JPII 12 (1) (2023) 123-134

Jurnal Pendidikan IPA Indonesia

http://journal.unnes.ac.id/index.php/jpii

GRAPHIC ORGANIZER-BASED SCIENCE LITERACY LEARNING MODELS IN ELEMENTARY SCHOOLS

Y. Fitria*[1], N. A. Alwi[2], R. Eliasni[3], Chandra[4], A. Kharisma[5]

[1,2,3,4]Universitas Negeri Padang, Indonesia
[5]Universitas Pendidikan Indonesia, Indonesia

DOI: 10.15294/jpii.v12i1.41004

Accepted: December 16th, 2022. Approved: March 30th, 2023. Published: March 31st, 2023

ABSTRACT

The purpose of this study is to test the level of effectiveness of graphic organizer-based scientific literacy learning models in elementary schools. This study's goal is to evaluate the efficacy of elementary school scientific literacy learning approaches that rely on visual organizers. Plomp design development was used to perform the study. The three primary phases of this kind of Plomp development research methodology were preliminary research, prototype, and assessment. Students at Indonesia's West Sumatra province's elementary schools in the fourth grade served as the study's subjects. The study's findings have a significance level of 0.05, or 0.000 < 0.05. In the experimental classes 1 and 2, it can be concluded that there is a substantial difference between student learning results before and after using the graphic organizer-based scientific literacy learning approach. The N-gain value for the experimental class 2 is 0.712 in the high category and the N-gain value for the experimental class 1 is 0.628 in the medium category. In conclusion, the graphic organizer-based scientific literacy learning model is effectively used in class IV of elementary schools.

Keywords: graphic organizer; learning model; scientific literacy

INTRODUCTION

Students learn science for the first time in a formStudents learn science for the first time in a formal setting in elementary school. Students' involvement with science learning will give them the knowledge to advance to a higher (El Achkar et al., 2019; Lu et al., 2020). The goal of science instruction in primary schools is to foster knowledge of Science ideas that may be applied in daily life. Additionally, science education can foster curiosity and a favorable outlook on technology, the environment, and public relations (Holbrook & Rannikmae, 2019; Subali et al., 2019).

To understand and make decisions in accordance with nature and changes in daily life, students must be taught to use Science knowledge, identify questions, and draw conclusions based on available evidence. This is known as PISA scientific literacy (Rosenblum et al., 2019; Atmojo et al., 2022; Karataş et al., 2022). At the elementary school level, science is one of the lessons that occupies a very important role because it can provide students with provisions in dealing with advances in science and technology in the digital era (Bergbauer & Staden, 2018; Dewi et al., 2019). As a result, it is envisaged that science education in schools would be able to use or execute scientific literacy. Science education in schools is anticipated to help pupils become more capable of navigating the advancement of science and technology by teaching them scientific literacy (Jamieson et al., 2017; Wilujeng et al., 2019). The application of learning models in the science classroom must consider children's developmental needs, environmental factors, and the learning goals attained (Smith et al., 2012; Bahtiar et al., 2022).

***Correspondence Address**
E-mail: yanti_fitria@fip.unp.ac.id

The science learning process must apply learning models that are appropriate to the developmental needs of children, environmental conditions, and the learning objectives achieved. Learning models that are designed according to children's development can automatically also suit children's learning styles (Merritt et al., 2017; Martinčević, 2020). Science learning can be stored for a long time in a child's memory if the child is directly involved in the learning process, such as the child's involvement in using science learning media found in the surrounding environment (Ohnishi et al., 2021). The environmental conditions found by children every day are very effective in facilitating science learning to be accepted by children's brains (Fakhriyah et al., 2017).

The application of learning models should be assisted by clear and systematic student worksheets, making it easier for children to understand the concept of science (Faisal et al., 2020). Interesting student worksheets can be designed using a special graphic organizer for science. The graphic organizer is a two-dimensional visual form that describes the relationship between facts, ideas, terms, concepts, and examples. Graphic organizers can help children's work in understanding science become easier with a clear grouping process (Regan et al., 2018). Students find it easier to connect facts related to the discourse students read.

The scientific literacy learning model is useful for facilitating the science learning process in elementary schools. All students are invited to be active in the learning process (Baker, 2017; Irmita & Atun, 2018; Karataş et al., 2022). Students try their own science process in a simpler form (Babaci-Wilhite, 2017; Baker, 2017). Simple science is associated with real science in the process of student life. Students are allowed to observe scientific processes and try them out for themselves. This process provides students with valuable experience. Students are accustomed to making reports. Reports made by students are not the same as monotonous reports commonly used in the learning process in elementary schools (Muchtar et al., 2018). Reports made by students are presented more attractively. Report presentation is assisted by using graphic organizers for science. The use of graphic organizers for science in making observation reports is a very new thing for Indonesian elementary school students. Students are not used to carrying out interesting presentations. An interesting presentation can increase students' enthusiasm for making science reports (Şentürk & Sari, 2018; Suryanti et al., 2018).

Science becomes very important to learn from elementary school age because science itself is a part of human life. Children can never be separated from the process of science in their lives. Even in the child himself, there is a very unique Science process (Setiawan et al., 2017; Fitria et al., 2018; Ichsan, 2019). Simplification in presenting science to students is a very important task for teachers to do. It aims to make science more easily understood by every student. Science cannot just be in the form of a complicated text. Science must be tested in a series of simple processes (Kurniaman et al., 2018; Torres-Porras & Alcántara-Manzanares, 2022).

