Improving Scientific Literacy in Primary Schools Using Experimental Methods

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Abstract: The research aims to increase scientific literacy in science learning using experimental learning methods, especially magnetic material in class IV SDK BOBA. The type of research used in this research is classroom action research where the research subjects are class IV students at SDK BOBA. This research was carried out in two cycles with the research stages used including planning, implementation, observation, and reflection stages. The research results showed that through the experimental method to increase students' scientific literacy in aspects of science as a body in cycle 1, it was 37.5% with very poor criteria. In contrast, in cycle 2, the percentage was 56.5%, with poor criteria and an increase of 19%. The percentage of the science aspect as a way to investigate in cycle 1 was 56.25% with poor criteria, while in cycle 2, the percentage was 75% with good criteria and increased by 18.75%. The percentage of the science aspect as a way of thinking in cycle 1 was 37.5% with very poor criteria, while in cycle 2, the percentage was 75% with good criteria and an increase of 37.5%. The percentage in the science aspect of the interaction between science, technology, and society in cycle 1 was 56.25% with poor criteria. In contrast, in cycle 2, the percentage was 75% with good criteria and increased by 18.5%. By using this method, students can develop critical thinking skills because, through this, students can experience an experimental process that begins with observing, analyzing, and then concluding.

Abstrak: Tujuan penelitian untuk meningkatkan literasi sains pada pembelajaran IPA dengan metode pembelajaran experiment khususnya materi magnetic dikelas IV SDK BOBA. Jenis penelitian yang digunakan dalam penelitian ini yaitu penelitian tindakan kelas dimana subjek penelitiannya ialah siswa kelas IV SDK BOBA. Penelitian ini dilakukan dalam dua siklus dengan tahapan penelitian yang digunakan meliputi tahap perencanaan, pelaksaanan, pengamatan, dan refleksi. Hasil penelitian menunjukan bahwa melalui metode eksperimen untuk meningkatkan literasi sains siswa pada aspek sains sebagai batang tubuh pada siklus 1 sebesar 37,5% dengan kriteria sangat kurang sedangkan pada siklus 2 persentasenya sebesar 56,5% dengan kriteria kurang dan mengalami peningkatan sebesar 19%. Persentase pada aspek sains sebagai cara untuk menyelidiki pada siklus 1 sebesar 56,25% dengan kriteria kurang sedangkan pada siklus 2 persentasenya sebesar 75% dengan kriteria baik dan mengalami peningkatan sebesar 18,75%. Persentase pada aspek sains sebagai cara berpikir pada siklus 1 sebesar 37,5% dengan kriteria sangat kurang sedangkan pada siklus 2 persentasenya sebesar 75% dengan kriteria baik dan mengalami peningkatan sebesar 37,5%. Persentase pada aspek sains Interaksi antara sains, teknologi, dan masyarakat pada siklus 1 sebesar 56,25% dengan kriteria kurang sedangkan pada siklus 2 persentasenya sebesar 75% dengan kriteria baik dan mengalami peningkatan sebesar 18,5%. Dengan menggunakan metode ini siswa dapat mengembangkan kemampuan berpikir kritis karena melalui hal ini siswa dapat mengalami proses percobaan yang diawali dengan mengamati, menganalisis dan kemudian menyimpulkan.

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A. Introduction

Rapid changes in the fields of science and technology have greatly improved the quality of human life. However, these developments are often accompanied by new problems related to ethics, morals, and global issues, which can actually threaten human dignity and survival. This is thought to occur due to low scientific literacy skills (Fuadi et al., 2020).

At the elementary school level, science or science is one of the subjects that plays an important role in the world of education, this is because science can be a provision for students facing difficulties in this era of globalization. In this global era, applying scientific abilities in learning is of course, to solve problems so that you have a high attitude and sensitivity towards yourself and your environment in making decisions based on scientific literacy learning at the elementary school level. Science or science is science material but with all considerations of school conditions (Fauziah et al., 2022). Scientific literacy can be realized if science education produces students who are able to think logically, critically, and creatively, are able to solve problems, master technology, and be adaptive to changes and developments over time. Therefore, scientific literacy is an important thing for students to have from elementary school age to face the era of globalization.

