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Classify, Measure, Tabulate: Exploring Teacher Strategies in Shaping Scientific Process Skills in Phase Change Physics

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ABSTRACT

Purpose of the study: This study aims to explore and describe the strategies used by physics teachers to enhance students' scientific process skills specifically in classifying, measuring, and tabulating data during the learning of phase changes of matter in senior high school.

Methodology: This study employed a qualitative naturalistic approach. Data were collected using in-depth interviews and photographic documentation. The participants included one physics teacher and 36 students of class XI F7 Senior High School 10 Jambi City. Istruments used were interview guidelines and documentation sheets. Data analysis followed the stages of data reduction, data display, and conclusion drawing.

Main Findings: The study found that teachers implemented various strategies to improve students' scientific process skills, particularly in classifying, measuring, and constructing data tables during the learning of phase changes of matter. Through structured guidance, contextual examples, and supportive assessments, students showed improved accuracy and independence in scientific data handling. Both teacher and student responses indicated that strategy-based teaching effectively enhanced students' analytical and practical competencies in physics learning.

Novelty/Originality of this study: This study offers a fresh perspective by exploring teacher strategies specifically designed to enhance students' abilities in classifying, measuring, and tabulating data within the topic of phase changes in physics. Unlike previous research, it integrates pedagogical, methodological, and model-based approaches, contributing new insights into the development of scientific process skills in secondary education settings.

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1. INTRODUCTION

Physics as part of science in Senior High School has a strategic role in shaping students' scientific thinking. In the Independent Curriculum, physics is not only taught as a collection of theories, but also as a vehicle for developing scientific literacy and high-level thinking skills [1]-[3]. One of the essential topics taught is changes in the state of matter, which is included in the material of temperature and heat and is very relevant to everyday life [2], [3]. Phenomena such as evaporation, condensation, and freezing are not only recognized by the naked eye, but also require in-depth scientific understanding [4], [5]. Therefore, this material is very appropriate for training observation skills, data analysis, and evidence-based conclusions.

The material on changes in the state of matter is important because it involves basic concepts about the relationship between energy, temperature, and particle structure in a substance. This material not only underlies advanced physics topics such as thermodynamics and heat transfer, but also becomes the foundation for cross-disciplinary understanding, such as chemistry and biology [6], [7]. In the context of 21st-century learning, students need to be guided to be able to evaluate these phenomena scientifically and systematically [8], [9]. This is in line with the objectives of the Independent Curriculum which emphasizes character building, critical thinking, and data-based problem-solving skills [10], [11]. Thus, learning about changes in the state of matter must be designed not only to convey content, but also to develop students' scientific skills.

One important aspect in science learning is the development of Science Process Skills (SPS), namely the ability to think and act like a scientist. Science process skills include abilities such as observing, classifying, measuring, interpreting data, and communicating results [12], [13] These abilities are essential for building conceptual understanding as well as students' practical skills in solving scientific problems [14], [15]. Science process skills trained since high school will provide long-term contributions to students' readiness in facing the challenges of technology and information [16]-[17]. Therefore, learning about changes in the state of matter must also focus on strengthening process skills that are relevant to real-life contexts.

In this context, the three indicators of science process skills that are the main focus are classifying, measuring, and tabulating data. All three are basic skills that are the foundation for scientific thinking and experimental data analysis [18], [19]. These skills are also in line with the learning outcomes in the Independent Curriculum High School Physics Syllabus (Kemdikbudristek, 2022), where students are expected to be able to present observation results in the form of tables or graphs and to measure physical quantities accurately [20]. In addition, strengthening science process skills is also in line with the development of the Pancasila Student Profile, especially in the dimensions of critical thinking and scientific reasoning [21], [22]. Therefore, teachers are required to have learning strategies that explicitly train these skills in every meeting.

Based on initial observations conducted at State Senior High School 10 Jambi City, it was found that teachers had used group discussion methods and simple experiments to deliver material on changes in the state of matter. However, the results of interviews showed that most teachers had not systematically trained students in classifying substances, measuring temperature or mass accurately, and making tables of observation data. In fact, these indicators are part of the process skills that need to be formed gradually and continuously. This shows a gap between the learning strategies used and the skills expected in the curriculum. Therefore, an in-depth study is needed on how teacher strategies can be optimized to improve the three aspects of science process skills.

