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A Study of Students' Science Process Skills at A National–Plus Middle School in Tarakan

Listiani[1] and Arief Ertha Kusuma[2*]
[1]Departmen of Biology Education, Teacher Training dan Education Faculty
Universitas Borneo Tarakan, Tarakan, Indonesia
[2]Departmen of Mathematics Education, Teacher Training dan Education Faculty
Universitas Borneo Tarakan, Tarakan, Indonesia
artha13qren@gmail.com*

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Abstract

Process science skills are essential for students to understand how the world works. This performance can be measured by exploring students' capacity for scientific knowledge development. The study investigated the science process skills of high school students at one of the National Plus Junior High Schools in Tarakan. The science process skills test was conducted by giving multiple-choice questions to 74 students referring to four indicators: interpreting, graphing, inferring, and explaining. Students answered ten questions representing the five indicators of science process skills under study. The results showed that, in general, students' science process skills in the National Plus Junior High Schools were relatively low. 77.3% of students were in the low category, 4.8% were in the medium category, and 17.9% had high science process skills. The interpreting indicators are at a moderate level (64%), while the other three skills are low, with percentages of 47%, 44%, and 22%, respectively. The low percentage of these four indicators indicates that science lessons need to be optimized by paying attention to and integrating science process skills in student activities during learning. Science teachers should be trained in integrating science process skills into learning. Therefore, developing and applying a learning model that can train science process skills comprehensively and can be implemented optimally is necessary.

Keywords: Science process skills; Science learning; Scientific approach

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INTRODUCTION

Scientific knowledge comprises the theories, precepts, and rules of the core of the sciences. Scientific information may be obtained using knowledge acquisition methods. Science process skills are one technique to learn new things. Students' capacity for inquiry, inference, and prediction increases along with their science process skills, and they can now better comprehend difficult situations. Science process skills are the instruments that students use to study their immediate environment and build scientific concepts (Gürses et al., 2015; Juniar et al., 2021; Nadia et al., 2021; Nurhuwaida et al., 2022; Risda et al., 2023; Singh, 2015).

Science education aims to enable individuals to use skills such as observing, classifying, inferring, measuring, communicating, predicting, hypothesizing, and experimenting. Since developing science process skills helps students acquire the abilities required to address everyday problems, students who cannot employ these skills will generally need help to succeed (Bulent, 2015; Gürses et al., 2015; Juniar et al., 2021; Singh, 2015). Students must be trained in and grasp science process skills by entering junior high school, as this is the underlying condition.

Science process skills, in general, the group are divided into two parts, namely basic process abilities include observing, inferring, measuring, communicating, classifying, forecasting, using time and spatial relationships, and using numbers; and integrated process skills consist of controlling variables, operational definition, creation of hypotheses and models, interpretation of data, and experimentation (Gizaw & Sota, 2023; Juniar et al., 2021; Kusuma & Rusmansyah, 2020).

These align with what Irwanto et al. (2018) stated: to create courses that will benefit students, teachers must first determine the students' level of science process skills. For example, students who do well on basic science process skills tests are likelier to perform well on integrated science process abilities tests.

Several previous studies have stated that secondary school science process skills are still low and need to be improved, as stated by Gürses et al. (2014), Handayani et al. (2018), Juniar et al. (2020), and Kusuma & Rusmansyah, 2020).

The indicator of science process skills with the lowest percentage is making graphs and interpreting data. These findings align with Handayani et al. (2018), who states that junior high school science process skills still need to improve on data interpretation indicators. Both indicators fall into the integrated science process skills category in addition to making conclusions and generalizations. One of the reasons scientific education has failed is that teachers need to pay more attention to student activities, and creativity in learning is one of the causes.

Science-related tasks like measuring, observing, gathering data, interpreting data, and drawing conclusions are often ignored, and pupils are not always actively engaged in the delivered lessons (Gizaw & Sota, 2023; Subekti & Ariswan, 2016). Applying a learning process emphasizing science process skills can allow students to make understanding complex and abstract concepts easier through scientific activities in science learning (Desmiawati et al., 2023; Elvanisi et al., 2018; Hikmawati et al., 2021; Rauf et al., 2013).

