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Strategies in Developing Junior High School Students' Science Process Skills in the Material of Temperature, Heat, and Expansion

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ABSTRACT

Purpose of the study: This study aims to explore how teacher strategies enhance students' science process skills, particularly observation, graphing, and communication during physics learning on the topic of heat, temperature, and expansion at the junior high school level.

Methodology: This study employs a naturalistic qualitative method aimed at exploring teachers' strategies in enhancing students' science process skills during physics lessons on temperature, heat, and expansion. Data were collected through interviews, and documentation, then analyzed descriptively to identify patterns and themes that reflect students' abilities in observation, communication, and data representation.

Main Findings: The study found that teachers effectively foster students' science process skills (SPS) in physics through varied strategies, including scientific approaches, step-by-step instruction, and cooperative learning. By integrating observation, graphing, and communication activities during laboratory sessions, teachers provided scaffolding, feedback, and peer collaboration. These strategies, supported by theories of Vygotsky, Bruner, and Ausubel, created an engaging and structured learning environment that promoted students' active participation and scientific reasoning.

Novelty/Originality of this study: This study presents a novelty through the use of informant triangulation involving teachers, laboratory assistants, and students, which is rarely applied in similar studies on science process skills (SPS). Three SPS indicators are systematically examined through four pedagogical strategies, supported by direct quotations that provide a contextual, comprehensive, and student-centered perspective in physics learning.

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1. INTRODUCTION

Physics learning is a process or interaction between educators and students assisted by learning resources that discuss physical or exact sciences [1]. Physics learning can also be interpreted as a form or method of developing critical thinking skills and solving problems in everyday life [2]. In this case, physics learning teaches students to be able to improve their understanding, skills, concept analysis, and application of problems and can relate them to everyday life [3], [4]. Physics learning also emphasizes more on the learning process so that students are able to develop physics concepts using their own language and are able to apply them in their everyday lives [5]. Therefore, physics learning does not only focus on mastering theory, but also on developing high-level thinking skills [6]. With the right approach, physics learning can be a means of forming students who are critical, creative, and able to face real-world challenges.

One of the important physics materials to learn is temperature, heat, and expansion [7]. This material is very important for students to learn because this material is always side by side with students' daily lives. This material can not only present abstract concepts, but can also provide a real understanding of how heat works in human life, such as in cooking activities, designing bridges, or understanding how equipment works at home [8] [9], [10]. By studying temperature, heat, and expansion, students will be trained to analyze phenomena that occur around them and relate them to the physics principles that have been learned [11], [12]. In addition, a good understanding by students of this material can increase students' awareness in applying physics concepts to be able to create practical solutions in everyday life.

Understanding the material on temperature, heat, and expansion not only enriches students' knowledge, but also becomes an effective means to form and train science process skills (SPS). Science process skills are very important to be developed and possessed by students in developing observation skills, making graphs, communicating, classifying, measuring, interpreting data, to concluding a phenomenon [13], [14]. Through simple experimental or observation activities related to changes in temperature and expansion, students can train their scientific skills directly and contextually [15], [16]. Thus, learning is not only centered on theory, but also on active and critical scientific thinking processes. These science process skills are important provisions for students to face the challenges of 21st century learning that demands science and technology-based problem solving [17].

Science Process Skills (SPS) for junior high school level, as stated in the syllabus and Learning Outcomes (CP) of Science phase D, include main indicators such as observing, questioning and predicting, planning and conducting investigations, processing and analyzing data, evaluating/reflecting, and communicating results. These indicators are important because they form a systematic and critical scientific mindset, improve analytical and real problem-solving skills, and encourage students' ability to integrate theory with practice through simple measurements and experiments, for example on temperature, heat, and expansion [18], [19]. In line with the Independent Curriculum, CP Science Phase D explicitly states that all elements of process skills must be achieved at the end of the phase, and process skills cannot be separated from knowledge competencies in determining learning objectives [20]. This makes it clear that SPS is not only a learning method but also a mandatory achievement in science learning, including physics in junior high schools, which emphasizes that material such as temperature, heat and expansion should be taught through a scientific approach that consistently integrates SPS activities [21], [22].