Scientific literacy is a person's ability to understand science to solve problems so that it can improve attitudes and sensitivity toward the surrounding environment. Mastery and the ability to understand science and technology in this digital era play an important role in the success of a nation's education. Science or science learning as a part of education has an important role in producing and forming students who can think critically, logically, creatively, innovatively, and with global competitiveness (Yuliati et al., 2019). Science learning is also expected to become the main foundation of education, as a vehicle for students to learn more about science contextually and implement it in everyday life. So, scientific literacy becomes mandatory for every student. As stated, Natural Science (IPA) is a human method that includes psychological activities, knowledge, as well as ways of organizing and measuring that can be tried again. Their validity is based on the behaviors of curiosity, determination, and persistence carried out by individuals to grasp the secrets of the universe. Science teaching and learning activities focus on sharing real professionalism with students regarding development potential, enabling them to understand the natural environment through a process of discovery, which will help students gain experience in the natural environment. However, in a pandemic, science studies must be completed online or independently by students (Handayani & Jumadi, 2021).

In science learning, literacy has a very important role because it prepares students to be qualified, reliable, and capable of international competence. To be able to create and develop scientific literacy in science learning, teachers need to create learning conditions that involve student activity. Learning is only dominated by teachers through lecture methods and textbooks, only involving active students. This boredom will cause students to need more reasoning and knowledge about scientific literacy. The emphasis on scientific

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literacy is not only aspects of knowledge and understanding of concepts and social life (Irsan, 2021).

Based on the PISA survey from 2020 to 2018, Indonesia is one of the countries with low scientific literacy. The PISA results for Indonesian students in 2015 alone were still below the average science score for OECD countries. The average science score for the scientific literacy domain in OECD countries is 493, while Indonesia has only reached a score of 403. This shows that there needs to be more in how science education is treated. In the national education system, scientific literacy is starting to be accommodated. This shows that there needs to be more in how science education is treated (Kane et al., 2016). The low science learning outcomes obtained by students are, of course, related to the science learning process, which still needs to provide opportunities for students to develop critical thinking skills. This science learning is still rote. It has not been able to show aspects of science as learning that are in accordance with the nature of science, according to Fadillah et al (2017), namely science as a way of thinking, science as a way of investigating, science as a body of knowledge, and science and its interaction with societal technology.

Based on previous research, shows that low scientific literacy is triggered by student-centered learning or a lack of involvement from students in the learning process. This is, of course, a major problem because scientific literacy is related to 1) scientific context, namely, students need to grasp a number of essential concepts to be able to understand certain natural phenomena and changes that occur due to humans. 2) the scientific literacy process, namely assessing students' abilities to search for, interpret, and treat evidence. 3) scientific context, namely literacy, which emphasizes the importance of knowing and understanding the context of the application of science as well as being able to apply science to solving the real problems they face, whether they occur to the child personally, the community where the child is, or life on earth more globally (Erayani et al., 2022).

In the learning process, several problems often arise, namely problems from within and from outside. The factors behind the problems that arise from within come from the students themselves, such as students' learning interests, students' learning styles, and the way students interact at school. External factors that cause problems arise, namely the student environment, parents, and teachers. The learning process is always separate from a teacher, so the main problems in learning can come from the teacher. This problem is the use of models or methods in learning (Somantri et al., 2018) state that "learning methods are ways of presenting lesson material carried out by educators so that learning occurs in students in an effort to achieve goals."

The latest concept developed in the current learning paradigm is the application of the experimental method (experiment). As expressed by Mayangsari et al (2014), the experimental method is a way of teaching that gives students the opportunity to carry out an experiment on something, observe the process, and write down the results of the experiment. The results of the experiment are presented to the class and evaluated by the teacher. This learning method aims to train students to discover concepts and to develop knowledge, where the teacher provides the widest possible opportunity for students to

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prove the experiment so that, through experimentation, students obtain answers in expressing opinions and develop abilities and skills in accordance with what they have obtained.