The process of learning science is a national problem in Indonesia. Many research findings state that science is too complicated to learn at the elementary school level. One of the main causes of students thinking that the complexity of science in Indonesia is due to the use of the applied learning model (Chan & Sherbino, 2015; Fakhriyah et al., 2017). The findings of previous research on science show that the learning model used for the process of introducing science to children is not maximized (Rehmat & Hartley, 2020; Spitzer & Fraser, 2020). Science is often presented in an abstract form. Educational practitioners are often concerned with real science processes. Science is rarely experimented with in simpler forms. Elementary school students are rarely given simpler piloting experiences. To overcome the problems faced by students and teachers, it is necessary to apply appropriate learning models in order to achieve the goals of learning science in Indonesian elementary schools. One learning model that presents science is simpler, namely the scientific literacy learning model (Hauer, 2016; Sharon & Baram-Tsabari, 2020). Some of the aforementioned factors form the context for why this research is urgent.

The novelty of this research and which has never been researched before is applying a graphic organizer by combining literacy learning models as an alternative that attracts students to learn and can improve elementary school students' scientific literacy skills. Scientific literacy skills will train students' thinking processes actively and innovatively in solving problems.

Science is a process of discovery and is related to how to systematically learn about nature. It is also the mastery of a body of information in the form of facts, concepts, or principles (Suryanti et al., 2018; Subali et al., 2019; Ecevit & Kıngır, 2022). If students can make connections between new knowledge and prior knowledge, meaningful learning can take place. This is consistent with Piaget's theory that knowledge is the product of organizing and adapting human thought processes that are continuously constructed from the process of experience, and every time a reconstruction can happen due to a new understanding obtained through a process of learning adaptation (Spitzer & Fraser, 2020; Mtsi, 2021).

Literally, the words literatus, which means literacy, and scientia, which means possessing knowledge, make up scientific literacy. scientific literacy is the capacity to apply Science knowledge to recognize issues, formulate hypotheses, and reach conclusions supported by data in order to comprehend and make choices about nature and the changes that humans have made to it (Wilujeng et al., 2019; Dewi et al., 2021). The key components of scientific literacy are (Liu et al., 2018): 1) thoughts or concepts that aid in understanding Science aspects of the world around us and that help us make sense of novel encounters by connecting them to what we already know; 2) procedures, which are mental and physical abilities utilized in gathering, analyzing, and applying data about the outside environment to advance learning and understanding; 3) dispositions, which represent openness, confidence, and attitudes for engaging in research, discussion, and additional learning 4) recognizing the character (and boundaries) of Science knowledge.

According to the explanation provided above, it is clear that the most crucial elements in helping students develop their scientific literacy are knowledge of science, Science procedures, the development of Science attitudes, and students' understanding of science. This will help students not only understand Science concepts but also apply their knowledge to solve a variety of problems and make decisions using Science reasoning. Students are expected to be able to apply the knowledge they learn in school to their daily lives in order to develop sensitivity and concern for the environment. This expectation is based on some conceptions of scientific literacy.

PISA (Program OECD for International Student Assessment-Organization for Economic Cooperation and Development) definition of scientific literacy is as follows: "the ability to make decisions about the natural world and how human activity has changed it by using Science knowledge to identify issues and generate conclusions based on evidence."This definition of scientific literacy sees scientific literacy as having multiple dimensions in its measurement, including science procedures, science content, and the context of science applications (Suryanti et al., 2018; Paristiowati et al., 2019; Walag et al., 2022). As a result, students are able to apply their Science knowledge to real-world issues that are connected to the subject matter they are studying. Science content relates to fundamental ideas for comprehending certain natural events and the changes brought on by human activity. The ability of students to apply their Science knowledge and understanding to a subject or a problem is what is known as the scientific process. Applications of science often deal with significant problems that affect people's daily lives in general (Avikasari et al., 2018; Pei-Ming Chianga, 2018; Bowers et al., 2020).

The purpose of this study is to evaluate, enhance, and expand elementary school pupils' capacity for scientific literacy. The need of having scientific literacy stems from the significance of thinking and action abilities that require mastering thinking and adopting a Science method of thinking in problem-recognizing (Afriana et al., 2016; Ardiyanti et al., 2019). For pupils to comprehend the environment, contemporary society, and technology, scientific literacy is crucial. A person's scientific literacy after the learning process varies depending on previous understanding, understanding during the learning process, and the ability of students to associate their understanding with other concepts or situations. According to Irmita and Atun (2018) and Walag et al. (2022), a comprehensive theoretical scale for the assessment of diving scientific literacy in schools is divided into four levels. The four stages of scientific literacy are as follows: 1) Lack of scientific literacy. Students are unable to relate concepts or do not understand science concepts and lack the vocabulary, concepts, context, or cognitive ability to identify science questions; 2) Nomenclature of science. Students are able to identify science topics, but their degree of comprehension is plainly lacking; 3) Practical knowledge of science. Students have limited knowledge of the topic, but they can express it appropriately; 4) Knowledge of Science concepts. Students get a basic comprehension of a science discipline's conceptual framework and can apply it to a general grasp of science, including procedural skills and comprehension of the process of scientific inquiry and technological design; 5) A multifaceted understanding of science. Students integrate science knowledge that transcends the ideas of science disciplines and science research techniques.

Scientific literacy learning develops following the direction of scientific development and social interaction, so literacy-based science learning is not easy to do. In Baumfalk et al. (2019), there are several broad issues with science learning that are linked to low scientific literacy, particularly at the level of basic and secondary indicators. Lack of connection between the subject matter being studied and events that occur in daily life is one sign of students disliking it. In line with these conditions, teachers in the future will face major challenges in implementing global and quality indicators. Teachers must increase scientific literacy so that they can bring students to be oriented toward the construction of meaning, active learning, accountability, use of technology, increasing student competency, the certainty of choice, and a multicultural society.