In line with this, several previous studies also support that learning strategies based on science process skills in science learning, especially in physics learning, are able to improve students' understanding of concepts and scientific skills in studying temperature, heat, and expansion materials. Learning strategies based on science process skills (SPS) students are able to express an idea, explain the use of accurate sensing data for an object or event and change data in tabular form into other forms such as graphs. In addition, students are also able to communicate the results of observations in groups and in front of the class, and are active in making observations and conducting experiments in groups in temperature and heat practicums [23].

In addition, other studies also state that the application of the process skills approach in science learning can improve students' science process skills. In the pre-cycle, students' science process skills were 42%. In cycle I, the application of the science process skills approach was carried out so that it produced results in the form of an increase in students' science process skills to 65%. In cycle II, improvements were made again to maximize students' science process skills. There were three improvements, namely group division, selection of a more comfortable experimental location, and optimization of teacher guidance when conducting experiments. These three improvements succeeded in increasing students' science process skills to 85% and as many as 4 or 40% of students received good grades and 6 or 60% of students received very good grades in science process skills [24].

Physics learning at the junior high school level often still focuses on delivering concepts theoretically, without actively involving students in the scientific thinking process. The material on temperature, heat, and expansion, which is actually very contextual to everyday life, has not been fully utilized as a medium to develop students' scientific skills [25]. Meanwhile, science process skills such as observation skills, graphing, and scientific communication are important aspects that need to be developed early on, but are often not optimally facilitated in classroom learning. Teachers have a strategic role in designing learning that not only emphasizes understanding concepts, but also encourages students to actively observe, analyze data, and convey the results of their thinking systematically [26], [27]. Through the right strategy, students can be involved in a more meaningful learning process, so that students are able to build scientific understanding and skills independently [28], [29]. Therefore, it is important to explore how teacher strategies can improve students' science process skills, especially in the context of physics learning on the material on temperature, heat, and expansion.

However, most previous studies are still limited to the study of the application of certain learning methods or models without comprehensively describing teacher strategies in building science process skills specifically, especially in the context of observation indicators, making graphs, and scientific communication. In addition, the involvement of laboratory assistants and students as additional sources of information is also rarely used as an important part of research data triangulation.

The purpose of this study is to describe teacher strategies in building students' science process skills (SPS) in physics learning, especially in the material of temperature, heat, and expansion at the junior high school level. This study focuses on three main indicators of SPS, namely observation skills, graphing, and scientific communication. By analyzing the teaching practices applied by teachers, it is hoped that this study can reveal effective learning approaches in developing students' scientific skills as a whole. In addition, this study also aims to explore teachers' contributions in facilitating contextual and meaningful scientific process-based learning. The results of this study are expected to be a reference for teachers and curriculum developers in designing learning strategies that can foster students' critical and scientific thinking skills. Thus, physics learning is not only a means to understand concepts, but also a vehicle for forming students' scientific character.

2. RESEARCH METHOD

2.1. Types of Research

This study uses a naturalistic qualitative method that aims to deeply understand teacher strategies in improving students' science process skills in physics learning, especially the material of temperature, heat, and expansion. This approach was chosen because the researcher wanted to capture the reality as it is in the school environment, without intervention or manipulation, and describe the phenomenon holistically according to its original context. In this case, the researcher acts as the main instrument that is directly involved in the process of data collection and interpretation of findings in the field. The data collected will come directly from learning activities, teacher and student interactions, and physics experiment activities in the classroom [30]-[33].

