is. The result criteria will be used to classify the average score of all elements related to the feasibility of the learning model

3. Results

3.1 Contact stage

The topic used in this science literacy research is problems related to the solar system. Initial observation results show that most students cannot distinguish between planets and other celestial bodies. In fact, as prospective elementary school teachers, they need to have a good basic understanding of so that they can teach these ideas to students well. There are several objectives to be achieved during this implementation. The educational objectives that must be achieved are (1) students are able to explain the main components of the solar system; (2) students are able to find the unique characteristics of each planet; (3) students can make simple games about the solar system for elementary school students.

3.2 Curiosity Phase

At this stage students are given a student worksheet which contains questions related to issues or problems related to the material being studied. To work on the worksheet, students are formed into six groups with nine members of each. The groups were formed heterogeneously.

3.3 Elaboration Phase

At this stage students explore concept stabilization. Exploration is carried out until the questions at the curiosity stage can be answered. The exploration of concept consolidation is carried out by various methods including meaningful lectures, discussions, questions and answers, and reading scientific texts. So that through this activity the ability of students can be more transferred both aspects of knowledge, process skills and values and attitudes.

3.4 Decision Making Phase

At this stage, joint decision-making is carried out from the problems submitted through student worksheets that are worked on in groups. Students seek information and reflect on what has been discussed through student worksheets. Furthermore, discussions and Q&A are held between lecturers and students so that the resolution of the problems that arise can really be understood well by students. At the end of this stage, students conclude the important points of the discussion.

3.5 Nexus Phase.

At this stage, students apply the context of the material learned into creative activities in the form of poster works. This application stage is carried out to embed students' knowledge through meaningful learning, not only in the context of learning but also outside the context of learning. In making posters, students show high enthusiasm. They present their understanding of the solar system material in the form of creative posters. This activity is carried out in groups, with each group member collaborating to complete the poster assignment. The poster-making process can be seen in the [Figure 1](#).



Figure 1. Students share their thoughts collaboratively

3.6 Assessment Phase

At this assessment stage, in addition to being carried out through student worksheets, students are also asked to carry out literacy in related scientific journals or texts. Literacy in scientific journals or texts is implemented in scientific essay writing activities. This literacy activity is applied to enrich concepts and knowledge, as well as their meaning in everyday life (Kaya & Elster, 2018; Peffer et al., 2015). The meaning in question is manifested in the relationship of the concept to the problems faced (Amanda et al., 2021; Odegaard et al., 2015).

Evaluation is carried out in several ways, including activities to create works in the form of posters, student worksheets, and also writing essays from literacy activities related to solar system articles. All assessment activities carried out are used to determine the achievement of learning objectives. In addition, this evaluation activity is also used to determine the achievement of the use of science literacy guidebooks. Student worksheets are designed with questions that need to be answered by students. The answers to these questions are used to describe, explain, and interpret the results of the application of science literacy guidelines for students.

The worksheet consists of three main questions that are worked on in groups. These questions include written explanations, creative activities, and information retrieval and reflection. Written questions are in the form of questions that function to measure students' understanding after carrying out literacy activities. In this case, students are asked to distinguish between inner and outer planets, as well as the differences between asteroids and comets. Furthermore, students are asked to write their ideas in free writing with the theme of the sun and its influence on the earth and other planets.

Furthermore, the assessment of creative activities is carried out by evaluating posters produced by students. In this case, the completeness of the planets and descriptions of the characteristics of each planet are one of the assessment elements. Another result observed is the design of simple learning activities about the solar system that can be carried out with elementary school students. In this case, students need to consider the depth and breadth of the material, contextualization, and apperception of the dialogue planned in learning the concept of the solar system.

In the final section, learning reflection is something that needs to be done by students. In this case, reflection is carried out by writing down the design of a space mission and planetary exploration. The focus of this activity is to understand the intent and purpose of the mission being carried out. Reflection is also carried out through the activity of writing impressions obtained through this kind of learning experience. The results of completing the worksheet are presented in Table 2.