In Tarakan, North Kalimantan, there is one junior high school that implements a curriculum-plus in the form of the use of English as the language of instruction in learning, which attracts the attention of researchers to be used as a place of research. In addition to English not being the mother tongue for some students, student interest and the difficulty of science subject matter are also challenging for teachers to deliver learning and make students master science lessons.

One of the strategies to help students master science lessons is that teachers must make appropriate learning plans. To determine the skill level of the science process, students need to conduct a diagnostic test at the beginning of the semester. This condition is in line with Sukarno et al. (2013) stated that analysis and mapping of students' scientific process skills are meant to help science teachers understand precisely and correctly how students' science process skills are being mastered. These will

allow teachers to create strategies that improve students' science process skills.

To get reliable data, a thorough analysis of the profile of students' science process skills are not only skills that students must master in the learning process in the classroom but also hone critical thinking skills and creativity needed for students to solve problems in everyday life (Desmiawati et al., 2023; Hartono et al., 2022; Kurniawan & Haka, 2023; Ningrum et al., 2022). For future educators to be able to create students who are focused on the theory that is taught and have to comprehend parts of skills, it is necessary to continue pursuing the science process skills that students now possess.

Practicing science process skills in junior high school students will support students in overcoming difficulties in following science learning (Kurniawan & Haka, 2023; Ningrum et al., 2022). Some alternative strategies that teachers can apply in science learning in training science process skills to students include home-based experiments, simulation in science learning media, inquiry interactive demonstration, student worksheets based on problem-based learning, discovery learning, STEM approach (Desmiawati et al., 2023; Hikmawati et al., 2021; Kurniati & Suyanta, 2022; Yalyn et al., 2022). The new learning strategies that are developed can be used as an option to provide training to science teachers in mastering science process skills and implementing science process skills-based learning.

As a result, one of the most important things teachers can do to help kids learn is to provide them with science process skills. Their development of science process skills significantly impacts students' academic success. Their science process skills fuel students' growth and development of good attitudes and goals toward science (Gizaw & Sota, 2023; Irwanto, 2023). Science teachers must have science process skills and be knowledgeable about innovative models, methods, and learning strategies that effectively teach science process skills to provide instruction that develops science process skills in their students (Desmiawati et al., 2023; Hikmawati et al., 2021; Kurniawan & Haka, 2023; Ningrum et al., 2022). Students' science process skill levels have to be determined, and teachers should be conscious of their knowledge and proficiency in this area so that teachers can implement relevant and effective teaching strategies. The importance of this prompted researchers to measure the level of science process skills of junior high school students in Tarakan.

This study's results differ from those of previous similar studies, namely describing the mastery of science process skills of Indonesian junior high school students who apply English as the language of instruction in learning. Another difference in the results of this study is in the indicators of process skills chosen to be studied. Strengthening and refreshing the science process skills of science teachers can be done through training activities to design science learning in the classroom to train science process skills for students.

METHOD

This research is a quantitative study, and the data was collected using a survey. A paper-based test survey was conducted in a National Plus school in Tarakan. This school was selected using purposive sampling, in which the respondents were selected based on their willingness and ability (Creswell, 2012). Seventy-four students, consisting of three grade levels—VII, VIII, and IX—comprised the study's sample group. The samples in this study were selected using the purposive sampling technique with consideration of all students who took science lessons in the even semester of the 2022/2023 academic year.

This study's test instruments were constructed from five indicators of science process skills: interpreting, graphing, inferencing, and explaining. The five indicators are extracted from sixteen indicators of basic and integrated science process skills based on several previous studies' indicators of process science skills, which have been done by Gürses et al. (2015), Handayani et al. (2018), Juniar et al. (2021), Kusuma & Rusmansyah (2020) Monica (2005), and Subekti & Ariswan (2016).