2.2. Population and Research Sample

This study involved all 30 students of class VII of MTsS Al-Hidayah Kebon IX as informants. This selection was made because students are the parties directly involved in physics learning, especially in the material of temperature, heat, and expansion. Informants were selected comprehensively so that researchers could obtain a complete picture of teacher strategies in improving students' science process skills [34]. This approach is in accordance with the characteristics of the naturalistic qualitative method which emphasizes in-depth understanding in a natural context [35]-[37].

2.3. Data Collection Technique

The data collection techniques in this study used two main methods, namely in-depth interviews and documentation [38]-[40]. In-depth interviews were conducted with teachers and several students to explore views, experiences, and strategies used in improving science process skills. The documentation method was used to collect data in the form of learning activity records, student work results, and relevant learning photos or videos. These three techniques complement each other in order to obtain rich, in-depth data that is in accordance with natural conditions in the field [41], [42]. This approach reflects the characteristics of naturalistic qualitative methods that seek to understand phenomena holistically through various authentic data sources. The researcher has prepared a teacher interview question sheet regarding observation activities, making graphs, and communication carried out by students in physics practicums. The question sheet is as follows:

Table 1. Teacher interview question sheet for observation, graphing, and communication activities carried out by students in physics practicums.

No	Question
1	How do you guide students when making observations in physics experiments?
2	Do students have difficulty in observing physical phenomena? How do you overcome this?
3	To what extent are students able to observe independently without teacher intervention?
4	In your opinion, to what extent are students able to observe the details of a phenomenon during the experiment?
5	Do students demonstrate accuracy in recording the results of observations during the practicum? Please provide an example.
6	How do you teach students to convert experimental data into graphs?
7	What are the difficulties students face in making graphs of observation results?
8	Do the graphs made by students illustrate their understanding of the concepts of temperature and heat?
9	Are students able to process experimental results into graphs correctly? What obstacles do they often experience?
10	What is your strategy in guiding students to understand how to compile graphs from practicum data?
11	How do you train students to present experimental results in class?

12	Are students actively discussing and asking questions during the practicum?
13	What is the role of the teacher in encouraging communication between groups?
14	How do you assess students' ability to convey opinions or discussion results orally in groups?
15	What are the challenges that students usually face when asked to present experimental results in front of the class?

The researcher has prepared a laboratory interview question sheet regarding observation activities, making graphs, and communication carried out by students in physics practicums. The question sheet is as follows:

Table 2. Laboratory assistant interview question sheet for observation, graphing, and communication activities carried out by students in physics practicums.

No	Question
1	As far as you have observed, do students pay attention to details when observing changes that occur during the experiment?
2	How do students behave when preparing tools and materials? Are they thorough and careful according to you?
3	Do students record or remember well the results of their observations during the activity?
4	Can students identify changes in color, temperature, or shape of objects during the experiment?
5	Do students appear focused and active in observing the processes that occur during the experiment according to you?
6	Have you ever seen students trying to make graphs from the data they obtained during the practicum?
7	In your opinion, do students seem to understand the relationship between the data collected and the graphs made?
8	What obstacles do students usually face in compiling graphs of experimental results according to you?
9	Do students ask you for help in drawing graphs or interpreting data?
10	How do you help students who have difficulty converting observation results into graphs?
11	How do you see student interactions when communicating with group members during practicums?
12	Do students often ask you about the use of experimental tools or procedures? How do they respond to your explanations?
13	In your opinion, are students able to explain the results of their experiments to teachers or other friends clearly?
14	How do you assess students' courage in expressing their opinions or observations during practicums?
15	Are there differences in communication skills between students? If so, what is usually the difference according to your observations?

The researcher has prepared a student interview question sheet regarding observation activities, making graphs, and communication carried out by students in physics practicums. The question sheet is as follows:

Table 3. Student interview question sheet for observation, graphing, and communication activities carried out by students in physics practicums.