Science education and scientific literacy go hand in hand. The connection between the two is a crucial component of achieving a more fulfilling science education. Science teachers must understand that literacy has a meaning that is woven throughout the science-learning process. It is required of science teachers to assist pupils in developing their scientific literacy through science education. Students are therefore expected to possess scientific literacy and develop resilience in order to deal with the challenges of the twenty-first century (Costan et al., 2021).

For the following reasons, it is crucial that pupils possess scientific literacy: 1) Understanding science can bring happiness and satisfaction to an individual, and it can be shared with anyone; 2) The world's nations face issues in their daily lives that call for science knowledge, science ways of thinking, and the interests of numerous people who need to be informed, such as air, water, and forests (Baker, 2017). Students' capacity to hold significant and fruitful employment in the future will also be improved by their understanding of science and their science talents. Being literate in science is crucial, so it is crucial to develop students' scientific literacy from an early age because they will be the future next generation. Making science education promote the development of scientifically literate human resources is one way to do this. Students' capacity to hold significant and fruitful employment in the future will also be improved by their understanding of and competency in science (Zaky et al., 2020).

The four basic areas of scientific literacy are science knowledge, science competence and processes, settings for applying science, and attitudes. First, the key science ideas required to comprehend both natural events and the modifications that humans have made to the environment are referred to as science content. This can clarify some characteristics of the surrounding questions that might be posed in a variety of science disciplines.

Without restricting itself to the essential components of each nation's national curriculum, PISA evaluates science knowledge as relevant to the science education curricula in participating countries. PISA tests are not just limited to school life; they are also situated within a wider range of general life scenarios. PISA evaluation questions concentrate on circumstances relating to people, families, and groups of persons (personal), to the community (social), and to living in many nations (global). The PISA context includes topics like health, natural resources, environmental quality, risks, and the most recent advances in science and technology. These are the areas of application of science in personal, social, and global settings (Spitzer & Fraser, 2020).

Second, Process science is the study of mental operations that aim to provide an explanation for a conclusion or provide a solution to a query, such as locating and analyzing (Flores, 2019). The following skills are examined during the science process: (a) understanding science concepts; (b) recognizing science problems; (c) identifying evidence; (d) drawing findings; and (e) communicating conclusions. Third, the context in which science is applied emphasizes real-world issues and uses science to address them. Support for science research, self-assurance, curiosity in science, and a sense of responsibility for resources and the environment make up the fourth attitude (Kalkan et al., 2020).

Referring to its four dimensions, scientific literacy is very relevant to the nature of science itself, namely science as a science process, science as a science product, and science as a science attitude (Holbrook & Rannikmae, 2019). Science as a science process implies that science is definite steps in investigating a problem, for example, observing, developing hypotheses, designing and carrying out experiments, interpreting data, measuring, and so on. Science as a science product can be interpreted that, in science, there are facts, principles, laws, and theories that have been accepted as truth. Science as a science attitude contains values and morals including high curiosity, critical, creativity, humility, open-mindedness, and so on (Pei-Ming Chianga, 2018; Torres-Porras & Alcántara-Manzanares, 2022).

Several issues were discovered based on observations made with respondents during observation and interviews. The actualization of scientific literacy learning, which directly involves students in the learning and discovery process, is an uncommon occurrence since the instructional materials employed do not adequately convey the process of learning scientific literacy. Scientific literacy teaching materials used in elementary schools are still not relevant to the real situation in the environment. Students consequently frequently lack the necessary knowledge to comprehend nature and make sense of experience in personal, social, and global contexts, the knowledge that is genuinely crucial and needs to be applied over the long term. There are only a few teaching tools that are put to use aim to shape students' perspectives on science education to educate future citizens, particularly citizens who can engage in a society that is increasingly impacted by science and technological advancements. Students' understanding of the nature of science, science methods, and the strengths and limits of science has not yet been fully established as a result of science education. The majority of learning activities have not resulted in the favorable attitudes that should emerge during the study of scientific literacy.

According to the 2018 PISA survey findings, Indonesia continues to have a poor level of average scientific literacy when compared to other nations. In the category of scientific literacy, Indonesia is still rated 73rd out of 79 nations with a score of 396 (Pei-Ming Chianga, 2018). This demonstrates how science and technology knowledge among Indonesian students is still quite low. Many factors contribute to Indonesian students' poor levels of scientific literacy, including the curriculum, instructors' choices of teaching strategies and models, facilities and infrastructure, educational resources, and more. The choice of methods and models by the teacher is one of the elements that is directly related to student learning activities and affects the low literacy of Indonesian students.

Students can learn science more meaningfully if they have strong scientific literacy abilities. The findings of the TIMMS and PISA surveys reveal that Indonesian pupils still have a limited level of scientific literacy. Despite improvements, scientific literacy in Indonesia is still lower than the average for OECD nations. The lack of science education focused on developing students' procedural skills and critical thinking habits is to blame for Indonesia's poor level of Science proficiency. The significance of scientific literacy for students connects to how they may comprehend the environment, economic health, and other issues faced by society with diverse demands of the times, especially being a problem solver by being competitive, creative, collaborative, and with character. Integration within the process of developing scientific literacy is crucial for achieving the objectives of science education (Baumfalk et al., 2019; Jusuf et al., 2019).

The learning process can result in the development of scientific literacy, which refers to the nature and sources of scientific knowledge, student aspirations for careers in science, and motivation to learn science. To enable Indonesian elementary students to participate in the global marketplace, literacy studies must be included in the elementary learning process. The high ability to apply scientific literacy must be taken advantage of in order for pupils to compete and compete in the global arena.