Questions in research institutions are presented in the form of multiple choices. The interpreting indicator includes five question items, the graphing indicator includes two question items, the concluding indicator includes two question items, and the explaining indicator includes one question item. The ten items used in this study were modified from the instrument declared valid and used in a previous study by Kusuma & Rusmansyah (2020) with thirty items and Monica (2005) with thirty items.

During the data collection process, the respondents are given 30 minutes to answer the questions. Before the students answered the questions, the researchers explained how to answer them to make it easier for students to answer test questions so that there are no obstacles for the students unfamiliar with the instruments used for evaluating science process skills. Data collection of science process skills is carried out by calculating the score of the answers given by students. Each correct answer values one score, while zero scores account for incorrect responses.

The research data were analyzed using Microsoft Office Excel applications to obtain a percentage of students' process skills. The percentage of science process skills per question item is determined by calculating the quotient between the student's correct answer score and the maximum score of each question. Meanwhile, the percentage of each science process skill indicator is determined by calculating the quotient between the correct answer score of each indicator divided by the maximum score of each indicator. The percentage of students' science process skills is divided into three categories: high, medium, and low. Categorization refers to Table 1, adapted and modified from Arikunto (2016), Kusuma & Rusmansyah (2020), and Monica (2005).

Table 1 Category of percentage students' science process skills

Range of Percentage	Category
> 76%	High
60% - 75%	Moderate
< 60%	Low

RESULT AND DISCUSSION

Result

The results of this study are presented as a percentage of the science process skills level. First, we analyzed the overall level of science process skills, followed by science process skills based on grades and then based on each measured variable. Overall, the students' science process skills are at a low level. These findings can be seen in Figure 1, showing that more than half of the respondents (77.3%) have low science process skills. However, some respondents have a high level of science process skills even though only less than 20 percent of the number of respondents (17.92%). The students' science process skills are generally in a low category.

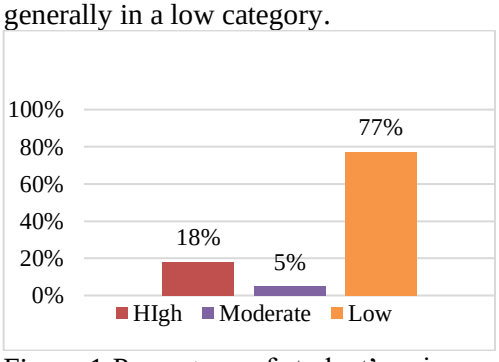

Figure 1 Percentage of student's science process skills

Based on the results of the data analysis, the science process skills of the national plus school students still need to improve. This condition can be seen in Figure 1, demonstrating that 77% of students are at a low level, 5% at a moderate level, and 18% at a high level.

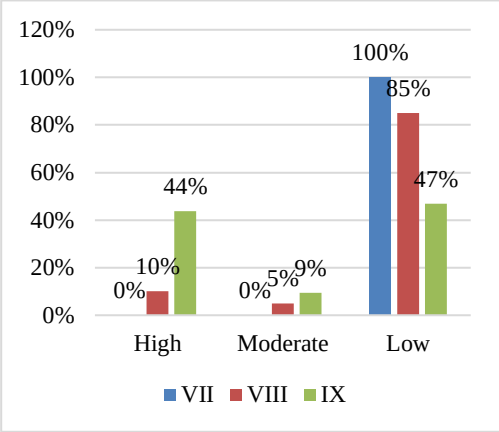

Figure 2 Percentage of science process skills by grade level

Figure 2 reveals the science process skills of the respondents based on their grades; the students of the ninth graders have the best science process skills among the grades, while the seventh graders have the minor skills. Seventh-grade students are the sample with the highest percentage for low level, with 100.0% of students at this grade categorized as having a low level of science process skills.