No	Question
1	What did you do when you first saw the experimental tools and materials that would be used?
2	When the experiment was taking place, what did you observe?
3	Did you notice any changes in color, shape, or temperature during the experiment? Give an example.
4	How do you record or remember the results of the observations you have made?
5	Do you feel that the observation activity helped you understand the material better? Why?
6	After conducting an experiment, have you ever made a graph from your observations?
7	In your opinion, is it difficult or easy to make a graph from experimental data? What is the reason?
8	How do you determine what data needs to be included in the graph?
9	Have you ever received help from a teacher or friend when compiling a graph? What form of assistance is it?
10	What are the benefits of making a graph in helping you understand the results of the experiment?
11	How do you feel when discussing with your group mates in conducting an experiment?
12	Do you find it easy to convey your opinions or experimental results to friends or teachers? Why?
13	Have you ever asked other groups when you had difficulties? Tell us about your experience.
14	How do you usually explain the results of an experiment in front of the class? Do you feel confident?
15	Why do you think it is important to share information or experimental results with others?

2.4 Data Analysis Techniques

This study uses a naturalistic qualitative approach to explore phenomena thoroughly in a real context [43]. Data from interviews and documentation were analyzed descriptively through the process of organizing, grouping, and interpreting information according to established indicators. The analysis began by transcribing the data, rereading it in depth, and identifying relevant patterns and themes. The validity of the data was maintained through reflection and verification with colleagues or related parties, and the results were presented in a systematic narrative form [44]. This approach is effective in describing the dynamics of physics learning and is expected to contribute to the development of better science learning strategies in secondary schools.

2.5 Research Procedures

This study began with the preparation of an instrument in the form of a list of interview questions addressed to teachers, students, and laboratory assistants to explore indicators of science process skills such as observation, communication, and presentation of data in graphical form. The instrument was first tested to ensure its clarity and relevance to the context of physics learning. In-depth interviews were then conducted, and all data were recorded systematically through field notes and recordings. Data analysis was carried out qualitatively naturalistically by grouping interview results based on SPS indicators and identifying emerging themes and patterns [45], [46]. The results of the study were compiled in the form of a narrative that explains the development of student abilities, and accompanied by conclusions and strategic recommendations for physics learning.

3. RESULTS AND DISCUSSION

3.1. Teacher Strategies in Building Students' Science Process Skills in Physics Learning Through Learning Approaches

After conducting interviews with teachers, laboratory assistants, and students, the following are the results of interviews conducted with teachers, as follows:

Table 10. Teacher interview answer sheet in observation activities carried out by students in physics practicums

No	Answer
1	I usually give initial instructions verbally and in writing, then accompany them when they start making observations so they know what to pay attention to.
2	Yes, some students have difficulty distinguishing physical and chemical changes. I help by providing examples and guiding questions.
3	Most students are quite independent, especially after several practicums, although there are still some who need to be directed.
4	They are quite good at observing, but sometimes only focus on the end result. I emphasize the importance of the process and note small changes.
5	Some students are very thorough, even adding additional information. For example, when observing expansion, they record the time and temperature in full.

The results of the interview with the laboratory assistant are as follows:

Table 11. Laboratory assistant interview answer sheet in observation activities carried out by students in physics practicums

No	Answer
1	Yes, most students are quite careful, especially when changes are obvious such as changes in color or temperature.
2	Most students are careful, but some are still in a hurry and don't check their tools enough before using them.
3	Some write them down in their notebooks right away, but some seem to rely on their memory.
4	Yes, most of them can, especially after I or the teacher give instructions on what to observe.
5	They are quite active, but their focus sometimes decreases when the practicum lasts too long or there are interruptions from friends.

The following are the results of the interview sheets with students:

Table 12. Student interview answer sheets in observation activities carried out by students in physics practicums

No	Answer
1	I check the tools one by one to make sure they are complete and not damaged.
2	I observe changes in temperature, changes in the color of the substance, and reactions that occur during heating.
3	Yes, for example when water is heated, the temperature rises and the color of the heated substance changes to darker.
4	I record the results of direct observations in a notebook and sometimes take photos of the tools if allowed.
5	Yes, because by seeing it directly I know what is meant by the temperature rising or a reaction occurring.