The experimental method is a teaching method that is suitable for science learning because it can involve students' activities directly by conducting experiments to discover concepts or theories and think critically. According to (Amir, 2015), the critical thinking process should be paid attention to and the learning carried out is oriented towards problem solving so that Students' thinking abilities are increasing. Furthermore, (Mahpudin, 2018) the learning process using the experimental method is quite good. This experimental method can facilitate student involvement in high-learning activities, and students are expected to show their creativity in learning natural sciences. Apart from that, students also feel appreciated and given the opportunity to develop themselves according to their respective abilities, which in turn will increase learning outcomes. Students learn enthusiastically and in a pleasant learning atmosphere.

Based on research conducted by researchers in class IV SDK BOBA, teachers still need to fully implement effective learning models that can help students understand the material presented. The learning process in class IV SDK BOBA still tends to be teacher-centered, better known as conventional learning. In the learning process, students only listen to the teacher's explanation about a topic or subject in a question-and-answer process between the teacher and students, without any involvement of the students during the learning process. The solution to overcome this problem is to use the experimental method, considering that there is much material that uses experiments or practicums. With this model, students are expected to have high motivation and interest in learning so that their scientific literacy skills are better.

This research was carried out with the aim of increasing student literacy using experimental methods, especially in the magnetic force sub-material for class IV SDK BOBA. In this way, students are expected to have scientific literacy and become strong citizens in the 21st century.

B. Method

The subjects of this research were fourth-grade students at SDK BOBA. This research is Classroom Action Research (PTK). According to (Jannah, 2015), PTK is research carried out in classes that have certain characteristics. PTK prioritizes creativity from teachers to provide ways to solve learning problems that teachers know about. PTK is research that directly provides corrective action for problems faced in the learning process. Data collection techniques: 1) Test: This test is used to obtain student understanding results. The test I use is an essay question. Then continue with a test that contains an experimental method to see the extent of the learning outcomes obtained by students. 2) Observation: The observation activity that must be carried out is paying attention to objects or seeing the extent to which students understand the material presented by the teacher to students obtained during the teaching and learning process in class. Data analysis techniques: In this

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research, researchers used data analysis techniques according to Kurt Lewin, which carried out several stages, namely planning, implementation, observation, and reflection.

At this stage, classroom action research is directed at analyzing data and finding efforts to improve learning so that the data analysis used in classroom action research can use quantitative and qualitative data obtained from student learning outcomes. The learning results were obtained from observing science learning activities using the experimental method. Research instruments used in research include lesson plans, worksheets, and observation sheets for students to improve their ability to understand magnetic material using experimental methods.

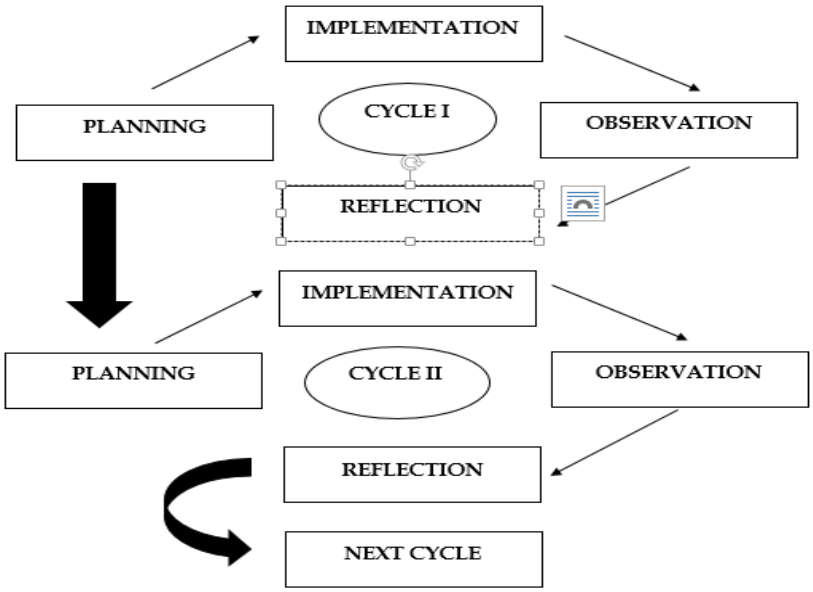

Figure 1. Systematic Research Procedures (Arikunto, 2015)