Several previous studies have discussed the enhancement of science process skills in science learning, but most tend to be general. For instance, research by Wulandari et al., [23] highlighted the effectiveness of project-based practicum in improving overall SPS but did not focus on specific skills like classification or data processing. Research by Inayah & Malik [24] emphasized the use of inquiry models to improve conceptual understanding but did not explore teacher strategies in developing students’ data analysis skills. Other studies focused more on student-centered approaches, without thoroughly examining how teachers contribute directly to shaping specific SPS indicators. This reveals a research gap that has not yet been fully addressed.

This study presents a novelty by specifically investigating teacher strategies in strengthening measurable and applicable science process skills namely, classifying, measuring, and tabulating data. Employing a naturalistic qualitative approach, this research aims to describe and analyze how teachers design and implement effective teaching strategies in physics learning on the topic of changes in the state of matter. The urgency of this study lies in the need for instructional practices that align with curriculum demands and current educational developments, especially in forming scientifically literate students who can think critically and base their reasoning on data. The findings of this study are expected to provide both theoretical and practical contributions to the advancement of science learning at the secondary school level.

2. RESEARCH METHOD

This study employs a naturalistic qualitative approach aimed at deeply exploring teacher strategies in fostering students’ science process skills, particularly in classifying, measuring, and constructing data tables within the topic of phase changes in physics learning [25], [26]. This approach was chosen to gain a comprehensive view of teaching practices and student responses in real classroom settings. The study examines how teachers implement instructional strategies and how students demonstrate science process skills. Data were collected through interviews and photo documentation of class and lab activities, then analyzed descriptively through data reduction, display, and conclusion drawing to reveal patterns in the effectiveness of teaching strategies.

2.1 Populations and Research Sample

The population in this study were all students of grade XI at Senior High School 10 Jambi City in the 2024/2025 academic year along with one physics laboratory teacher involved in the practicum activities. This population was selected based on its relevance to the material on changes in the state of matter that had been taught in physics learning and the implementation of practicums involving science process skills. The sample was determined using a purposive sampling technique, namely deliberate selection based on certain criteria that are relevant to the objectives of the study [27]. The sample in this study was class XI F7 consisting of 36 students and one physics laboratory teacher. The selection of this class was based on the active involvement of students in the practicum on changes in the state of matter that required them to classify data, take measurements, and organize data into tables, which are the main focus of the development of science process skills in this study.

2.2 Data Collection Techniques

Data collection in this study was carried out through two main techniques that are in line with the naturalistic qualitative approach, namely in-depth interviews and photo documentation. This approach is used to gain a complete understanding of teacher strategies in improving students' ability to classify, measure, and present data through tables in physics learning on the material of changes in the state of matter, in a natural context without variable manipulation [28]. Interviews were conducted in a semi-structured manner with one physics teacher and several students of class XI F7 who were actively participating in the practicum, with a focus on exploring perceptions, experiences, and learning strategies applied in the experimental process. In addition, documentation in the form of photographs of practicum activities was used as complementary data to capture students' real activities in processing and interpreting data, while strengthening the validity of information from the interview results [29]. The entire documentation process was carried out with permission from the school and participants, and was analyzed triangulated to ensure the validity and credibility of the data obtained in this study.

2.3 Data Analysis Techniquen

The data analysis technique in this study uses a qualitative descriptive analysis method that is carried out in stages and in depth to comprehensively explore teacher strategies in shaping students' science process skills and student responses in the context of real physics learning. This approach is used to process non-numerical data, such as the results of interviews with physics laboratory teachers and students and visual documentation of learning activities, in order to obtain an authentic picture of students' abilities in classifying, measuring, and tabulating data according to the natural context in class [30]. The analysis process begins with data reduction, namely the stage of filtering and organizing raw data into information that is relevant to the focus of the study. Furthermore, the organized data is presented systematically in the form of thematic narratives, direct quotes, and visual documentation, in order to trace the relationship between teaching strategies and student activities in applying process skills. The final stage in the form of drawing conclusions and verification is carried out by interpreting the patterns that emerge to answer research questions regarding the effectiveness of learning strategies in strengthening students' scientific competence in the material on changes in the state of matter.