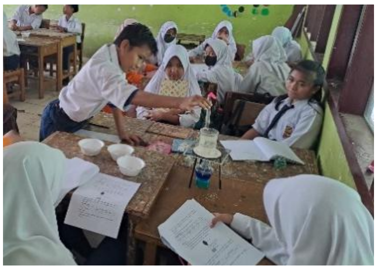

Figure 2. Students are observing a thermometer

The teacher's strategy in building students' science process skills (SPS) through a physics learning approach is carried out by applying a scientific approach [47]. In this approach, students are invited to actively observe physical phenomena directly through practical activities. The results of interviews with teachers showed that teachers provided initial directions, both verbally and in writing, and accompanied students when making observations so that students could understand the focus of the observation. Teachers also realized that some students had difficulty distinguishing physical and chemical changes, so teachers provided assistance in the form of examples and guiding questions. The laboratory assistant stated that most students were quite thorough, although some were still in a hurry when preparing the equipment or did not record the results systematically. From the student's side, it was stated that observation activities were very helpful in understanding the material because they could see directly the changes in temperature, color, or shape that occurred during the practical work.

The findings are in line with the views of a number of learning theories that emphasize the importance of active involvement in learning. The scientific approach applied by teachers in observation activities supports the development of students' science process skills. Based on Vygotsky's theory, assistance from teachers and laboratory assistants in providing scaffolding during observation allows students to develop in the zone of proximal development of students [48]. Piaget's theory also supports that students build understanding through direct experience, such as observing phenomena in concrete terms [49]. Gagne's theory emphasizes that the learning process begins with attention, which can be achieved with students' active involvement in observing [50]. In addition, Bruner's theory through the discovery learning approach encourages students to independently find and connect concepts from concrete experiences experienced in practicums [51]. Thus, the teacher's strategy through the scientific approach is effective in forming observation skills which are an important part of SPS.

This study strengthens the findings of previous studies that the scientific approach can improve students' observation skills and conceptual understanding [52]. In addition, other studies also state that laboratory activities encourage an increase in students' SPS in observing and recording data. By presenting triangulation of data from teachers, laboratory assistants, and students, this study provides a comprehensive and more contextual picture [53]. It can be concluded that the right learning approach, especially the scientific approach, contributes greatly to forming and strengthening students' SPS, especially in the observation aspect of physics learning.

3.2. Teacher Strategies in Building Students' Science Process Skills in Physics Learning Through Teaching Methods

After conducting interviews with teachers, laboratory assistants, and students, the following are the results of interviews conducted with teachers, namely:

Table 13. Teacher interview question sheet in graphing activities carried out by students in physics practicums

No	Answer
1	I teach the steps to make graphs in stages, starting from making tables, choosing axes, to drawing lines based on data.
2	The difficulty is generally in choosing the scale and axis labels. There are also those who do not understand the relationship between variables.
3	For some students, yes. But some still make graphs without understanding the meaning of the relationship between variables.
4	Some can, especially those who diligently record data. The obstacle is often due to inaccuracy in measuring or writing down initial data.
5	I usually repeat examples of simple graphs on the board, then let them try themselves with guidance when needed.

The results of the interview with the laboratory assistant are as follows:

Table 14. Laboratory assistant interview question sheet in graphing activities carried out by students in physics practicums

No	Answer
1	Yes, usually after the practicum is finished and they record the results, they start making graphs in their workbooks.
2	Some understand, but some are still confused about determining the axis or scale of the graph.
3	Generally have difficulty in choosing the right scale and making proportional graphs.
4	Yes, some students often ask if the graph is correct or how to read the results.
5	I usually give an example of a simple graph or direct them back to the table data to make it easier to map.