Science content, science methods, and the context of scientific applications are all assessed as part of scientific literacy. With an emphasis on conceptual understanding and practical application, scientific literacy incorporates both curriculum-aligned content and cross-curricular material. The thought processes used by students to find solutions to issues are referred to as the scientific process, while the context is the place in which science concepts are applied (Servant-Miklos, 2018; How & Hung, 2019). According to this perspective, measuring a student's degree of scientific literacy also includes determining how well they comprehend different facets of the scientific method and how well they can apply what they have learned to circumstances that they would encounter in the real world. This translates to the assessment of scientific literacy being focused on the mastery of life skills, critical thinking skills, and capacities to apply science processes in students' everyday lives in addition to the knowledge of science content (Trinter et al., 2018).

Based on the problems that have been stated above, it is necessary to conduct research that can offer better solutions. Conducting research on the creation of scientific literacy teaching materials utilizing the graphic organizer technique for science is one way to improve students' scientific literacy and inculcate a science mentality. The science-specific graphic organizer technique is a visual diagram that shows how different concepts, facts, and phrases relate to one another within a single, overarching topic. A concept map or concept diagram may also be used to describe a graphic organizer. The purpose of this study is to test the effectiveness of the graphic organizer-based scientific literacy learning model in elementary schools.

METHODS

The research was conducted by applying education development design research. The Plomp development research model is the kind of development research that is employed to accomplish research goals. Four key phases make up the Plomp development research model: (1) preliminary research, (2) design, (3) test, evaluation, and revision phases, and (4) assessment (Kollmeier et al., 2016; Shi et al., 2019). Needs analysis, curriculum analysis, and student characteristics were all conducted at the preliminary analysis stage (preliminary research). The following shows a picture of the stages of the Plomp development research model:

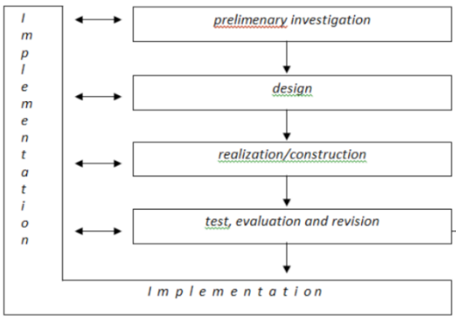

Figure 1. Plomp Implementation Design

Models for teaching scientific literacy that are practically applicable in primary schools are produced via preliminary study and continue to the creation of a product design, then the design phase (also known as the prototyping phase). A teacher utilizes the finished product design in trials and evaluates it. The validation process, which is the next step, will then be examined by professionals. Expert consultation outcomes are taken into consideration while revising a product. After revision, tests were run in a few chosen schools, followed by individual and small-group evaluations. The application of instructional materials was observed during testing. Following revisions made in response to feedback from the instructor or observer, the product is tested at the following school to determine its efficacy (assessment stage). In the final step, teachers and students were surveyed for their opinions, and the efficiency of the utilization of teaching resources was evaluated. In the final stage, known as the assessment phase, the research findings were highlighted even more.

The evaluation stage demonstrated the value of the graphic organizer-based scientific literacy learning paradigm. The benefits of using the Plomp model (Kollmeier et al., 2016; Strijker et al., 2020) include: First, it is more appropriate to use for the creation of instructional materials. Second, the description is thorough and systematic. Third, before being tested, the instructional materials are revised by themselves and consulted with experts. Fourth, there is an evaluation done individually and in small groups before conducting field tests.

The research subjects were fourth-grade students of elementary schools in Indonesia. The research sample was taken in the province of West Sumatra. The research findings were further emphasized in the last stage, namely the assessment phase. The assessment phase shows the effectiveness of the scientific literacy learning model based on graphic organizers. The modification of the stages of this research model is to distribute the product results to elementary schools to see the success and usability of the products that have been developed. The development model selected in each study has advantages that can be used as a basis and reference in the selection of models that are carried out.

The data analysis technique used was the normality test, homogeneity test, and t-test to test the effectiveness of using the graphic organizer-based scientific literacy learning model in class IV of elementary school. The t-test used is the independent sample t-test.

RESULTS AND DISCUSSION

The results of the research at the preliminary research stage show that students need workbooks that provide more enthusiasm and make it easier to understand science. This is because students' science abilities are still weak. Students who understand science, in theory, have difficulty understanding practical actions from science because it is very rare for science trials to take place in schools. The teacher needs indicate that teachers need a learning model that can make it easier for students to understand science thoroughly. The findings at the preliminary research stage serve as a basis for developing a graphic organizer-based scientific literacy learning model in elementary schools.

The findings in the prototyping phase resulted in a scientific literacy learning model based on graphic organizers consisting of eight syntaxes. The syntax of the graphic organizers-based scientific literacy learning model developed can be described in more detail, namely: (1) Orientation to science problems; (2) Identifying the method of inquiry; (3) Analysis of the difficulty of the investigation; (4) Investigative speculation; (5)

Designing experiments; (6) Science inquiry; (7) Presenting the findings of Science investigations; (8) Evaluating the process of Science inquiry.

The social system built in the graphic organizers-based scientific literacy learning model, namely: students must work in groups and be actively involved. The teacher monitors the learning process so that it is carried out following the learning objectives to be achieved. When performing in groups, students must respect the opinions of others.