2.4 Research Procedure

The procedure in this study began with the preparation stage, which included the preparation of research instruments in the form of interview guides and documentation sheets, adjusted to the aim of exploring students' data interpretation abilities in the practicum on material changes in the state of matter. After the instrument was developed, the researcher submitted an official permit to the school and coordinated with the physics teacher regarding the schedule and technical implementation of the learning activities that were the focus of the observation. The implementation stage included data collection through in-depth interviews with teachers and students, as well as documentation in the form of photos of practicum activities that took place naturally in the classroom. The data obtained were analyzed using a qualitative descriptive approach through the stages of data reduction, data presentation, and drawing conclusions to identify relevant meaning patterns [31], [32]. In the final stage, the researcher compiled findings and conclusions that reflected the process of students' interpretation of practicum data, while also providing implications for strengthening science process skills in physics learning.

3. RESULTS AND DISCUSSION

The results of this study were obtained through the main technique of in-depth interviews with teachers and students of class XI F7 and documentation during the activity. The results of the study are presented in table form to be more systematic. The results of in-depth interviews with physics laboratory teachers and students of class XI F7 and documentation during the activity are as follows:

3.1. Teacher Strategies in Improving Students' Ability to Classify, Measure, and Create Data Tables in Physics Learning Material on Changes in the State of Matter in High Schools Through Learning Approaches

Table 1. Interview Results on Learning Approaches

No.	Question	Teacher Answer Summary
	Teacher Interview Guide	
1.	What learning approach do you apply when teaching changes in the state of matter in class?	Teachers use a contextual approach to relate changes in the state of matter to everyday phenomena, so that students can more easily understand basic concepts.
2.	How does this approach help students understand how to classify lab data?	The approach used emphasizes exploration and group discussion to encourage active involvement in the data classification process.
3.	Does the approach used encourage active student involvement in taking measurements?	Teachers design problem-based learning activities to encourage students to measure and observe changes in temperature and the shape of substances directly.
4.	How does this approach facilitate students in creating and compiling practical data tables?	The teacher prepares a worksheet that guides students in collecting and grouping data based on physical changes observed during the practicum.
5.	What obstacles did you encounter in implementing this learning approach, especially in improving students' science process skills?	The teacher facilitates reflection after the practical activities so that students can re-arrange the data into a table systematically.
	Student Interview Guide	
1.	In your opinion, what learning approaches do teachers often use in explaining the material on changes in the state of matter?	Students stated that learning that was linked to everyday life helped them understand the process of changing substances more concretely.
2.	How does that approach help you classify data from experimental results?	The group discussion approach made them more courageous in expressing ideas when classifying substances was carried out together.
3.	Does the approach used make you more confident in taking measurements during the practicum?	Students feel it is easier when the teacher provides structured instructions for measuring temperature and time of changes in substances.
4.	How do you learn to create data tables through the learning approach used by the teacher?	They began to understand the importance of measurable data when compiling observation tables because the teacher encouraged them to fill in the tables directly after the experiment.
5.	In your opinion, what are the advantages and disadvantages of the approach used by teachers in physics learning?	Learning with a contextual approach makes students more careful and aware of the relationship between observation and recording scientific data.

The interview results showed that the learning strategy implemented by the teacher namely by linking the material on changes in the state of matter to the context of everyday life was proven effective because it was able to reduce the level of abstraction of concepts and increase the relevance of learning for students. The scientific approach used, which emphasized the activities of observing, asking, and associating, not only made students actively involved cognitively, but also formed scientific thinking patterns in them. This strategy was effective because it encouraged students to experience the scientific process directly, so that they not only knew the steps, but also understood the reasons behind each stage. Thus, students were better able to classify, measure, and process data systematically. The effectiveness of this approach was also seen from the increasing ability of students to interpret the results of the practicum logically, because they built understanding through experience and reasoning, not just procedural memorization.