The following is the interview result sheet with students, as follows:

Table 15. Student interview question sheet in the graphing activity carried out by students in physics practicum

No	Answer
1	Yes, I have made a temperature graph against time after recording the results of the water heating experiment.
2	I think it is quite difficult because I have to be careful in determining the scale and position of the points on the graph.
3	I enter data that changes, such as temperature and time, and follow the format of the observation table.
4	Yes, the teacher helps explain how to make the X and Y axes, and friends help match the data I have.
5	Helps me see the relationships between data and makes it easier to draw conclusions from experimental results.

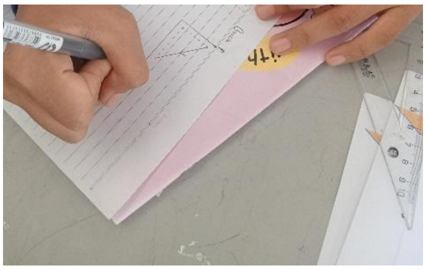

Figure 3. Students are making graphs

The teaching method used by the teacher in building science process skills (SPS), especially in graphing activities, reflects a gradual and participatory approach. The teacher explained that she used step-by-step teaching, starting from making a table, selecting an axis, to drawing a graph based on the data from the practicum. "I teach the steps to make a graph in stages, starting from making a table, selecting an axis, to drawing a line based on the data," said the teacher during the interview. The laboratory assistant added that students were often seen making graphs in their workbooks after recording the results of the practicum, although some still had difficulty choosing the scale and axis. From the students' perspective, they said that the teacher provided direct assistance in determining the X and Y axes, while friends helped check the data. This situation shows that the teaching process does not only focus on transferring information, but also on facilitating and strengthening collaboration that supports the development of SPS. This shows that the teaching method used is collaborative, with direct guidance from the teacher and interaction between students, thus contributing to the development of graphing skills as part of SPS.

These findings are in line with David Ausubel's theory of meaningful learning, which emphasizes the importance of the relationship between new knowledge and cognitive structures that students already have [54]. In this context, graphs become a form of visualization that helps students understand the relationship between physics variables, such as temperature and time. Jerome Bruner's theory is also relevant, especially in the constructivism approach, where students can actively construct their own knowledge through direct experience [55]. Teacher assistance and interaction with peers reflect Vygotsky's scaffolding concept, which emphasizes the importance of the zone of proximal development (ZPD) in helping students achieve higher understanding with social support [56]. In addition, Robert Gagné's learning theory also supports that systematic learning stages, starting from attention to transfer ability, can be facilitated through structured teaching methods like this. With the integration of these theories, it is clear that teaching methods have a key role in activating students' scientific thinking skills, especially in the context of physics practicums [57].

This finding is also in line with previous research showing that the use of demonstration and experiment methods can improve students' ability to create graphs and interpret data [58]. Other studies also concluded that group discussion methods in physics practicum activities can encourage students to actively compile graphs better and understand the relationship between empirical data and theory [59]. In this context, the use of a guided practice-based teaching approach provides students with wider opportunities to explore data and compile it into an accurate graphical representation. Therefore, the right teaching method, with a combination of direct guidance and independent activities, has proven effective in building students' SPS, especially the skill of compiling graphs from experimental data.

3.3. Teacher Strategies in Building Students' Science Process Skills in Physics Learning Through Learning Models

After conducting interviews with teachers, laboratory assistants, and students, the following are the results of interviews conducted with teachers, namely:

Table 16. Teacher interview question sheet in communication activities carried out by students in physics practicums

No	Answer
1	I encourage them to have group discussions first, then appoint representatives to present the results in front of the class.
2	Some groups actively discuss and ask questions, but there are still some who are passive and just wait for instructions.
3	I usually give open questions and ask them to compare the results between groups, so that interaction occurs.
4	I see from the clarity of the argument, the accuracy of the information, and the ability to answer questions from friends or teachers.
5	The challenges are often due to nervousness, lack of confidence, or not understanding the concept well so that it is difficult to explain.