The reaction principle built into the application of the graphic organizers-based scientific literacy learning model consists of a series of teacher activities. The teacher guides students to form small research groups. The teacher confronts students with various science problems that can be found in the surrounding environment. The teacher ensures that students are involved in the discussion process about the science problems they face. The teacher directs students to develop their own methods or strategies for solving science problems. The teacher directs students' thinking to analyze the possible difficulties they will face in the research process later. Students make a list of problems. The teacher provides worksheets for students to make assumptions about the findings they will examine. The teacher directs students to make a research flow that they will do. The teacher asks students to be responsible for their respective tasks in groups. The teacher asks students to start the process of scientific inquiry. The teacher observes and guides the investigation process so that the findings lead to the expected results. The teacher reminds students to make an investigation report in the group portfolio. The teacher allows students to present their findings in front of their friends. The teacher and students analyze the deficiencies in their investigation.

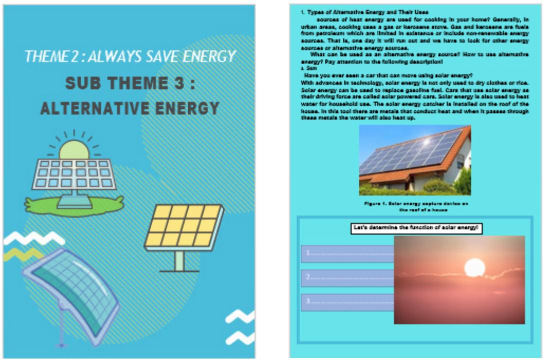

Figure 2. The Student's Book uses a Graphic Organizer-Based Scientific Literacy Learning Model in Elementary Schools

Support systems in the development of scientific literacy learning models based on graphic organizers, namely in the form of syllabi, lesson plans, media, tools, student books, teacher manuals, and student worksheets. The impact of instruction in the development of scientific literacy learning models based on graphic organizers shows the ability to understand science. Meanwhile, the impact of accompanying the development of scientific literacy learning models based on graphic organizers shows being responsible, teamwork, and conscientious. Figure 1 shows some of the contents of student books that are used to facilitate science learning in elementary schools.

The scientific literacy learning model based on graphic organizers has been declared valid and practical to apply in the learning process. Students are very enthusiastic about learning to use student books designed using graphic organizers-based scientific literacy learning models. Teachers are assisted with guidebooks to make it easier for teachers to apply graphic organizers-based scientific literacy learning models.

The operational activities of the graphic organizers-based scientific literacy learning model are carried out based on the syntax of the graphic organizers-based scientific literacy learning model that has been designed: (1) Orientation of science problems. Students are faced with scientific problems that exist in their surroundings. Students discuss the science problems they face. Students have formed small groups to discuss the scientific problems being discussed; (2) Identifying the method of inquiry. Students have determined the science problem they will investigate. Students return to discuss with their friends to develop their own methods or strategies for solving science problems; (3) Analysis of the difficulty of the investigation. Students analyze the possible difficulties they will face in the research process later. Students make a list of problems; (4) Investigative speculation. Students make assumptions about the findings they will examine. Students make several conjectures that will likely appear in research findings; (5) Designing experiments. Students make a flow of research that they will do. Students form work teams. Each student has their own task in the investigation process; (6) Science inquiry. Students do research. The teacher observes and guides the investigation process so that the findings lead to the expected results; (7) Presenting the findings of science investigations. Students make an investigation report in a group portfolio. Students present their findings in front of their friends; (8) Evaluating the process of scientific inquiry. Students open a question-and-answer session about their findings. Students analyze deficiencies in their investigations.

Figure 3. The Learning Process Uses a Graphic Organizer Based Scientific Literacy Learning Model in Elementary Schools

The research findings described focus on the findings in the assessment phase. The assessment phase shows the results of the effectiveness of the graphic organizers-based scientific literacy learning model. The trial was carried out by comparing the scientific literacy learning model based on graphic organizers with the popular science model used in Indonesia. The following is a data processing of learning comparison research findings between using a scientific literacy learning model based on graphic organizers and a science model in the fourth grade of Indonesian elementary schools.

Table 1. Paired Samples Test of the Experiment 1

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest - Postest	15.600	15.500	3.100	21.998	9.202	5.032	24	.000

The decision-making criterion in the paired sample t-test is if the sig. (2-tailed) < 0.05 then there is a difference in the average value and if the sig. (2-tailed) > 0.05, then there is no difference in the average value. Based on the table above according to the applicable criteria a significance value <0.05 or 0.000 <0.05. The conclusion is that there is a significant difference between student learning outcomes before and after using graphic organizers-based scientific literacy learning models in the experimental class 1.

Table 2. Paired Samples Test of the Experiment 2

	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Pretest - Postest	19.080	13.013	2.603	24.451	13.79	7.331	24	.000

The decision-making criterion in the paired sample t-test is if the sig. (2-tailed) < 0.05 then there is a difference in the average value and if the sig. (2-tailed) > 0.05, then there is no difference in the average value. Based on the table above according to the applicable criteria a significance value <0.05 or 0.000 <0.05. The conclusion is that there is a significant difference between student learning outcomes before and after using the science model in the experimental class 2. To see the effectiveness between the two models (science and scientific literacy based on graphic organizers) what needs to be done is to compare the average posttest scores of the experimental class 1 and the experimental class 2. Based on the calculations that have been done, it is found that the average posttest score of the experimental class 1 is 83.84 and the average posttest score of the experimental class 2 is 85.88. Thus, the average of the experimental class 2 > the average of the experimental class 1 or 85.88 > 83.84. The conclusion is that learning science in grade 4 using a scientific literacy learning model based on graphic organizers is more effective than using a science learning model.