a. Planning
   At the planning stage the teacher explains that this method is very necessary in science learning so that students are able to understand the material being explained.
b. Implementation
   At this implementation stage, namely the implementation of the research plan, Researchers here carry out experiments with syntax that has been prepared in advance by the researcher. Here, the researcher carried out actions in cycles one and
c. Observation
   In this stage, the researcher observed student activities that focused on magnetic material in science learning through direct learning. This is done to obtain data and sources to make improvements in the next cycle. Student observations can be seen from student grades and the recording of all the obstacles experienced.

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d. Reflection

At this stage, data analysis is carried out based on observations. This process becomes material for consideration for the implementation of the next cycle. In this stage, the researcher found several things that were taken into consideration in carrying out the next cycle: 1) there was still a lack of grades obtained, and 2) student learning outcomes in magnetic material had yet to reach the indicators.

Testing data analysis techniques using the Meltzer formula to see the value in each cycle using the formula:

$$\text{Percentage (\%)} = \frac{\text{Number of marks x number of students}}{\text{Total number of students}} \text{ X } 100\%$$

The success-level criteria are as follows:

80% -100% = Excellent
70% - 79% = Good
60% - 69% = Medium
50% - 59% = Less
0% - 49% = Very Poor

C. Result and Discussion

Result

Results from Using Experimental Methods

Learning activities to increase scientific literacy using experimental methods in this research were carried out in two cycles, each consisting of 4 stages, namely: 1) Planning stage. (1) prepare teaching modules and determine the design of scientific literacy indicators that will be studied in cycle 1; (2) formulate scientific literacy learning indicators for each meeting in accordance with the basic competencies in the curriculum; (3) prepare a Learning Implementation Plan (RPP); and (4) design learning tools, such as observation reports. 2) Implementation stage. The implementation stage of learning activities with scientific literacy indicators will be carried out on Tuesday–Wednesday, 10-11 October 2023, in class IV SDK Boba. The learning activities refer to the learning implementation plan. At this stage, the researcher applies learning to the experimental method. On the 11th, at the end of the teaching and learning process for cycle 1, a test on the results of increasing students' scientific literacy was held. By holding this test, we can determine students' ability to complete the test based on the scientific literacy indicators provided. 3) Observation. Researchers carried out observation activities to assess students' activeness in the learning process when they were in groups. In implementing the actions in cycle 1, were carried out over two meetings.

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Figure 1. Test Results for Increasing Science Literacy in Cycle 1

Table 1. Data on Aspects of Science Literacy in Cycle 1

Aspects of Scientific Literacy	Scientific Literacy Indicators	Number of Students Who Meet the Criteria	Percentage
Science as the body	Presents facts related to magnetic force and presents concepts related to magnetic material.	2	37,5%
Science as a way of inquiry	Requires students to answer questions through the use of magnetic materials	3	56,5%
Science as a way of thinking	Describe the steps involved in conducting experiments on magnetic materials.	2	37,5%
Interaction between science, technology, and society	Describe the application of magnets in everyday life.	3	56,5%

Based on the results of increasing scientific literacy, as shown in the table, a graph of increasing students' scientific literacy will be created as follows:

