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Analysis of Wave Laboratory Reports to Identify Science Process Skills of UNNES Undergraduate Physics Education Students

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Abstract

The purpose of this study was to identify the science process skills of physics education students through analysis of practicum reports on wave courses at the Faculty of Mathematics and Natural Sciences, Universitas Negeri Semarang. The research method used is qualitative descriptive. The entire population in this study is used as a sample. Therefore, the sample in this study consists of third-semester students for the 2022/2023 academic year in the Physics Education program, totaling 94 students into 3 classes: A, B, and C. Observations indicate that the wave practical sessions are conducted using an open inquiry approach, without any practical guidance modules. The assessment of practical reports is conducted according to the predetermined evaluation rubric. The students' science process skills in preparing wave laboratory reports are categorized as high. Analysis results show that the highest average percentage of science process skills is found in the grouping indicator, at 88.32%, while the lowest is in the hypothesizing indicator, at 73.72%. The lecturer is assisted by laboratory assistants in evaluating the students' practical reports, with the assessment based on the results obtained in the report preparation. Students are considered to be in the high category if they are able to prepare reports according to the systematic report structure and meet the science process skills criteria.

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INTRODUCTION

Science Process Skills (SPS) is something that is needed, especially for physics students. Physics education students are prospective physics teachers who must have the competencies stated in the Regulation of the Minister of Education and Culture Number 64 of 2013. SPS are the ability of students to apply scientific methods in understanding, developing, and discovering knowledge with a variety of skills (Raysa, 2020). Physic teaching and learning process should emphasize more on process skill approach so that student can finding facts, construct concepts, theories, and scientific attitude by their self, which finally can affect positively on the quality of education process or education product (Yunianti *et al,* 2019). Through SPS students will become more understanding of concepts in learning directly, students can do it independently, namely by developing SPS (Misbah *et al*, 2018). SPS need to be trained or developed in physics teaching because process skills have a role in helping students learn to develop their minds, provide opportunities for students to make discoveries, improve memory, provide intrinsic satisfaction, and help students learn Physics concepts (Zai et al., 2019).

The development of science process skills, a supportive learning model is required, one of which is the inquiry-based learning model. The inquiry model is used to hone SPS by encouraging students to ask questions and draw conclusions from general principles based on experience and practical activities (Priansa, 2017). Students are expected to learn independently by improving their ability to justify issues during the learning process (Yusra et al., 2021).

The use of open inquiry laboratories can stimulate and enhance conceptual competence in SPS. According to the Standard for Science Teacher Preparation (NSTA & AETS, 1998), inquiry is categorized into three levels: discovery learning, guided inquiry, and open inquiry. At the discovery learning level, the main action of the lecturer is to identify problems and processes, followed by students proposing alternative solutions. At the guided inquiry level, the lecturer presents the problem, and students determine the process and solution. At the open inquiry level, the lecturer provides the context for problem-solving, and students identify and resolve the problem themselves. Inquiry activities can be implemented through fieldwork and laboratory work (inductive) (Sarwi, 2010).

Writing a practicum laboratory reports is one way that can be used to identify students SPS. However to date, the preparation of laboratory reports has not enough received much attention in lectures (Arian, 2020). The purpose of writing a laboratory report is to communicate findings to the reader in a complete manner so that the reader understands and comprehends what was done during the practical session. According to this objective, the report includes the purpose, practical methods, theoretical background, tools and materials, data from the practical session, discussion, conclusions, and the bibliography used in preparing the wave laboratory report. Some difficulties experienced by students in reporting practical work include challenges in structuring the report and a lack of understanding of the purpose of report preparation (Santa et al., 2016).

Producing a good laboratory report requires supporting factors that can positively impact the writer. In addition to these supportive factors, there are often obstacles that diminish the quality of the produced work. These obstacles can stem from external sources or from the writer themselves. The following are some of the barriers that can affect the productivity of written work: 1) External Barriers: Lack of early habituation, Insufficient motivation from the learning environment, Students only understanding the concepts, Limited research opportunities for writing scientific papers, Lack of appreciation from the academic community for student work, Absence of a curriculum that includes scientific writing, no designated time for training, Lack of financial support, 2) Internal Barriers: Lack of talent, and Insufficient internal motivation (Rahmiati, 2014:90).

Based on the above explanation, it is evident that SPS are crucial in preparing laboratory reports, which involve specific stages that require each student to produce different insights according to the research focus. SPS are also necessary to address any obstacles in report preparation, ensuring that each student can compile practicum reports optimally.

Based on the results of observations that have been made in April 2023 followed by filling out questionnaires in May - June 2023, which were shown to laboratory assistants and students of the third semester of the 2023 academic year at the Physics Department of Universitas Negeri Semarang, it shows that in the practicum of learning waves is carried out open ended, there is no practicum implementation guidebook, and there is no assessment rubric to assess SPS in the process of preparing practicum. Therefore, this research aims to identify the SPS of physics education students through analysis of the wave practicum reports that have been prepared.