The following is presented in the histogram figure of the comparison value of the average class scores of the Experiment 1 and the Experiment 2:

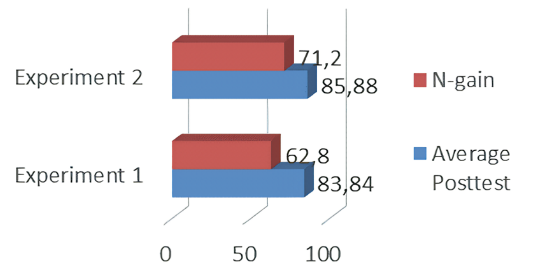

Figure 4. Comparison of the Average Scores of the Experiment 1 and the Experiment 2

From the histogram image above, it is clear that learning using scientific literacy learning models based on graphic organizers is more effective than using science learning models. This is supported by the opinion of Klucevsek (2017) and Magaji et al. (2022) who say that the help of approaches or methods that are adaptive can help students achieve learning goals. The same is also explained by Rosenblum et al. (2019) that elementary school students will learn more easily if accompanied by interesting concepts. Students will be interested in problems related to their lives so that students will find and investigate for themselves what steps will be taken to solve the problem. This is definitely supported by the learning process designed by the teacher. One of the learning process strategies is by employing a graphic organizer-based for teaching scientific literacy, which would substantially help pupils learn.

According to the calculations, the experimental class 2 has a higher N-gain value than the experimental class 1. The two classes' N-gain values being compared provide proof of this. The N-gain value for the experimental class 2 is 0.712 in the high category, and the N=gain value for the experimental class 1 is 0.628 in the medium category. The N-gain test was used to determine how to gauge the improvement in cognitive learning outcomes and science process skills between pre and post-learning. In the experimental class 2, there is an increase in student learning progress from before and after learning. Thus, learning scientific literacy based on graphic organizers in the experimental class 2 is well used to improve students' abilities and competencies.

The novelty of this research is to base a teaching material designed using graphic organizers and combined with a literacy learning model, which can train mindsets and add aesthetics to attract students' attention in learning. The contents and requirements for scientific literacy in grade IV elementary schools are met by the scientific literacy teaching resources using the graphic organizer technique.

Students find it simpler to fully comprehend the reading's contents when employing graphic organizer strategies to organize the various concepts and assignment descriptions found in scientific literacy instructional materials. By utilizing graphic organizer techniques, the content of training materials for scientific literacy can reach the chosen fundamental competencies. Additionally, the language used in instructional materials is simpler and clearer so that any student may understand it spelled correctly, sentence by sentence. The instructional materials created include pleasing color gradations so that they can encourage pupils to adhere to the learning process.

CONCLUSION

The research conducted aims to see the effectiveness of graphic organizer-based scientific literacy learning models in elementary schools. Based on the research findings, it shows that the scientific literacy learning model based on graphic organizers is declared feasible, practical, and more effective to be applied in the science learning process in the fourth grade of Indonesian elementary schools. Based on the scientific literacy model using the graphic organizers for science strategy that has been carried out, it is concluded that an analysis of the profile of the curriculum, students, and the learning needs of scientific literacy using the graphic organizers for science strategy has been found with a very good average category. The impact of this research is that students' literacy skills improve because graphic organizers strategies are effectively used to achieve learning objectives. Students are very enthusiastic and passionate about learning because students become the main actors in learning or are student-centered. This research has a great opportunity to be developed in the future, especially in terms of teaching and education. One of the studies that can be carried out further is the development of graphic organizer strategies into technology that students need, where the technology used can be used by students anywhere and anytime. This can be one of the learning media for students and graphic organizers can also be linked to other abilities and competencies such as higher-order thinking or numeracy literacy. The use of the graphic organizer strategy can be expanded because it has been proven to be able to support student success in learning.

REFERENCES

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Project-based learning integrated to stem to enhance elementary school students Science literacy. *Jurnal Pendidikan IPA Indonesia*, *5*(2), 261–267.

Ardiyanti, Y., Suyanto, S., & Suryadarma, I. G. P. (2019). The role of students science literacy in Indonesia. *Journal of Physics: Conference Series*, *1321*(3).

Atmojo, I. R. W., Ardiansyah, R., & Saputri, D. Y. (2022). Empowering Science-Based Entrepreneurship (SciPreneur) Skills through CEL-BaDiS up Learning Model on Food Biotechnology Materials. *International Journal of Instruction*, *15*(3), 83–102.

Avikasari, A., Rukayah, R., & Indriayu, M. (2018). The Influence of Science Literacy-Based Teaching Material towards Science Achievement. *International Journal of Evaluation and Research in Education (IJERE)*, *7*(3), 182–187.

Babaci-wilhite, Z. (2017). A rights-based approach to science literacy using local languages : Contextualising inquiry-based learning in Africa. *International Review of Education*, *63*(3), 381–401.

Bahtiar, B., Ibrahim,I., & Maimun, M. (2022). Analysis Of Students' Science Literacy Skill In Terms Of Gender Using Science Teaching Materials Discovery Model Assisted By Phet Simulation. *Jurnal Pendidikan IPA Indonesia*, *11*(3), 371–386.

Baker, D. R. (2017). Focus On Science Literacy : The Role Of Writing and Speaking In The Construction Of Science Knowledge. *Eurasian Journal Of Educational Research*, *24*(3).

Baumfalk, B., Bhattacharya, D., Vo, T., Forbes, C., Zangori, L., & Schwarz, C. (2019). Impact of model-based science curriculum and instruction on elementary students' explanations for the hydrosphere. *Journal of Research in Science Teaching*, *56*(5), 570–597.

Bergbauer, A., & Staden, S. Van. (2018). Social interaction determinants of South African reading literacy achievement: Evidence from prePIRLS 2011. *International Journal of Instruction*, *11*(2).

Bowers, N., Merritt, E., & Rimm-Kaufman, S. (2020). Exploring Teacher Adaptive Expertise in the Context of Elementary School Science Reforms. *Journal of Science Teacher Education*, *31*(1), 34–55.