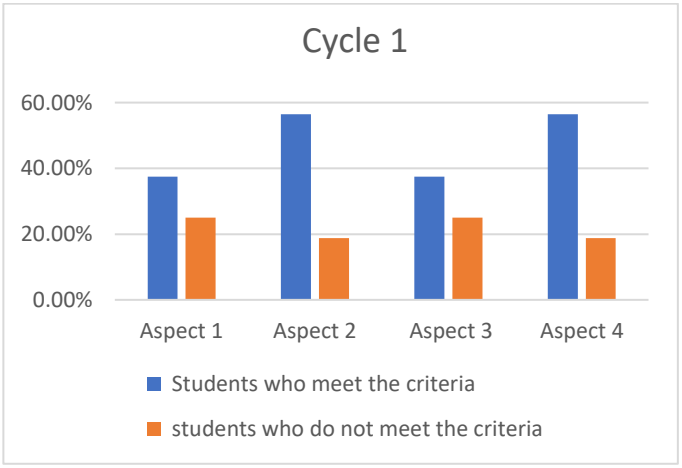

Figure 2. Results of Increasing Students' Scientific Literacy

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4) Reflection

After the learning activities were carried out, together with the class IV SDK Boba teacher, they reflected on the shortcomings. The results of the reflection on the implementation of learning in cycle 1 are as follows: (1) students are not yet accustomed to using teaching aids in conducting experiments. (2) Students need to be more active and appear more active in responding to the material presented by the teacher. (3) Students do not dare to express opinions regarding the material being taught. (4) Students still need to show seriousness in participating in learning. (5) The enthusiasm of students in carrying out the assignments given still needs to be visible. (6) The average score for each scientific literacy indicator has yet to achieve maximum results. Based on the results of the reflection above, some things need attention and improvement, such as (1) motivating students to be braver in asking questions related to the difficulties they experience during the learning process using the experimental method. (2) motivating for students to be active in discussions. (3) encourage students to dare to express opinions regarding the subject matter. For this reason, it is necessary to follow up to address the deficiencies above by carrying out cycle 2:

Figure 3. Preparation for Cycle 2 Science Literacy Improvement Test

Table 2. Data on Aspects of Science Literacy in Cycle 2

Aspects of Scientific Literacy	Scientific Literacy Indicators	Number of Students Who Meet the Criteria	Percentage
Science as the body	Presents facts related to magnetic force and presents concepts related to magnetic material.	3	56,5%

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Aspects of Scientific Literacy	Scientific Literacy Indicators	Number of Students Who Meet the Criteria	Percentage
Science as a way of inquiry	Requires students to answer questions through the use of magnetic materials.	4	75%
Science as a way of thinking	Describe the steps involved in conducting experiments on magnetic materials.		75%
Interaction between science, technology, and society	Describe the application of magnets in everyday life.	3	75%

Based on the results of increasing scientific literacy, as shown in the table, a graph of increasing students' scientific literacy will be created as follows:

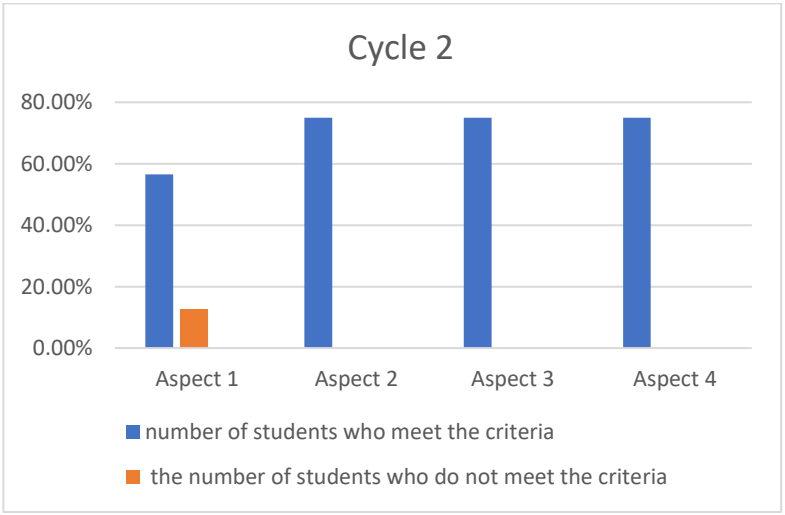

Figure 4. Results of Increasing Students' Scientific Literacy

Based on the results of the data analysis above, it is stated that students' scientific literacy using the experimental method from cycle to cycle has increased. This can be seen from the average of each literacy indicator. From the results of this analysis, there is a very positive influence of the direct learning model through the experimental method on students' scientific literacy in PBM science on magnetic material. In the aspect of PBM science skills, it can be seen from the initial abilities of students in class IV SDK BOBA.