METHODS

This study employs a qualitative descriptive method. Descriptive methods are procedures used to investigate by describing the state of subjects or objects based on observable or actual facts. Qualitative research, also known as naturalistic research, is a type that presents information in a descriptive form and is more qualitative in nature (Sugiyono, 2020: 13).

The entire population in the study being the sample, namely 94 students of the Physics Education study program, semester III of the 2022/2023 academic year, divided into 3 classes.

The data collection techniques used in this study include a questionnaire on laboratory report preparation filled out by students, which contains 45 statements, a questionnaire for evaluating laboratory reports completed by laboratory assistants, interviews, and wave laboratory reports.

Indicators of the ability of SPS according to Rustaman (2007), consists of 8 skills, that is:

1) **Observing:** Observation is the most fundamental skill in the process of acquiring knowledge and is crucial for developing other process skills. Observation involves the process of perceiving conditions and their characteristics, enriching experience with objective and realistic elements.
2) **Classifying:** Classification is the process skill of sorting various objects or events based on their specific characteristics, resulting in the grouping of similar objects or events.
3) **Interpreting:** Interpretation includes the skill of connecting one thing with another, understanding relationships and meanings.
4) **Predicting:** Prediction involves making statements about what will happen in the future or something that is not yet known but will be known in the future.
5) **Communicating:** This skill involves conveying the results of one's findings to others, either verbally or in writing. It can include writing reports, creating papers, composing essays, making diagrams, tables, charts, and graphs.
6) **Hypothesizing:** This skill involves providing alternative answers to research questions. While prediction is the process of using observation or data to forecast future events based on scientific knowledge, hypothesizing involves explaining by manipulating one variable to see if it affects another variable.
7) **Applying Concepts:** This refers to the activity of practicing known knowledge to achieve a specific goal.

Concluding: This involves drawing conclusions from experiments based on patterns of relationships between observations.

Table 1. Aspects and Indicators of Science Process Skills

Aspects	Indicators
Observing	• Observe directly • Collect/use relevant facts
Classifying	• Record each observation separately • Look for differences and similarities • Contrasting characteristics • Finding the basis for grouping or classification
Interpretation	• Connecting the results of observations • Finding patterns in a series of observations
Prediction	• Using patterns of observation • Suggesting what might happen in circumstances that have not been observed
Communicating	• Change the form of presentation • Organize and submit reports systematically • Discussing an experiment
Hypothesize	• Recognizing that there is more than one possible explanation of an event • Realizing that an explanation needs to be tested with evidence
Applying concepts	• Uses learned concepts in new situations • Uses concepts in new experiences to explain what is happening
Conclude	• Explaining the results of an experiment or research • Read graphs or diagrams • Provide/describe empirical data from experiments or observations..

The aspects assessed in this section are: SPS in the second semester, and SPS in high, low, and medium ability groups. These aspects are evaluated by following these steps: 1) processing the data collected from the scoring of laboratory report documents, questionnaires supported by interview results, 2) describing all obtained information using explanatory details, 3) performing data reduction, 4) creating categories for SPS in the preparation of laboratory reports, 5) describing SPS details based on the established categories, 6) analyzing the obtained findings, 7) comparing findings with literature, 8) interpreting the findings, 9) drawing conclusions.

Table 2. Category level of science process skills (Azwar, 2014)

Science Process Skills Scores and Categories	
Range of values obtained	**Ability Criteria**
X < 33.33	Low
33.33 ≤ X < 66.67	Medium
66.67 ≤ X	High

RESULTS AND DISCUSSION

1) Observation indicator

The indicator for observing involves the process of perceiving conditions and their characteristics, and enriching experience with objective elements (Rustaman, 2007). SPS for the observing indicator consist of 3 components of the practical framework: "Objective," "Tools and Materials," and "Method of Practical Implementation." The objective of the practical session provides an explanation of the goals to be achieved by the students, while tools and materials describe the items that will be used. The framework for the report is as follows: "Objective" is covered in statements 1, 2, and 3; "Tools and Materials" are covered in statements 4, 5, and 6; and "Method of Practical Implementation" is covered in statements 7, 8, 9, and 10. The average SPS for the observing indicator per statement can be seen in Table 3.

Table 3. Average SPS for the observing indicator statement item

Report Outline	Statement Number	Percentage (%)	Category
Objective	1	87.87	High
	2	88.72	High
	3	90.21	High
Tools and Materials	4	85.00	High
	5	88.30	High
	6	86.80	High
Practicum Implementation Method	7	88.94	High
	8	90.00	High
	9	91.28	High
	10	86.17	High
Average		**88.32**	High

Based on Table 3, it can be seen that the highest percentage for the observing indicator is statement number 9, with 91.28%, while the lowest percentage is for statement number 4, at 85.00%. Overall, the average percentage for the observing indicator is 88.32%, which falls into the high category. Among the students, 84 are classified in the high category for this indicator. Students in the high category are able to clarify the problems addressed through practical activities by explaining all the objectives of the practical session. This indicator can be further optimized within the open inquiry model at the inquiry stage, where students create various objectives that will then be investigated through scientific statements. Students are able to correctly list the tools and materials and understand in detail the function of the tools and materials to be used. The skill of using tools and materials is crucial for students during practical sessions, as this skill significantly affects the results of the practical work. This can be achieved through direct experience and connecting it with concepts learned during observation (Darmaji et al., 2018).