Chan, T., & Sherbino, J. (2015). The McMaster modular assessment program (McMAP): A theoretically grounded work-based assessment system for an emergency medicine residency program. *Academic Medicine*, *7*(90), 900–905.

Costan, E., Gonzales, G., Gonzales, R., Enriquez, L., Costan, F., Suladay, D., Atibing, N. M., Aro, J. L., Evangelista, S. S., Maturan, F., Selerio, E., & Ocampo, L. (2021). Education 4.0 in Developing Economies: A Systematic Literature Review of Implementation Barriers and Future Research Agenda. *Sustainability (Switzerland)*, *13*(22).

Dewi, C. A., Erna, M., Martini, Haris, I., & Kundera, I. N. (2021). Effect of Contextual Collaborative Learning Based Ethnoscience to Increase Student's Science Literacy Ability. *Journal of Turkish Science Education*, *18*(3), 525–541.

Dewi, C. A., Khery, Y., & Erna, M. (2019). An ethnoscience study in chemistry learning to develop Science literacy. *Jurnal Pendidikan IPA Indonesia*, *8*(2), 279–287.

Ecevit, T., & Kıngır, S. (2022). Primary Student Teachers' Teaching-Learning Conceptions, Attitudes and Self-Efficacy Beliefs toward Science Teaching. *Journal of Turkish Science Education*, *19*(3), 773–785.

El Achkar, A. M. N., Leme, V. B. R., Soares, A. B., & Yunes, M. A. M. (2019). Life satisfaction and academic performance of elementary school students. *Psico-USF*, *24*(2), 323–335.

Faisal, Gi, G. M., & Martin, S. N. (2020). Analysis of government-funded research in Indonesia from 2014-2018: Implications for research trends in science education. *Jurnal Pendidikan IPA Indonesia*, *9*(2), 146–158.

Fakhriyah, F., Masfuah, S., Roysa, M., Rusilowati, A., & Rahayu, E. S. (2017). Student's science literacy in the aspect of content science? *Jurnal Pendidikan IPA Indonesia*, *6*(1), 81–87.

Fitria, Y., Helsa, Y., Nirwana, H., & Zulkarnaini, A. P. (2018). The integration of science and math. *Journal of Physics: Conference Series*, *1088*.

Flores, J. E. (2019). LNU Pre-service Secondary Science Teachers' Science Literacy and Science Teaching Self-Efficacy. *Journal of Physics: Conference Series*, *1254*(1).

Hauer, K. E. (2016). Ensuring resident competence: A narrative review of the literature on group decision making to inform the work of clinical competency committees. *Journal of Graduate Medical Education*, *8*(3), 156–164.

Holbrook, J., & Rannikmae, M. (2019). The Meaning of Science Literacy. *International Journal of Environmental & Science Education*, *4*(3), 275–288.

How, M. L., & Hung, W. L. D. (2019). Educing AI-thinking in science, technology, engineering, arts, and mathematics (STEAM) education. *Education Sciences*, *9*(3).

Ichsan, I. Z. (2019). ILMIZI: Innovation Learning Model for Natural Science and Environmental Learning based on HOTS. *International Journal for Educational and Vocational Studies*, *1*(6), 578–584.

Irmita, L., & Atun, S. (2018). The influence of Technological Pedagogical and Content Knowledge (TPACK) approach on science literacy and social skills. *Journal of Turkish Science Education*, *15*(3), 27–40.

Jamieson, J., Jenkins, G., Beatty, S., & Palermo, C. (2017). Designing programmes of assessment: a participatory approach. *Medical Teacher*, *39*(11), 1182-1188.

Jusuf, R., Sopandi, W., Wulan, A. R., & Sa'ud, U. S. (2019). Strengthening teacher competency through ICARE approach to improve literacy assessment of science creative thinking. *International Journal of Learning, Teaching and Educational Research*, *18*(7), 70–83.

Kalkan, Ö. K., Altun, A., & Atar, B. (2020). Role of teacher-related factors and educational resources in science literacy: An international perspective. *Studies in Educational Evaluation*, *67*(August).

Karataş, F. Ö., Orçan, F., Çelik, S., Uludüz, Ş. M., Bektaş, B. T., & Akaygün, S. (2022). Perception and Reality: Two Dimensions of Science Literacy Measures. *Journal of Turkish Science Education*, *19*(1), 129–143.

Klucevsek, K. (2017). The intersection of information and science literacy. *Communications in Information Literacy*, *11*(2).

Kollmeier, B., Schädler, M. R., Warzybok, A., Meyer, B. T., & Brand, T. (2016). Sentence Recognition Prediction for Hearing-impaired Listeners in Stationary and Fluctuation Noise with FADE. *Trends in Hearing*, *20*, 1–17.

Kurniaman, O., Zufriady, Z., Mulyani, E. A., & Simulyasih S. B. N. (2018). Reading Comprehension Skill Using Graphic Organizer for Elementary School Students. *Journal of Teaching and Learning in Elementary Education (Jtlee)*, *1*(2), 75.

Liu, M., Liu, S., Pan, Z., Zou, W., & Li, C. (2018). Examining science learning and attitude by at-risk students after they used a multimedia-enriched problem-based learning environment. *Interdisciplinary Journal of Problem-Based Learning*, *13*(1), 1–11.

Lu, C. C., Hong, J. C., Chen, F. F., & Ma, S. Y. (2020). Elementary School Students Learn Arduino Programming to Assemble Sensory-Controlled Works. *International Journal of Information and Education Technology*, *10*(4), 265–270.

Magaji, A., Ade-Ojo, G., & Bijlhout, D. (2022). The Impact of After School Science Club on the Learning Progress and Attainment of Students. *International Journal of Instruction*, *15*(3), 171–190.