Table 2. Results of student science literacy percentage

No	Group	Indicators	Percentage (%)		
			1 st questions	2 nd questions	3 rd questions
1.	First	a) Explaining three differences between outer and inner planets.	30	40	20%
		b) The influence of the sun on life on earth and other planets.			
		c) The difference between asteroids and comets			
		d) Make a solar system poster			
		e) Objectives and findings of space missions			
		f) Write reflection and conclusion			
2.	Second	a) Explaining three differences between outer and inner planets.	30	30	30
		b) The influence of the sun on life on earth and other planets.			
		c) The difference between asteroids and comets			
		d) Make a solar system poster			
		e) Objectives and findings of space missions			
		f) Write reflection and conclusion			
3.	Third	a) Explaining three differences between outer and inner planets.	30	40	20

No	Group	Indicators	Percentage (%)		
			1 st questions	2 nd questions	3 rd questions
		b) The influence of the sun on life on earth and other planets. c) The difference between asteroids and comets d) Make a solar system poster e) Objectives and findings of space missions a) Write reflection and conclusion			
4.	Fourth	a) Explaining three differences between outer and inner planets. b) The influence of the sun on life on earth and other planets. c) The difference between asteroids and comets d) Make a solar system poster e) Objectives and findings of space missions f) Write reflection and conclusion	30	40	30
5.	Fifth	a) Explaining three differences between outer and inner planets. b) The influence of the sun on life on earth and other planets. c) The difference between asteroids and comets d) Make a solar system poster e) Objectives and findings of space missions f) Write reflection and conclusion	30	30	30
6.	Sixth	a) Explaining three differences between outer and inner planets. b) The influence of the sun on life on earth and other planets. c) The difference between asteroids and comets d) Make a solar system poster e) Objectives and findings of space missions f) Write reflection and conclusion	20	30	30

The results of the students' science literacy test showed a higher score compared to creative activities, although the presentation of students' creative activities was quite good. The percentage of students' literacy tests was in questions 1 and 3, while number 2 was the creative activity of making posters. Students have explained the literacy questions in great detail and quite clearly. Several groups have achieved a percentage indicator of 90%, but there is one group that obtained a percentage indicator of 80%. The complete percentage of students' literacy abilities can be seen in [Figure 2](#).

