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Analysis of Elementary School Students' Science Process Skills in the Merdeka Curriculum

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Abstract: Science literacy in Indonesia is still far below the global average, thus highlighting the need for substantial improvement in science education, especially in science process skills. This study aims to analyze the basic science process skills of 4th grade elementary school students by using a descriptive approach through classroom observation and written tests. The results showed an average score of 54, categorized as poor, with the score of each aspect being observing 62 (fair), interpreting 61 (fair), classifying 56 (poor), predicting 54 (poor), planning experiments 51 (poor), and communicating 42 (bad). The study identified weak communication and experiment planning skills as the main factors contributing to low science literacy. Therefore, the implementation of inquiry-based learning strategies is essential to enhance science process skills and improve overall science literacy. The findings provide valuable insights for educators to design more effective and engaging science learning in primary schools.

Keywords: Elementary school students'; Merdeka curriculum; Science process skills

Introduction

Science learning is very important to train students to think scientifically and understand how science works in everyday life. In addition to instilling scientific knowledge and attitudes, science learning also emphasizes science process skills that encourage students to be more active in exploring concepts and finding solutions to problems faced (Dani et al., 2024; Masus, 2020). With these skills, students can think critically, creatively, and be better prepared to face future challenges, thus forming a generation that is adaptive to the development of science and technology.

However, science learning in Indonesia still faces major challenges, especially in terms of students' low science literacy. The Program for International Student Assessment (PISA) 2022 results show that Indonesian students' science literacy score only reached 383, far below the global average of 485 (OCDE, 2023). This condition shows that science literacy in Indonesia still needs to be improved, so efforts are needed to improve the quality of science learning to overcome this gap.

Science literacy is closely related to science process skills, as it enables students to understand, analyze and apply scientific concepts in various situations, as well as use science knowledge to identify questions, draw conclusions based on evidence, and make decisions about the environment and changes that occur due to human activities (Harlen, 1999; Sari & Yarza, 2022). Skills such as observing, interpreting data and conducting experiments help students connect theory with practice, deepen their understanding of science, and critically evaluate information and make evidence-based decisions, which are important aspects of science literacy (Kaya et al., 2012; Pradana et al., 2020). In addition, these skills play a major role in improving science literacy, as students who master them are better able to understand science concepts in depth and apply them in everyday life (Husna et al., 2022). Therefore,

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strengthening science process skills is a strategic step to improve students' science literacy.

The goal of education and science education is to educate individuals who can adapt to different conditions, think flexibly, question, be creative, think critically and multi-directionally, solve problems, use science process skills when solving problems, consider the world from a scientist's point of view, respect others, and tolerate ideas (Aktamış & Yenice, 2010). Indonesia currently uses the Merdeka curriculum which includes science process skills as one of the science learning outcomes. This is one of the strengths so that science learning in Indonesia becomes more focused on what Indonesian students really need.

Science process skills help students discover science concepts independently through the scientific method, understand complex concepts, and apply them in everyday life (Acesta, 2014; Angelia et al., 2022; Asidiqi & Adiputra, 2023; Mardianti et al., 2020; Nisa et al., 2020). Basic science process skills include observation, classification, measurement, prediction, inference, and communication skills, while integrated science process skills are more complex by combining several basic skills, including variable control, hypothesis formulation, experimentation, modeling, and data interpretation (Gizaw & Sota, 2023; Gültekin & Altun, 2022; Idris et al., 2022; Jannah & Shofiyah, 2023; Yuliananingsih & Rokhimawan, 2020). In the Merdeka Curriculum, science process skills are one of the science learning outcomes in phase B (grade 4), which includes Observing; Asking questions and predicting; Designing and conducting investigations; Analyzing data and information; Evaluating and reflecting; and Communicating results (Kemendikbudristek, 2022). Science learning in this curriculum is expected to provide students with opportunities to learn by exploring, investigating and understanding science concepts and using them in everyday life. Although in its implementation, science teaching is still more focused on products so that students' process skills are still low (Aisah & Agustini, 2024; Dani et al., 2024; Dwisetiarezi & Fitria, 2021). Therefore, this study will analyze elementary students' basic science process skills, such as observing, classifying, interpreting, predicting, planning experiments, and communicating results.