This finding is consistent with other studies that found science process abilities among Indonesian students were still lacking and proposed the following reasons: Teachers should concentrate more on student activities since there needs to be more creativity in the classroom, which is one of several explanations why scientific education fails. To use the learning approaches in the classroom, most teachers need to brush up on their strategies that encourage student motivation to engage in learning activities (Handayani et al., 2018; Irwanto, 2023; Juniar et al., 2021; Kusuma & Rusmansyah, 2020; Priyatni et al., 2021). At this grade, students transition from elementary school to the junior high school level and need more experience practicing science process skills in learning. At the elementary school level, grade VII students' science process skills have yet to be trained intensively, with science learning emphasizing scientific activities.

Other concerns mentioned by the OECD (2018) and UNESCO (2017) include students' discontent with science, their lack of enthusiasm for studying it, and teachers' insufficient preparation for teaching science topics and developing their ability to teach skills. Meanwhile, students of class VIII and class IX who already have experience practicing science process skills in science learning have a high percentage at medium and high levels of science process skills. Therefore, class VIII and Class IX students can already adapt to the science learning process teachers teach by involving and applying science process skills.

Poor scoring students generally are why many research participants have inferior science process abilities. Only a tiny percentage of students engage in science-related learning activities. The following demonstrates how engaging in scientific learning activities may improve students' science process skills. Students require additional science process skills to finish various experimental tasks, including inquiry and discovery. Even though experimentation is the mainstay of science, it is nevertheless a process. The scientific method will operate as intended if sufficient scientific knowledge is available (Gizaw & Sota, 2023; Irwanto, 2023; Sukarno et al., 2013). Several challenges contribute to the respondents' limited proficiency with science process abilities. Teachers have proposed several aspects, including time efficiency in scientific instruction. Since students need to get used to learning activities emphasizing scientific

engagement, shorter class periods are required. Limited resources, inadequate understanding of science process skills, insufficient confidence in instructing science process skills, scarcity of science resources, low student interest in science classes, and the incapacity to translate scientific terms into one's native tongue all lead to these circumstances (OECD, 2018; Singh, 2015; UNESCO, 2017).

Table 2 Percentage of correct answers per-item test

Science Process Skills Indicator	Percentage of Correct Answer Per Item (%)					Average
Item Number	1	2	3	4	6	
Interpreting	69.0	83.0	84.2	7.2	83.0	65.3
Item Number	7	10				
Graphing	56.2	60.0				58.1
Item Number	8	9				
Inferencing	64.0	40.2				52.1
Item Number	5					
Explaining	18.7					18.7

The research testing item comprises five questions about indicators employed for chart interpretation (interpreting). Table 2 exhibits that this indication belongs to the moderate group with an average percentage score of 65.3% for correct responses. Science process abilities fall into primary, casual, and experimental categories. Determining and graph interpretation belongs to the casual skill set. In this study, graph interpretation is the first processability indication examined. Interpreting is giving voice to ideas, feelings, or theoretical opinions on a particular object based on core ideas influenced by the interpreter's background. Everyday tasks like reading and analyzing data or information from a graph need science and maths (Ningrum et al., 2022; Susac et al., 2018; Zorlu et al., 2013).

According to Mcdermott et al. (1987), when interpreting graphs, a student must be able to recognize visual elements that relate to specific concepts. In addition, many students appear to require assistance deciding which qualities to read while responding to inquiries regarding the information shown in the graph. Science teachers should, therefore, design learning that emphasizes activities that train students to master reading skills and interpret data or information from a graph. Additionally, Lati et al. (2012) and Planinic et al. (2013) contend that the lack of opportunity for students to practice data interpretation skills and draw conclusions may have contributed to their poor ability to graph and understand data. Most teachers frequently have to do this stage, which leads to this situation. Learning takes time, after all. The difficulties experienced by the junior high school students who were the samples of this study were evident from the many students' wrong answers when answering the indicator questions in making graphs and interpreting data.