Figure 2. Learning approach

The learning approach used by teachers is in line with constructivism learning theory, especially according to Vygotsky who emphasizes the role of the social environment and scaffolding in the formation of knowledge. In this theory, students do not only receive information, but build their own understanding through interaction and concrete experience [33], [34]. The scientific approach used by teachers reflects the internalization process through the zone of proximal development (ZPD) [35]. The advantage of this theory is that it is able to accommodate differences in students' levels of understanding and encourage their active involvement in the learning process. Therefore, the application of a learning approach based on constructivism strengthens the process of forming scientific skills gradually and meaningfully.

This research is relevant to previous studies by Latukau [36] which states that the scientific approach is effective in improving students' understanding of concepts and science process skills. However, previous studies have not specifically highlighted students' ability to create data tables as part of the interpretation of practicum results. Thus, this study improves previous studies by adding a focus on the skills of classifying, measuring, and arranging data in tabular form. This provides a new contribution to the realm of physics learning based on process skills. This study also strengthens the argument that the right approach can encourage students to think scientifically in the context of practicums.

3.2. Teacher Strategies in Improving Students' Ability to Classify, Measure, and Create Data Tables in Physics Learning Material on Changes in the State of Matter in High Schools Through Teaching Methods

Table 2. Interview Results on Teaching Methods

Teacher Interview Guide		
No.	Question	Teacher Answer Summary
1.	What teaching method do you use most often to teach the material on changes in the state of matter?	The teacher combines interactive lecture and demonstration methods to build students' initial understanding of changes in the state of matter.
2.	How does the method support students in accurately classifying experimental data?	The practicum is carried out using a direct experimental method so that students can carry out their own measurements and classify the results.
3.	Does this method allow students to be directly involved in the measurement process? Explain.	The teacher provides direction on the correct data recording methods, such as the use of units, repeated measurements, and observation of variables.
4.	How do you use your teaching methods to facilitate students in compiling data from practical work into tables?	The teacher applies the question-and-answer method during the practicum to stimulate students' thinking skills in distinguishing between physical and chemical changes.
5.	Are the methods used flexible to students' learning styles in understanding physics concepts practically?	Guru memberikan latihan menyusun tabel dari data mentah untuk melatih keterampilan pengorganisasian informasi.
Student Interview Guide		
1.	What teaching methods does your teacher often use in the material on changes in the state of matter?	Students feel that the lecture method is not boring because the teacher intersperses it with questions and answers and short experiments.
2.	Does this method help you understand the steps of practical data classification?	They gain hands-on experience of experimental methods, which helps in measuring and recording results more accurately.
3.	How effective is the method used by the teacher in guiding you in taking measurements?	The teacher's directions in filling out the table were very helpful, especially in placing the data in the correct columns.
4.	Do you find it helpful to create a data table of experimental results using the method applied?	Questions from the teacher during the practice made them think more critically about the differences between types of substances and types of changes.
5..	If you were given a choice, which teaching method do you think is easiest to understand this material? Why?	The method of practicing compiling tables is the easiest way to understand this material, because it helps you think more systematically and makes it easier to interpret the results of the experiment.

The interview data suggest that the effectiveness of the teacher’s strategies interactive lectures, demonstrations, and experiments stems from their alignment with core principles of active learning and constructivist pedagogy. Rather than passively receiving information, students engaged directly with scientific phenomena, which enhanced their conceptual understanding and retention. The experimental method was particularly effective because it encouraged students to practice measurement and data classification firsthand, thereby reinforcing essential scientific process skills. Demonstrations played a complementary role by making abstract concepts more tangible, which is especially crucial in understanding microscopic or non-visible changes in states of matter. Additionally, teachers' ability to adapt these methods based on classroom context and student readiness contributed to more targeted instruction, allowing them to scaffold learning in a way that met diverse student needs. This adaptive, student-centered approach is what ultimately made the strategies effective not merely their use, but their thoughtful integration to build connections between theory and practice, and to foster the development of scientific thinking.