Many previous studies focused on improving science process skills by using several models such as problem-based learning, project-based learning, or inquiry (Mardianti et al., 2020; Nurtriana et al., 2024; Yuliati, 2016). Research on the profile of students' science process skills is still very limited, especially at the primary school level, and the existing analysis still focuses on the context of Curriculum 2013 (Beaumont-Walters & Soyibo, 2001; Eliyana, 2020; Ginting et al., 2023). Therefore, this study aims to analyze elementary school students' basic science process skills in the context of the Merdeka Curriculum. The main focus of this research is the six aspects of basic science process skills, namely observing, classifying, measuring, interpreting, predicting, planning experiments, and communicating results. This analysis is expected to provide an overview of the extent to which these skills have developed as well as identify aspects that need to be strengthened in science learning in primary schools.

Method

This study employs a descriptive approach aimed at offering a thorough overview of elementary school students' science process skills. The subjects involved in this research included 33 students from a public elementary school in Bandung Regency. The sample was selected through a non-probability sampling method, specifically purposive sampling, which allowed for intentional selection based on particular criteria or considerations. This approach ensures that the sample represents the specific characteristics needed to analyze science process skills within this educational context effectively (Sugiono, 2013). The sample selection criteria also consider the school's readiness to adapt Merdeka Curriculum thoroughly, including teachers' involvement in training related to this curriculum. In addition, selecting schools that have implemented Merdeka Curriculum allows for a more accurate analysis of the effectiveness of this approach in improving students' science process skills.

Table 1. Indicator of science process skills

Science Process Skills	Indicator
Observing	Observe the events in the practicum video including the change from liquid to solid in pure water and salt water.
Classifying	Classify some of the objects in the video based on similarities in their properties or characteristics.
Predicting	Suggest what might happen in the unobserved situation based on evidence from observing the practicum video.
Interpreting	Connect observations and find patterns in a series of observations.
Planning Experiments	Determine the tools, materials, variables and sources used for the experiment.
Communicating	Describe empirical data from experiments or observations and organize them systematically.

(Aisah & Agustini, 2024; Angelia et al., 2022; Pradana et al., 2021)

The instruments used for data collection are tests and non-tests. This test instrument contains 15 fill-in questions which are the development of 6 aspects of basic science process skills, namely observing, classifying, interpreting, predicting, planning experiments, and communicating. To measure science process skills, indicators are needed in each aspect. In this study, the indicators used were adapted from several instruments developed in previous studies. The indicators are listed in Table 1.

The non-test instrument used in this study was observation of science learning sessions. Specifically, the observed learning components focused on the methods applied by the teacher, the types of learning resources used, and the learning activities conducted. The results of these observations were then linked to the various aspects of science process skills to determine which skills were effectively developed and which were not. For data analysis, direct statistical techniques were applied: scores for each aspect of the skills were calculated and averaged to determine the overall percentage. This made it possible to categorize the students' science process skills, providing a clear picture of their proficiency in each area (Very Good, Good, Fair, Poor and Bad).