Table 2 also reveals that 58.1% of the students answered the graphing indicator questions correctly. Two test items denote indicators for graphs. On the other hand, the outcome indicates that pupils have identified as having poor graphing abilities. Graphs are a process skill in integrated science. According to Zorlu et al. (2013), graphs are a more straightforward and visually appealing means of communicating and displaying experiment data than other techniques.

Students' abilities to create graphs that display experimental result data have been assessed using two exam questions in this study. Based on the experiment findings, students had to choose the relevant graph (Gizaw & Sota, 2023; Planinic et al., 2013).

Inferencing is the third science process skill indication in this research. After explanation, this element has the second-lowest percentage rate. A conclusion is a judgment or choice drawn from a specific conversation or notion using deductive or inductive reasoning. To communicate the findings of experiments or observations clearly and succinctly, scientific studies require conclusions. The results of an experiment may be summarized using experimental data shown as a graph or an observation table. Concluding is the third measure of the science process abilities examined in this investigation. Following the presentation of observational data in graphs and observation tables, students have to draw the appropriate inferences from the experimental data (Gizaw & Sota, 2023; Nixon et al., 2016; Planinic et al., 2013; Wijaksana, 2021; Zorlu et al., 2013).

Table 2 demonstrates that with 18.7% of test items correctly answered, explaining is one of the test indications with the lowest percentage of correct answers. In science, explaining is a skill that must learned because, through a systematic explanation, the information recipient understands the principle, analogy, causal relationship, or sequence of steps of a procedure. Explaining is presenting information to increase the likelihood that the information will be accepted and understood clearly. Science divides explanation into four categories: making distinctions, building things, converting information, and giving matter meaning (Findeisen et al., 2021; Findeisen & Seifried, 2023; Ogborn et al., 1996). Recipients may only construct their knowledge with the aid of a plausible explanation. Although an adequate explanation sets the stage for successful knowledge construction, it does not convey knowledge. Accordingly, a person's mastery of their abilities affects their capacity for explanation (Denancé & Somat, 2015; Findeisen & Seifried, 2023; Kulgemeyer & Schecker, 2013).

Unfortunately, Explaining has the lowest percentage of correct answers among the science process skills indicators. Interestingly, the ability of seventh graders to Explain is beyond that of eighth and ninth graders. In addition, the ninth graders' ability to answer the explaining question is only the lowest percentage among the grades.

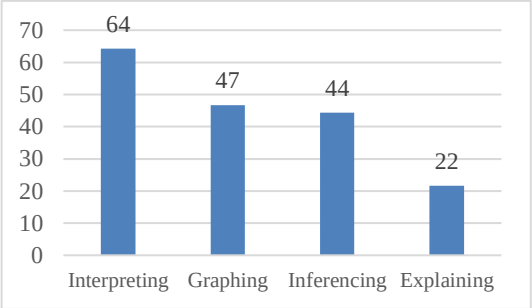

Figure 3 Percentage of correct answers for each indicator

Based on the percentage of students who correctly answered (64% of the whole study sample), Figure 3 reveals that the Interpreting indication is moderate. In interpreting indicators, students should choose the proper assertion based on data from observations or experiment results presented in tables and graphs. These results are coherent with the findings of Sukarno et al. (2013), who state that interpreting ability is still low in secondary school students. One cognitive ability that helps students make sense of the data gathered from an experiment is interpretation. Data from experiments are frequently interpreted in various ways, some of which may be accurate while others may not. Though comments based on observations are called

interpretations, some of these claims may be affected by theoretical frameworks (Abungu et al., 2014; Gizaw & Sota, 2023).

Figure 3 exhibits the graph with 47% of the answers correct. Students must choose the appropriate graph for the two questions, including graphing indications based on experimental and observational data, among other things. The questions contain experimental result data. The findings of Planinic et al. (2013) and Susac et al. (2018), which indicate that comprehending the area under the graph is a rather tricky notion that looks unlikely to emerge spontaneously, are consistent with the student's deficit in this graphing indication.