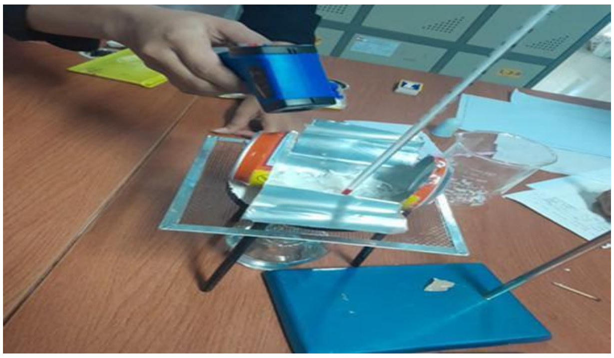

Figure 3. Teaching Methods

The teaching method used by the teacher is in line with the Behaviorist learning theory, especially the stimulus-response principle developed by Skinner. In this context, students are given stimulus through experimental activities or demonstrations, then reinforced with direct feedback from the teacher [37]. The advantage of this theory is its ability to create cognitive and procedural habits in scientific thinking through structured exercises. With an explicit method, students are systematically guided to master the skills of measuring and classifying [38]. Therefore, the application of behaviorist-based teaching methods is effective in building scientific thinking and acting habits.

This study supports the findings of Ute et al. [39], which stated that the experimental and demonstration methods were able to significantly improve students' understanding of physics concepts. However, previous studies were still general and had not explored the role of teaching methods in the formation of classification and data presentation skills. This study refines previous results by focusing on the relationship between teaching methods and students' interpretive abilities. Thus, the contribution of this study clarifies the relationship pathway between specific teaching methods and science process skills. It also strengthens the argument that appropriate teaching methods can develop students' scientific thinking skills in a more structured manner.

3.3. Teacher Strategies in Improving Students' Ability to Classify, Measure, and Create Data Tables in Physics Learning Material on Changes in the State of Matter in High Schools Through Learning Models

Table 3. Interview Results on Learning Model

Teacher Interview Guide		
No.	Question	Teacher Answer Summary
1.	What learning model do you choose to improve students' abilities in classifying, measuring, and creating data tables?	Teachers apply guided inquiry learning models to encourage students to actively ask questions and seek answers through experiments.
2.	Why did you choose this learning model in the context of changes in the state of matter?	In this model, students are asked to formulate a hypothesis based on initial observations before conducting the practicum..
3.	How does implementing the model in a lab session help students improve their science process skills?	The teacher guides students to classify substances based on the physical characteristics that appear during the heating or cooling process.
4.	Is the learning model collaborative or individual? How does it affect the compilation of data tables by students?	The project-based learning model is applied to make students compile complete practical reports with data and tables.
5.	How do you evaluate the effectiveness of learning models in improving student learning outcomes in the data processing aspect?	The teacher evaluates the students' work based on the clarity of the classification, the accuracy of the measurements, and the neatness of the data table that is prepared.

Student Interview Guide		
1.	What learning model does your teacher use when teaching the material on changes in the state of matter?	Students feel that the inquiry model makes them more challenged and curious about the results of the changes in substances that occur.
2.	How does the model help you understand how to classify and measure lab results?	Formulating a hypothesis before practice helps them focus on observing and recording data.
3.	Do you find it easier to create data tables when teachers use this learning model?	The activity of classifying substances becomes more meaningful because they see the physical changes being observed directly.
4.	Do you study in groups or individually? How does that affect your understanding?	Making a practical report as part of a project makes students learn to compile tables more professionally.
5..	In your opinion, is the learning model used by the teacher effective or not in helping you learn? Explain.	Feedback from teachers on their reports makes students more careful in measuring and recording lab data.