Table 2. Criteria of science process skills

Average Score (%)	Criteria
87-100	Very Good
73-86	Good
59-72	Fair
45-58	Poor
≤44	Bad

Result and Discussion

Analysis of students' science process skills was carried out through tests and observations of learning carried out in the classroom. Based on the observation results, learning activities are carried out interactively. Teachers also utilize digital media and technology as learning resources so that students become interested in listening to what is presented. The content of the learning video presented is still dominated by understanding concepts, the questions and answers are also about the concept of material, namely about changes in the form of objects. Therefore, conceptually most students can follow and answer the questions asked by the teacher correctly. As we know, the learning outcomes in the Merdeka curriculum have two basic elements, namely concept understanding and process skills. Meanwhile, during learning, there was no process to hone students' science process skills, no practice directly or through videos. To assess the extent of students' science process skills, a test was administered to measure their proficiency in six fundamental aspects: observing, classifying, predicting, interpreting, planning experiments, and communicating. The test consisted of 15 questions designed to measure each of these key areas. Before taking the test, students were stimulated by watching a practical demonstration video on the topic of changes in the state of substances, specifically focusing on the freezing process of pure water and salt water. This aims to engage and prepare students in understanding the concepts that will be tested. The following section presents the scores from the assessment of students' science process skills.

Table 3. The score of science process skills

Basic Science Process Skills	Skor	Criteria
Observing	62	Fair
Classifying	56	Poor
Predicting	61	Fair
Interpreting	54	Poor
Planning Experiments	50	Poor
Communicating	42	Bad
Average	54	Poor

Based on Table 3, it can be seen that the average score of students' science process skills is 54 with less criteria. This low score is because science learning in the classroom is still dominated by understanding concepts and rarely trains students' science process skills. From the results of observations supported by interviews with teachers and students, it is known that during the 4 months of studying science in grade 4, it was recorded that only 1 time did practicum activities and even then just followed the steps from the book. In this case, the teacher as a facilitator must also be able to understand the essence of the science learning outcomes in the Merdeka curriculum, so that process skills must also appear in learning.

In addition to the general science process skills score, the following also presents the results of students' science process skills in each aspect. This analysis is carried out to find out which aspects are good and which aspects are still lacking so that they can be taken into consideration in planning the science learning process that suits the needs of student development. The difference in scores for each aspect is presented in Figure 1.

The students achieved the highest average score in observation of 62 which is fair criteria, but this is still below expectations as observation is a fundamental skill. This low result was influenced by the lack of focus and thoroughness as well as the lack of note-taking as less than 10 of the 33 students were observed recording their

observations. Another study also mentioned that factors that influence the observation process include students' habits of rushing so that they are less thorough, as well as teaching methods that rarely train observation skills (Kelly, 2013; Widdina et al., 2018). This finding suggests that students need to be trained to design investigations independently with accuracy and precision in observation. Lack of understanding of instructions and dependence on teacher procedures hinder the development of this skill, so a learning approach that encourages students to actively observe and record systematically is needed. Observing is the first aspect of process skills in the Merdeka Curriculum learning outcomes. For grade 4 or phase B students, achievement in this aspect includes the ability to observe phenomena and events simply using the five senses and record their observations. However, in classroom learning practices, observing skills are still not optimally implemented, so there needs to be improvements in teaching methods so that students are better trained in this skill.