Figure 3 shows 44% on the inferencing as well. This condition implies that for students to draw valid inferences from experimental data, they require assistance. If students comprehend and possess a cognitively sound understanding of a subject or instructional material, they may offer or build a conclusion from it or experimental data. Drawing inferences from observations, generating hypotheses, and constructing potential explanations are all examples of inferring using past data. People try to determine the reasons for occurrences they witness through their inferring skills. They were speculating on the cause of an incident (Boud & Dawson, 2023; Gizaw & Sota, 2023; Kim, 2021). For students to acquire information and draw inferences from a concept or teaching material, teachers must deliver learning that develops comprehension and creates connections between topics they teach.

This study tested the indicators of explaining process skills with questions that presented charts/schemes and explanations. Then, students were asked to explain based on the explanations and schemes provided. Figure 3 shows that the average percentage score of the three classes is 22%. Students answered the test questions by explaining the skill indicators correctly. These findings show that many students still need to understand science concepts better to use this information in making analogies or cause-and-effect relationships. For the rest of the categories, all students expressed low ability in graphing, inferencing, and explaining. Overall, the result depicts the middle schoolers' science process skills, showing that the students can better interpret the data among the indicators. Although explaining data is a minor skill that ninth graders possess, they are better at inferencing, graphing, and interpreting than seventh and eighth graders. This condition, indeed, must be overcome by presenting students with a learning process that trains students to make analogies and cause-and-effect relationships of an event or phenomenon based on the knowledge and understanding that students have (Barnett, 2021; Findeisen & Seifried, 2023).

The data analysis indicates that our respondents must still enhance their science process skills. To build their knowledge in science, students need to study in a science-friendly environment that prioritizes science process skills. Students must comprehend science fundamentals during their education since these abilities are the basis for concept development. Teachers must have an excellent conceptual understanding of science process skills to perform well with science process skills. Comprehensive conceptual knowledge of the scientific process makes it easier for teachers to define and explain science process skills to students, such as inferring, communicating, formulating hypotheses, experimenting, interpreting data, predicting, and identifying variables and graphs (Gizaw & Sota, 2023; Irwanto, 2023; Kusuma & Rusmansyah, 2020). Teachers must have a solid knowledge of these skills to

guarantee that scientific concepts are explored and built in the classroom. Science instruction should be process-based so students can use their hands and minds to gain practical experience (Desmiawati et al., 2023; Hikmawati et al., 2021; Singh, 2015).

In improving the student's science process skills, teachers must be able to act as mentors, moderators, facilitators, and consultants in learning (Desmiawati et al., 2023; Limatahu et al., 2018). According to thorough research, science teachers' understanding of science process skills needs to be improved and updated through training exercises, Listiani & Kusuma (2017) state short training to introduce scientific learning strategies to teachers can improve teacher professionalism in planning and implementing learning based on scientific approaches to facilitate and make it easier for students to understand the meaning and how to get a concept or theory. The training focuses on implementing or creating learning models to improve students' science process skills and assessment. Creating unique instructional tools that guide teachers and students to practice science process skills is another area where science teachers can improve. The goal is for teachers and students to collaborate and maintain consistency as they build their science process skills. Thus, the teacher can help students to master the skills of the scientific process in learning optimally (Abungu et al., 2014; Gizaw & Sota, 2023; Gürses et al., 2015; Irwanto, 2023).

CONCLUSION

The most significant percentage of correct answers that fall into the medium category among the four indications of science process abilities appears in interpreting. However, the other three indicators—the explaining, the inferencing, and the graphing—all fall into the poor range. These findings demonstrate the need for instructors to have a solid understanding of science process skills and to provide students in junior high schools with the finest possible instruction in science (physics). Thus, any curriculum has recently emphasized implementing science process skills during physics learning and proposed scientific methods to integrate into science (physics) teaching. This skill allows students to demonstrate the ability to observe, infer, measure, communicate, classify, and predict any information. This recommendation is because of the importance of these skills for students to understand science better. Students with science process skills can think critically and see science as a process instead of a product.

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