The teachers implemented inquiry-based learning and problem-based learning (PBL) strategies to teach the concept of changes in the state of matter. These approaches prompted students to actively formulate questions, investigate laboratory data, and draw conclusions through independent exploration. The effectiveness of these strategies lies in their alignment with the nature of scientific inquiry encouraging students to engage in higher-order thinking and develop a structured approach to data classification and analysis. By centering learning around students' active participation, these models not only fostered critical thinking but also promoted ownership of learning, which in turn increased motivation and deeper conceptual understanding. As a result, students demonstrated improved abilities in organizing data into tables and articulating their findings clearly, indicating that the instructional strategies were successful in cultivating core scientific competencie

Figure 4. Learning Model

The learning model used by the teacher is in line with Piaget's Constructivism theory which emphasizes the importance of active and explorative learning experiences. In this theory, students build knowledge through direct interaction with objects or phenomena, such as in practical activities [40]. The strength of this theory lies in its ability to foster deep conceptual understanding through the process of internalizing knowledge. The use of inquiry and PBL models encourages students to think reflectively and creatively, in line with constructivist principles [41]. Therefore, the application of this active learning model is very appropriate in the context of developing classification, measurement, and data presentation skills.

This study is in line with a study by Musliman and Kasman [42], which showed that the inquiry model significantly improves students' scientific thinking skills. However, previous studies have not explicitly linked learning models to the skills of compiling data tables in the context of a change in state of matter practicum. This study provides a new contribution by highlighting how learning models impact students' data interpretation systematically. Thus, this study refines previous results and enriches the study of active learning models. These findings are important for strengthening the pedagogical foundation in laboratory-based physics learning.

3.4. Teacher Strategies in Improving Students' Ability to Classify, Measure, and Create Data Tables in Physics Learning Material on Changes in the State of Matter in High Schools Through Teaching and Learning Strategies

Table 4. Interview Results on eaching and Learning Strategies

Teacher Interview Guide		
No.	Question	Teacher Answer Summary
1.	What teaching and learning strategies do you consider most effective in guiding students to understand the material on changes in the state of matter?	Teachers apply scaffolding strategies in guiding students who have difficulty understanding observation data.
2.	How are these strategies directed so that students are better able to classify and measure data?	Differentiation strategies are also applied by providing different guidance according to students' ability levels.
3.	Are the teaching and learning strategies used able to involve students in the process of compiling experimental data tables independently?	The teacher provides an empty table template as a practice medium so that students get used to arranging data sequentially.
4.	How do you adapt learning strategies to the diverse needs of students in understanding the science process?	Collaborative strategies are used by forming heterogeneous groups to encourage sharing of understanding.
5.	To what extent have the teaching and learning strategies used contributed to concrete improvements in student learning outcomes?	The teacher provides post-practical reflection so that students can review the classification and measurement steps.
Student Interview Guide		
1.	What kind of teaching and learning strategies do teachers often use when teaching material on changes in the state of matter?	Students said they were helped by the scaffolding strategy because they could focus more on understanding each data component.
2.	How does this strategy help you in classifying and measuring data from the results of the lab?	Adjusting assignments according to their abilities ensures that students do not feel burdened, but remain challenged.
3.	To what extent did the teacher's strategy help you in compiling the data table properly and correctly?	Table templates help them understand the structure of scientific data and how to fill it in correctly.
4.	Does the teacher's strategy make the learning process more interesting or confusing? Explain.	Group work helps accelerate understanding and strengthens classification and measurement skills.
5..	In your opinion, what kind of learning strategy is most suitable for learning physics material well?	Post-practicum reflection gives them the opportunity to evaluate their thinking and strategies for recording data systematically.

The effectiveness of the teacher's strategy lay in its alignment with principles of active learning and scientific inquiry. By posing provocative questions, the teacher stimulated cognitive dissonance that compelled students to think critically and re-examine their assumptions. Group work fostered collaborative reasoning, allowing students to articulate their thoughts, challenge each other's interpretations, and construct shared understanding. Reflecting on practicum results required students to evaluate their data, recognize errors, and draw logical conclusions, thereby internalizing scientific thinking. Organizing data into structured tables also developed their ability to classify variables and identify relationships among them. Importantly, the teacher's real-time feedback functioned as a formative tool, guiding students toward more accurate analysis and reinforcing scientific habits of mind. This combination of strategies was not only instructional but transformational, as it cultivated essential process skills and deepened conceptual understanding.