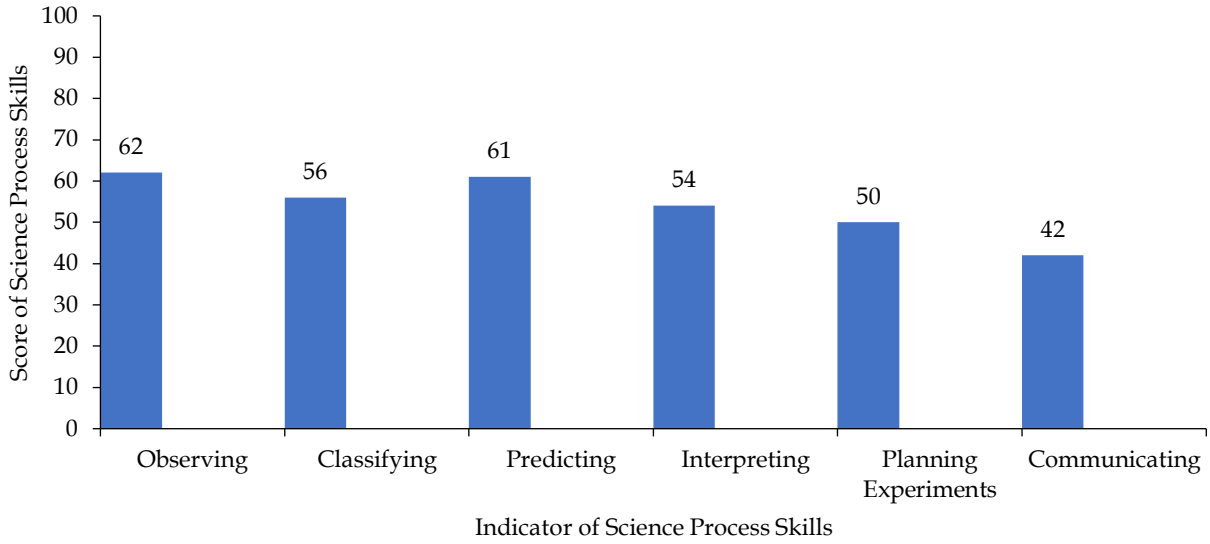

Figure 1. Score of science process skills

In the classifying aspect, students scored 56 with poor criteria. Students' answers to classification are still in the range of general grouping, only a small number of students can classify more specifically and are related to the concept of the material being taught. Students should classify objects based on certain properties or characteristics observed and the classification can be said to belong to the same series (Dani et al., 2024). Some of the reasons why students have difficulty in classifying are that they are not accustomed to relating learning material concepts to real-life activities (Wazni & Fatmawati, 2022). So, even if the concept has been mastered, its implementation in life may not necessarily be mastered. So both elements must be trained continuously. In the Merdeka curriculum, the skill of classifying is an important part of the scientific thinking process that is integrated into learning outcomes, especially in the aspects of understanding concepts and process skills. These skills should be optimally applied in science learning by encouraging students to relate concepts to real life through continuous practice so that their scientific thinking skills are sharpened.

In the prediction aspect, students get a score of 61 with fair criteria. Although the criteria are fair, most students' answers still contain many errors in predicting an event or event in science. Prediction skill is the ability of students to compile general statements that explain the occurrence of a phenomenon and must be testable (Firdaus & Mirawati, 2017). In this study, some of the errors in students' predictions were caused by students' lack of attention to the context of the problem. Many students were influenced by events or information given in previous problems, which should have served as a basis for comparison, not as part of the main problem context. This leads to confusion in making predictions for the next scenario, so it is important to provide guidance and clarification to ensure students understand the intent of each question. Previous research has also shown that prediction is one of the aspects with a low score, indicating that this skill still needs strengthening in learning (Sugiarti & Ratnaningdyah, 2020; Yuliati, 2016). In the Merdeka curriculum learning outcomes, prediction is highlighted as the second point in the process skills element, which aims to enable students to identify questions that can be investigated scientifically and make predictions based on prior knowledge. To achieve this goal, learning activities should actively involve students in making

predictions that are aligned with the concepts they have understood. This will improve their ability to make accurate and informed predictions.

In the interpretation aspect, students received a score of 54, which falls under the poor criteria. This aspect requires students to interpret observational data and respond to questions based on the presented information. While most students managed to provide the correct answers, they often failed to support their responses with explanations grounded in the data. Ideally, students should base their answers on the factual evidence or data provided to them. When interpreting, students are expected to analyze and process the data—whether presented in graphs, tables, or other formats—and then draw meaningful conclusions from it. This skill is very important for developing a deep understanding of the concept of science, because it encourages students to not only look for answers, but also to do data-based analysis, where interpretation must be based on authentic investigative data so that students can develop thinking skills through the scientific method approach (Pradana et al., 2020, 2021). This is in accordance with the learning outcomes of the Merdeka curriculum, the fourth point of process skills, namely students are able to process, analyze data and information and are able to compare observations with predictions and provide scientific reasons.