Discussion

After carrying out cycle 1, the level of achievement of students' scientific literacy using the experimental method on magnetic material, students have not experienced an increase in the aspects and indicators of scientific literacy: 1) Aspect: Science as a body of knowledge; 2) Indicator: Presenting facts related to style magnets and presenting concepts related to magnet material; 2 students achieved KKM with a percentage of 37.5%. 2) Aspect:

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Science as a way of investigating; indicator: Requires students to answer questions through the use of magnetic material; 3 students achieved KKM with a percentage of 56.25%. 3) Aspect: Science as a way of thinking; indicator: Describes the steps in conducting experiments on magnetic materials; 2 students achieved KKM with a percentage of 37.5%. 4) Aspect: Interaction between science, technology, and society; indicator: Describes the application of magnets in everyday life; 3 students fulfilled the KKM with a percentage of 56.25%. This is because (1) students are not used to using teaching aids in conducting experiments. (2) Students need to be more active and appear more active in responding to the material presented by the teacher. (3) Students do not dare to express opinions regarding the material being taught. (4) Students still need to show seriousness in participating in learning. (5) The enthusiasm of students in carrying out the assignments given still needs to be visible.

Meanwhile, in cycle 2, students have completed and obtained an average percentage of 75%. This happens because the learning process is always directed and focused on students, where students work together to carry out practicums and discuss and work on questions with each other according to the scientific literacy indicators given. So, as seen from the test results from cycle 1 to cycle 2, it was 18.5%. So, this research can be stopped in class 2.

From the analysis of the data produced, the experimental method obtained increased results in improving students' scientific literacy abilities. Experimental methods have a big influence on students' scientific literacy. The experimental method provides opportunities for students, both individuals and groups, to carry out experiments that are deliberately designed and planned to prove the truth of a theory by taking/using an orderly and systematic method. In accordance with the steps taken before implementing the experimental method in science learning (Rafika, 2016), 1) Clearly formulate what skills and abilities students are expected to achieve after the experiment is carried out. 2) Formulate the learning objectives that will be achieved through this experiment. 3) Prepare the tools and materials that will be used during the experiment. Seriously consider whether the tools and materials are easy to obtain and whether they have been tried beforehand so that the experiment runs smoothly.

The experimental method also has several advantages, according to (Susdamayanti, 2014), which can influence scientific literacy. 1) Make students believe in conclusions that are in accordance with the results of their experiments. They can draw their conclusions, but the meaning is the same as the truth. 2) Fostering students to make breakthroughs with discoveries from their experiments and be of benefit to others. Because this learning method is fun, students can carry out their trials or experiments at home without having to be given an assignment first. 3) The results of student experiments can be used in schools and society. 4) Train students' accuracy and tenacity when conducting experiments. Based on the discussion above, experimental methods are really needed to improve students' literacy skills.

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This research shows that in the application of scientific literacy for fourth-grade students at SDK BOBA, there are several main things in the application of students' scientific literacy, including students' knowledge about science, students' processes in science, the development of students' scientific attitudes, and student's ability to understand science, not only about concepts but also applying the scientific abilities possessed by each student in overcoming various problems and being able to make decisions in accordance with the rules of science. Students are invited to think critically when conveying ideas verbally and conveying the results of their learning. With scientific literacy, students are expected to be able to apply the knowledge they gain at school and then apply it to their daily lives in general and personally so that they are responsive and care about nature and the environment where they live.

As for the methods and approaches used in learning, there are no restrictions, meaning that teachers are free to use any method with an emphasis on achieving the main goal of scientific literacy. This main objective is the result of teacher interaction with students, namely the development and mastery of scientific readiness and science process skills. The learning process focuses on providing direct experience and applying the essence of science.