Martinčević, J. (2020). An educational approach to elementary school students. *Croatian Journal of Education*, *22*(3), 789–821.

Merritt, J., Lee, M., Rillero, P., & Kinach, B. M. (2017). Problem-based learning in K–8 mathematics and science education: A literature review. *The Interdisciplinary Journal of Problem-Based Learning*, *11(2)*.

Mtsi, N. (2021). Examining The Support Given To Teachers To Promote Science Learning And Science Literacy In Selected South African Schools. *PONTE*, *77*(4), 56–75.

Muchtar, H., Suparman, M. A., Tamuri, A. H., & Susanto, E. (2018). The Influence Of Learning Models And Learning Reliance On Students' Science Literacy. *Jurnal Pendidikan IPA Indonesia*, *7*(4), 458–466.

Ohnishi, Y., Nakano, T., Tamai, T., Mori, S., & Kawada, K. (2021). Practical learning of science for elementary school students via programming and control experimentation. *Journal of Robotics, Networking, and Artificial Life*, *7*(4), 266–269.

Paristiowati, M., Hadinugrahaningsih, T., Purwanto, A., & Karyadi, P. A. (2019). Analysis of students' Science literacy in contextual-flipped classroom learning on acid-base topic. *Journal of Physics: Conference Series*, *1156*(1).

Pei-Ming Chianga, H.-I. T. (2018). The Application Of Differential Person Functioning On The Science Literacy Of Taiwan Pisa 2015. *Humanities and Social Science Reviews*, *6*(1).

Regan, K., Evmenova, A. S., Good, K., Legget, A., Ahn, S. Y., Gafurov, B., & Mastropieri, M. (2018). Persuasive Writing With Mobile-Based Graphic Organizers in Inclusive Classrooms Across the Curriculum. *Journal of Special Education Technology*, *33*(1), 3–14.

Rehmat, A. P., & Hartley, K. (2020). Building engineering awareness: Problem-based learning approach for STEM integration. *Interdisciplinary Journal of Problem-Based Learning*, *14*(1).

Rosenblum, L. P., Ristvey, J., & Hospitál, L. (2019). Supporting Elementary School Students with Visual Impairments in Science Classes. *Journal of Visual Impairment and Blindness*, *113*(1), 81–88.

Şentürk, C., & Sari, H. (2018). Investigation of the contribution of differentiated instruction into science literacy. *Qualitative Research in Education*, *7*(2).

Servant-Miklos, V. F. C. (2018). The Harvard connection: How the case method spawned problem-based learning at McMaster University. *Health Profession Education*, *5*(19), 163–171.

Setiawan, B., Innatesari, D. K., Sabtiawan, W. B., & Sudarmin, S. (2017). The development of local wisdom-based natural science module to improve science literation of students. *Jurnal Pendidikan IPA Indonesia*, *6*(1), 49–54.

Sharon, A. J., & Baram-Tsabari, A. (2020). Can science literacy help individuals identify misinformation in everyday life? *Science Education*, *104*(5), 873–894.

Shi, L., Han, L., Yang, F., & Gao, L. (2019). The Evolution of Sustainable Development Theory: Types, Goals, and Research Prospects. *Sustainability (Switzerland)*, *11*(24), 1–16.

Smith, K. V., Loughran, J., Berry, A., & Dimitrakopoulos, C. (2012). Developing Science Literacy in a Primary School. *International Journal of Science Education*, *34*(1), 127–152.

Spitzer, W., & Fraser, J. (2020). Advancing Community Science Literacy. *Journal of Museum Education*, *45*(1).

Strijker, D., Bosworth, G., & Bouter, G. (2020). Research Methods in Rural Studies: Qualitative, Quantitative and Mixed Methods. *Journal of Rural Studies*, *78*(June), 262–270.

Subali, B., Kumaidi, Aminah, N. S., & Sumintono, B. (2019). Student achievement based on the use of Science method in the natural science subject in elementary school. *Jurnal Pendidikan IPA Indonesia*, *8*(1), 39–51.

Suryanti, S., Ibrahim, M., & Lede, N. S. (2018). Process skills approach to develop primary students' Science literacy: A case study with low achieving students on water cycle. *IOP Conference Series: Materials Science and Engineering*, *296*(1).

Torres-Porras, J., & Alcántara-Manzanares, J. (2022). Are Pre-Service Teachers Able to Answer Children's Questions About The Natural Sciences? The Characterization of Questions by Children and Students of the Early Childhood Education Degree. *Journal of Turkish Science Education*, *19*(2), 374–388.

Trinter, C. P., Moon, T. R., & Brighton, C. M. (2018). Characteristics of students' mathematical promise when engaging with problem-based learning units in primary classrooms. *Journal of Advanced Academics*, *26*(1), 24–58.

Walag, A. M. P., Fajardo, M. T. M., Bacarrisas, P. G., & Guimary, F. M. (2022). A Canonical Correlation Analysis of Filipino Science Teachers' Science Literacy and Science Teaching Efficacy. *International Journal of Instruction*, *15*(3), 249–266.

Wilujeng, I., Dwandaru, W. S. B., & Rauf, R. A. B. A. (2019). The effectiveness of education for environmental sustainable development to enhance environmental literacy in science education: A case study of hydropower. *Jurnal Pendidikan IPA Indonesia*, *8*(4), 521–528.

Zaky, R. A., Islami, E., Nuangchalerm, P., Sultan, U., Tirtayasa, A., & Info, A. (2020). Comparative study of Science literacy : Indonesian and Thai pre-service science teachers report. *International Journal of Evaluation and Research in Education (IJERE)*, *9*(2).