The results of the interview sheet with the laboratory assistant are as follows:

Table 17. Laboratory interview question sheet in communication activities carried out by students in physics practicums

No	Answer
1	The communication is quite active, they often ask each other and share opinions about the steps of the experiment.
2	Often, especially regarding the use of new tools. They are generally enthusiastic and understand quickly after I explain.
3	Some are able to explain well, but some are less confident or are still confused with physics terms.
4	Some are very brave and active, but some are quiet and listen more to other friends talking.
5	Yes, the difference usually lies in the level of confidence and understanding of the concept. Students who understand better are usually more fluent in speaking.

The following is the interview result sheet with students:

Table 18. Student interview question sheet in communication activities carried out by students in physics practicums

No	Answer
1	I am happy because I can exchange ideas and feel more confident when working together.
2	Sometimes it is easy, but if I don't understand I feel hesitant to express my opinion.
3	Yes, when I don't know how to read a thermometer, I ask the next group and they explain patiently.
4	I practice first with my group mates before the presentation, and when I deliver it I am quite confident.
5	Because it can help friends understand the material, and we can also get input if there are mistakes.

Figure 4. Students carry out communication activities

The learning model applied by the teacher in building science process skills (SPS), especially in the communication aspect, emphasizes collaboration and group presentations. Based on the interview, the teacher used a group discussion approach followed by a presentation by student representatives. "I encourage them to have a group discussion first, then appoint a representative to present the results in front of the class," said the teacher. The laboratory assistant added that students looked quite active when discussing in groups and were enthusiastic when asking about the procedures for using the tools. Students themselves said that discussing with friends made them more confident, and they tended to find it easier to convey their results if they had understood the concept first. This situation shows that students' scientific communication is built gradually, starting from internal group interactions to the courage to speak in class forums. Thus, this cooperative-based learning model and presentation of practicum results support students' scientific communication skills in the context of physics learning.

This finding is relevant to Vygotsky's social learning theory, which emphasizes the importance of social interaction and communication in building knowledge [60]. Group discussion activities and presentation of results show the application of the zone of proximal development (ZPD), where students who are more knowledgeable can help their friends understand concepts. In addition, Gagne's learning theory, which describes the stages of learning from attention to transfer, also appears to be applied when students are given the opportunity to process information actively through communication and presentation [61]. This cooperative model also strengthens students' metacognitive abilities in evaluating and explaining their observations verbally. Bruner's theory can also be associated with this strategy, where learning is carried out through a discovery process facilitated by social interaction and a systematic learning structure [62].

Previous research also supports this finding. Previous research found that the Jigsaw cooperative learning model can improve students' scientific communication skills in physics subjects [63]. Other research shows that the use of project-based learning models can improve students' activeness and confidence in conveying experimental ideas [64]. Based on these results, learning models that emphasize collaboration and communication have proven effective in building aspects of SPS, especially in students' scientific communication skills during physics practicums.

3.4. Teacher strategies in building students' science process skills in physics learning through teaching and learning strategies

The teaching and learning strategies implemented by teachers in physics learning play an important role in shaping students' science process skills (SPS). In terms of observation, teachers not only deliver instructions at the beginning of the practicum but also provide provocative questions during the observation to help students observe physical phenomena. One student stated that they were helped to understand the concept of temperature and changes in state because they were directed to pay attention to changes in color and temperature directly. Meanwhile, the laboratory assistant added that teachers often reminded students to focus on the process, not just the end result, which is an important strategy in training accuracy. In terms of making graphs, teachers assigned students to independently compile graphs from experimental data with the necessary assistance, and students admitted that they were accustomed to determining the axes and scales because they were often asked to present data in visual form. In terms of communication, teachers encouraged students to discuss in groups, present experimental results, and provide feedback between groups, which according to one student, this was able to help in understanding the concept more deeply because they heard explanations from other friends' perspectives. This strategy shows that teachers not only act as facilitators, but also as active mentors in building a scientific culture in the classroom.