This is in line with what was stated by Muyasaroh et al (2021), that students' low literacy skills can be improved by using appropriate learning models. This is supported by Ulfa et al (2017), who found that students' literacy skills can be improved by implementing a science learning model that prioritizes the development of attitudes, ideas, and process skills that emphasize the scientific discovery approach to increase students' enthusiasm, interest, motivation and curiosity about science. Meanwhile, providing direct experience and application of science is obtained through practicum. A practicum is a series of activities that allow a student to apply skills or practice something. Through practicums, it is hoped that students will be interested in learning, participate, and not be apathetic.

According to Pohan et al (2016), the way to integrate elements of scientific literacy in science subjects in elementary school is: 1) Formulating scientific literacy indicators according to learning KD; 2) Internalizing aspects of scientific literacy in the subject matter, and 3) Designing scientific literacy in the form of an RPP. 4) Ask questions in the form of arguments and analyze problems. The obstacles to implementing Scientific Literacy in Elementary Schools: 1) Scientific literacy guides students to think critically, while critical thinking is a challenge in itself for students. One of the factors that influences students' scientific literacy abilities is critical thinking abilities (Pohan et al., 2016). 2) Implementing scientific literacy in schools not only demands students' abilities but also requires teachers' abilities to teach literacy-based science and teaching students to have scientific literacy skills is challenging. Teachers have an important role in developing students' scientific literacy abilities (Siregar et al., 2020).

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D. Conclusion

Based on the research results obtained to increase students' scientific literacy by using experimental methods in natural science learning for class IV SDK BOBA students, several things can be concluded as follows: 1) implementing learning through experimental methods can increase students' scientific literacy in science learning for class IV SDK BOBA. This can be seen in the research results that, through experimental methods to increase students' scientific literacy in aspects of science as a body of knowledge, in cycle 1, it was 37.5% with very poor criteria. In contrast, in cycle 2, the percentage was 56.5% with fewer criteria and experienced an increase of 19%. The percentage of the science aspect as a way of investigating in cycle 1 was 56.25% with poor criteria, while in cycle 2, the percentage was 75% with good criteria and increased by 18.75%. The percentage of the science aspect as a way of thinking in cycle 1 was 37.5% with very poor criteria, while in cycle 2, the percentage was 75% with good criteria and increased by 37.5%. The percentage in the science aspect of the interaction between science, technology, and society (interaction of science, technology, and society) in cycle 1 was 56.25% with poor criteria. In contrast, in cycle 2, the percentage was 75% with good criteria and increased by 18. 5%.

Applying the experimental method to develop science process skills and scientific literacy, teachers can prepare everything needed in the learning process, namely in the form of media lesson plans and various materials and equipment needed in science learning, especially the use of experimental methods. Teachers can carry out learning well and optimally, and teachers can evaluate process assessments in the form of observation notes, anecdotal records, and scales of development achievements. Applying the experimental method to develop science process skills and scientific literacy, teachers can prepare everything needed in the learning process, namely in the form of media lesson plans and various materials and equipment needed in science learning, especially the use of experimental methods. Teachers can carry out learning well and optimally, as well as evaluate process assessments in the form of observation notes, anecdotal records, and scales of development achievements. By using this method, students can develop critical thinking skills because they can experience an experimental process that begins with observing, analyzing, and then concluding. The experimental method feels fun because students can see what they are doing directly.

Based on several of the researchers' conclusions that have been put forward, the researcher conveys several suggestions as follows: 1) Teachers should always try to implement new ways of managing learning in class and outside the classroom so that students always think ahead and try to do their best, especially in efforts to improve learning outcomes. Students who are less able to understand the lesson so that the grades or results obtained could be better. So, we need a learning model with varied methods to get satisfactory learning results. 2) it is very important to provide motivation and reinforcement by teachers to students through the application of experimental methods, it is very important to do this through the application of experimental methods because it is very necessary in the learning process to stimulate children's interest in learning about the

https://doi.org/10.51276/edu.v5i2.931

importance of studying seriously. There should be further research from other parties by applying experimental methods in natural science learning to the same concept or different classes.

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