Figure 5. Teaching and Learning Strategies

This teaching and learning strategy is in line with the Humanistic theory developed by Carl Rogers, which emphasizes the importance of a supportive and dialogical learning environment. In this theory, students are positioned as active subjects who have the potential to grow independently if facilitated with empathy, acceptance, and appreciation [43]. Reflective strategies, collaborative work, and feedback are in line with the humanistic approach because they foster self-awareness and meaningful understanding. The advantage of this theory is that it is able to encourage students' emotional and intellectual involvement in a balanced way [44]. Therefore, humanistic learning strategies are effective in improving students' scientific abilities personally and socially.

This study is consistent with findings by Surya and Aprinawati [45], which emphasizes the effectiveness of reflective and collaborative strategies in improving science process skills. However, previous studies have not explored in depth how these learning strategies shape students' abilities in compiling and interpreting table data accurately. This study adds a new dimension by highlighting the importance of teacher strategies in lab-based learning. By refining the approach used in previous studies, this study broadens the understanding of effective teaching practices in physics classrooms. These results provide strategic recommendations for teachers in designing learning that focuses on strengthening students' scientific skills.

Based on the interview results compiled in four tables, the teacher's strategy in improving students' ability to classify, measure, and create data tables in physics learning on the material of changes in the state of matter involves a combination of active learning approaches, direct experimental methods, scientific inquiry models, and contextual learning strategies. The teacher explained that direct student involvement through practical activities is key in building science process skills, especially in observing, grouping data, and compiling information in the form of systematic tables. Students responded that the method helped them understand concepts concretely and honed their accuracy in recording and measuring data. The interview results also showed an increase in the ability to connect observation results with theoretical concepts, which is the core of science process skills. Thus, the right learning strategy can significantly strengthen the dimensions of students' basic science skills in physics classes.

The novelty of this study lies in the exploration of teacher strategies in fostering students' science process skills specifically, namely the ability to classify, measure, and organize data in tabular form in the context of changes in the state of matter through a practical approach. This study not only describes the learning methods used by teachers, but also analyzes the relationship between these strategies and students' responses and experiences directly. The naturalistic qualitative approach applied provides a comprehensive and in-depth picture of the effectiveness of teacher strategies in laboratory-based physics learning [46]. This study is significant because it highlights elements of fundamental science process skills that are rarely studied separately in previous studies. Therefore, this study strengthens and updates the physics education literature with a more detailed and contextual focus.

This study implies that physics teachers need to consciously design and implement learning strategies that support the development of students' science process skills, particularly in classification, measurement, and data presentation. An approach that emphasizes active practicum and empirical data reflection has proven effective in fostering conceptual understanding and scientific thinking skills [47]. his study can also serve as a reference for designing practice-based science learning modules or instruments at the high school level. However, this study has several limitations. In addition to being limited to one class and one school making the findings less generalizable there is also a possibility of bias in the interview responses, as they rely on participants' subjective perceptions. Furthermore, the documentation techniques used may not have captured the full depth of classroom interactions or contextual nuances. Future research is encouraged to broaden the study scope across multiple schools and employ method triangulation or integrate quantitative data to enhance the validity and applicability of the findings.

4. CONCLUSION

This study confirms that the implementation of teacher strategies through carefully selected approaches, methods, and models effectively enhances students' abilities in classifying, measuring, and organizing data in tabular form, thus fulfilling the initial objectives outlined in the introduction. The findings indicate that science process skills can be significantly fostered through structured substance change practicums, particularly when accompanied by intensive and guided teacher facilitation. These results emphasize the pivotal role of teachers in constructing learning experiences grounded in scientific inquiry, thereby nurturing students' foundational scientific thinking. Beyond validating the research objectives, this study contributes to the pedagogical discourse by offering a replicable model for skills-based physics instruction. Future development may include the integration of these strategies into laboratory-based modules across diverse physics topics to holistically expand students' science process competencies..

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