In the aspect of planning an experiment, students scored 54 with poor criteria. In this aspect, students had shown initial understanding by being able to list some of the tools and materials needed to conduct the experiment, but their lists were often incomplete, and sometimes gave incorrect quantities. In addition, although some students realized that certain variables needed to be kept consistent throughout the experiment, they still lacked an understanding of why this consistency was important. The overall ability to plan an experiment is still low because at the primary school level students usually engage in experiments or lab activities by simply following predetermined instructions. They tend to prepare and carry out activities as outlined in their worksheets, without much exposure to independent experimental planning. This lack of practice in designing experiments makes students' skills in planning investigations underdeveloped. In fact, the ability to plan and organize an investigation is an important component of scientific inquiry, and nurturing this skill early on can play a significant role in students' overall scientific development (Nur'ariyani et al., 2023). The ability to plan an experiment consists of the ability to determine the tools and materials to be used, determine the manipulation variables, then students are trained to process the results of observations to conclude (Rophi et al., 2024; Verawati et al., 2014). This is also in line with the learning outcomes in the Merdeka curriculum, in the process skills element point 3 students are able to make plans and carry out operational steps to answer questions posed in an experiment.

In the aspect of communicating, students obtained a score of 42 with bad criteria. This aspect has the lowest score of all aspects of basic science process skills tested. Students are still limited in communicating what has been observed and conveying it in writing. Only 4 out of 33 students were quite complete in communicating an experiment, most others only conveyed one or two sentences that could not describe a report of the experiment. In this aspect, students must be able to describe and explain the results of experiments or observations empirically or based on data, and organize them systematically either through words, actions, or graphic symbols (Aisah & Agustini, 2024; Monhardt & Monhardt, 2006). In other studies, the communication aspect was also low because students had difficulty in reading and explaining images, graphs, and tables due to the lack of habit of using these methods (Elvanisi et al., 2018). In the learning outcomes of the Merdeka curriculum point 6 of the student process skills element, students are expected to be able to communicate the results of investigations orally and in writing in various formats. This low score may not be able to fully describe students' communication skills, because the test is in writing, some students may be more skilled at communicating in oral or other forms so further confirmation is needed.

Mapping the basic science process skills of grade 4 elementary school students who use the Merdeka curriculum turns out that the highest is observing and the lowest is communicating although overall all aspects are still low. The Merdeka curriculum that has accommodated learning that touches all aspects of the nature of science is not necessarily implemented in the classroom. It needs socialization and training for teachers in understanding the curriculum and how teachers can implement process skills in science learning (Sari & Yarza, 2022). The role of the teacher as a facilitator who emphasizes practicum activities also contributes to improving students' science process skills (Dökme & Aydınlı, 2009). To support this, learning models that actively involve students are needed, such as inquiry-based learning, projects, problems, and discovery, which can train critical thinking skills, problem solving, and scientific communication (Aktamış & Yenice, 2010; Fahmi et al., 2024; Lusidawaty et al., 2020; Susilawati et al., 2024; Wulandari et al., 2024; Yuliati & Susianna, 2023). With continuous learning adaptation, the learning process not only focuses on concepts, but also hones process skills and scientific

attitudes, making it more meaningful and useful for students.

Conclusion

The results show that the science process skills of fourth graders need improvement, especially in the area of communication, which received the lowest score. This finding is in line with the Independent Curriculum, which emphasizes process skills in learning outcomes. To develop these skills, teachers need to apply active learning methods such as direct experimentation and group discussions. If limited tools are an obstacle, technology can be used as an alternative learning resource. In addition, training for teachers and periodic assessments are needed to ensure more effective and engaging science learning that is able to hone students' scientific skills.

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Conflicts of interest
The authors confirm that there is no conflict of interest in this study.

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