The teaching and learning strategies implemented by this teacher are in line with Bruner's constructivism theory which emphasizes the importance of active involvement of students in the learning process through direct experience and dialogue [65]. The discussion process in small groups, training in making graphs, and presentation activities reflect the principle of meaningful learning according to Ausubel, where students build understanding based on the relationship between new information and existing knowledge [66]. In addition, the involvement of teachers as guides during the practicum reflects the zone of proximal development in Vygotsky's theory, namely that students are able to achieve higher understanding with the help of more expert people [67]. Gagne's learning theory also supports this practice through a sequence of learning events starting from attention to processing and presenting results [68].

The findings in this study are also in line with the results of previous studies. Research conducted by previous researchers showed that the use of collaborative learning strategies based on practicums can improve students' scientific observation and communication skills [69]. In addition, other studies have revealed that graphing exercises in inquiry-based learning have been shown to be effective in improving logical thinking skills and conceptual understanding [70]. The findings of this study reinforce that teaching and learning strategies that are oriented towards active, collaborative, and reflective learning play a very important role in building aspects of science process skills holistically.

The results of this study indicate that teacher strategies in building students' science process skills (SPS) in physics learning are carried out through various approaches, including learning approaches, teaching methods, learning models, and teaching and learning strategies. The three SPS indicators studied, namely observation, graphing, and communication, have been consistently fostered through practical activities and active discussions. Teachers not only provide instructions, but also provide direct guidance and provide feedback that is appropriate to the needs of students. Laboratory assistants and students also play an active role in supporting the learning process through technical support and participation in scientific communication. These results reinforce the importance of integration between theory and practice in building students' SPS. Overall, the strategies implemented show synergy between the roles of teachers, laboratory assistants, and active participation of students in the learning process.

This study offers novelty in the informant triangulation approach, namely teachers, laboratory assistants, and students, which is rarely used in similar studies on science process skills. Focusing on three SPS indicators that are systematically dissected in four pedagogical strategies provides a comprehensive and in-depth picture. In addition, this study not only highlights teacher practices, but also places student experiences and laboratory assistants' views as an important part of learning reflection. The use of direct quotes from informants strengthens the validity of the findings and provides an authentic nuance to the field context. This study also highlights the importance of practicum-based learning as a means of forming SPS in physics subjects. Thus, the holistic approach in this study is a new contribution to the development of physics learning strategies based on process skills.

The implications of this study indicate that teacher strategies in fostering students' SPS must be designed in an integrated manner between approaches, methods, models, and teaching-learning strategies. Teachers need to integrate active and practice-based learning as a medium to develop students' observation, graphic skills, and scientific communication. Schools also need to actively involve laboratory assistants in the learning process so that technical support is in line with learning objectives. However, this study has several limitations, including the data coverage which only covers one school and limited informants. This limits the generalization of the results to a wider educational context. Therefore, further research is recommended to involve more schools and explore the relationship between SPS indicators in different learning contexts.

4. CONCLUSION

This study shows that teacher strategies in building students' science process skills (SPS) in physics learning are carried out comprehensively through learning approaches, teaching methods, learning models, and teaching and learning strategies. The three SPS indicators studied, namely observation, graphing, and communication, were proven to develop through the active involvement of teachers, laboratory assistants, and students. Teachers play an important role in providing direction, guidance, and stimulation of scientific thinking. Laboratory assistants support the smooth running of practicums and help students understand observation data. Meanwhile, students show a positive response through active participation in practicum activities and reflection on learning outcomes. Overall, an integrated and practice-oriented learning strategy is able to shape students' scientific skills gradually and sustainably.

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