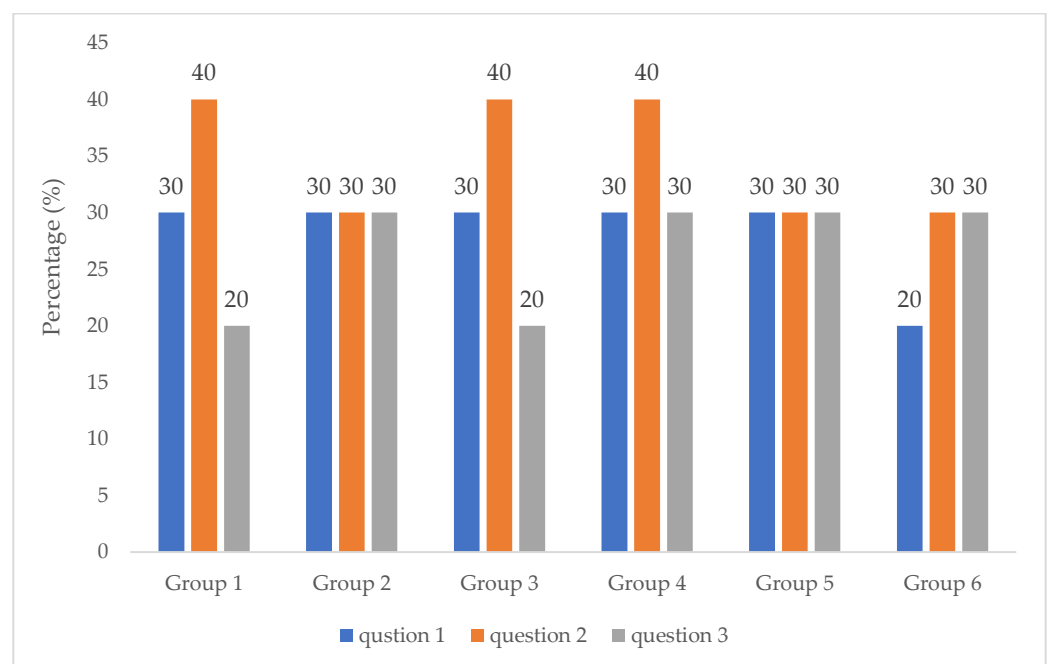


Figure 2. Percentage of students' literacy



Figure 3. Photo of student poster results

From a series of development activities, there are several evaluation results which are used to improve the guidebook. So that in the end the guidebook is at the stage of entering submission to the International Standard Book Number (ISBN). In addition, learning objectives have also been maximally achieved with various activities during the implementation of science literacy books. This can be seen from the results of student work on the student worksheet, each group has answered the questions correctly. In addition, the posters that have been made show that the posters are appropriate according to the material that has been studied, namely related to the solar system. While the essays made by students have also been in accordance with the reading material that has been read.

4. Discussion

The results of the implementation of the science literacy guidelines show that students have succeeded well at each stage. Students can learn about the planets they hope for, as well as celestial bodies such as satellites, comets, and asteroids. In its implementation, several objectives have been identified as being achieved, including the ability to explain the main components of the solar system, the ability to find unique characteristics of each planet, and the ability to design simple games about the solar system for elementary school students. At the curiosity stage, students in groups have been able to answer questions related to issues or problems related to the material. The elaboration stage of students' abilities, both cognitive, psychomotor, and affective aspects, is quite mature. At the decision-making stage, discussions and questions and answers between students and lecturers regarding problems and material information can be understood well by students, in addition, students are able to describe conclusions related to important information from the discussion. Students have explained literacy questions in great detail and quite clearly. several groups have reached a percentage indicator of 90%, but there is one group that gets a percentage indicator of 80%. At the nexus stage, students are able to apply the context of the material in a creative activity in the form of poster work. Lastly, at the assessment stage, students are able to write

journals and essays related to literacy. Evaluation is carried out comprehensively to identify all learning objectives, namely knowledge, skills, and attitudes (Permanasari, 2016).

It is also supported by other studies that found that critical thinking skills are very important for students who will become teachers in preparing the generation of this century. This ability is needed to prepare the generation of this century who are able to compete and solve future challenges (Nuraini, 2017). Hernani and Mudzakir (2010) stated that interest in reading science can be stimulated by setting aside special time. This emphasizes the importance of reading science books in developing students' thinking skills, especially in dealing with complex science problems in everyday life. (Nurdin, 2020) stated that the relationship between science, technology, and society, including the development of social and economic aspects, and its benefits for making daily decisions in interacting with the environment, is known as inherent science (Syofyan & Rachmadtullah, 2019).

Furthermore, to enter and move towards 21st century skills, students must be accustomed to applying the four (4) pillars of learning: learning to know, learning to do, learning to live together. Teachers must be able to be creative, work diligently, and be committed to improving their abilities, including being able to facilitate and inspire student learning and creativity, design and develop learning experiences, and be role models in learning methods (Febri et al., 2020; Noprianda et al., 2016). Basically, the goal of modern education is to realize the ideals of a nation that is honorable and equal to other nations around the world. This goal is achieved through the formation of a society through the development of quality human resources, meaning that everyone will become an independent person and have the ability to realize the ideals of their own nation (Sari & Sinthiya, 2022).

To implement scientific literacy in schools, not only student abilities are needed, but also teachers who have the ability to teach literacy-based science to students. Teachers have an important role in developing students' scientific literacy skills (Siregar et al., 2020). Critical thinking skills are one of the components that influence students' scientific literacy skills. However, critical thinking is a challenge for students (Cahyana et al., 2017).

5. Conclusion

The results of the study indicate that the science literacy guidebook has been effective in helping students understand the material, especially the solar system. In addition, learning objectives have also been achieved optimally with various activities during the implementation of the science literacy book. This can be seen from the results of students' work on the student worksheet, each group has answered the questions correctly. In addition, the posters that have been made show that the posters are in accordance with the material that has been studied, namely related to the solar system. While the essays made by students have also been in accordance with the reading material that has been read.

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