This is demonstrated by one of the objectives of the practical session in the Melde experiment, where students have several goals for their practical work, including determining the wave speed. Variations in mass and types of strings are tested, and the relationship between wave speed and the string is studied. For example, the objectives of the Melde experiment are to determine the wave speed, measure the wavelength, and study the relationship between wave speed (v) and string tension (F). Variations in mass and string type are used to observe wave speed and wavelength and to study the relationship between wave speed and the string. The tools and materials used include a board or table, sewing thread, fishing line, mattress string, pulleys, weights with three different variations, a power supply, a vibrator, a ruler, red connecting cables, and black connecting cables. The observing skills demonstrated by students include writing each objective of the practical session, detailing each observation object, understanding the function of tools and materials, and effectively using the tools and materials during the practical work. Each step of the practical session is described in statement form. Students mentioned that "To make things clearer, I usually add a diagram showing how to use the equipment." Research by Laela (2016) also shows that observation has a significant impact on improving SPS.

2) Classification Indicator

The indicator for interpreting (interpretation) involves connecting results from observations and finding patterns within a series of observations (Rustaman, 2007). The SPS for the interpreting indicator consist of one component of the practical framework: "Theoretical Basis." The theoretical basis is used to explain the theory itself or to assist in analysis within a research study. The theoretical basis component applies an indicator such as investigating the sources of references for each citation used in the theoretical basis. The theoretical basis is organized to provide a logical and systematic framework so that researchers can develop hypotheses from the conducted study (Qotrun, 2021). The framework for "Theoretical Basis" is covered in statements 11, 12, 13, 14, 15, 16, and 17. The average SPS for the interpreting indicator per statement can be seen in Table 4.

Table 4. Average SPS for the Interpreting Indicator Statement Item

Report Outline	Statement Number	Percentage (%)	Category
Theoretical Basis	11	84.26	High
	12	72.98	High
	13	76.81	High
	14	83.40	High
	15	86.96	High
	16	72.55	High
	17	89.57	High
Average		**80.79**	High

Based on Table 4, it can be seen that the highest percentage for the interpreting indicator is statement number 17, at 89.57%, while the lowest percentage is for statement number 16, at 72.55%. Overall, this indicator falls into the high category based on the number of students. Students with high SPS show the ability to gather data or information for the "method of practical implementation," ensuring that the practical work is carried out accurately. The indicator used is explaining the method in detail. Designing an experiment is a pattern or procedure used to collect or obtain data in research.

Students are able to define a term, complete with a definition from a reference source. They can explain the definition of a term descriptively, with examples and background. An experiment observing diffraction patterns and determining the feather density from various habitats is conducted. Diffraction is described as the spreading of waves due to an obstacle. The smaller the obstacle, the greater the wave spreading. The obstacle can be a screen with a small slit that allows a small portion of the wavefront to pass through. It can also be a small object, such as a wire or disc (Halliday, 2005). According to Serway (2009), the result of diffraction is bright and dark fringes, similar to the interference patterns shown in the figures.

3) Prediction Indicators

The predicting indicator involves making forecasts about what can later be observed. Prediction can be defined as anticipating or making forecasts about future events based on patterns, trends, or relationships between facts, concepts, and principles in science. The SPS for the predicting indicator are found in statements 18 and 19. Predicting functions to enable a person to make forecasts or predictions based on observations, measurements, or research that show tendencies of certain phenomena. Students predict what might happen during the practical session in situations that have not yet been observed. The average SPS for the predicting indicator can be seen in Table 5.

Table 5. Average SPS for the Predicting Indicator Statement Item

Report Outline	Statement Number	Percentage (%)	Category
Prediction	18	80.64	High
	19	80.85	High
Average		**80.74**	**High**

Based on Table 5, it can be observed that the highest percentage for the forecasting indicator is found in statement number 19, with 80.85%, while the lowest percentage is in statement number 18, with 80.64%. Overall, the average percentage for the forecasting indicator is 80.74%, which falls into the high category. Additionally, considering the total number of 94 students, this indicator is also categorized as high.

Students articulate what might occur in unobserved conditions using their own reasoning and restate the underlying physical laws guiding the practical work with their own words. Students categorized as high are able to predict what might happen in unobserved conditions using their own reasoning and are also capable of connecting patterns to draw relevant conclusions. In contrast, students categorized as moderate still struggle to connect these patterns and do not always draw relevant conclusions. These students explain a physical term based only on their understanding of the issue at hand. For example, in the case of a string wave, they might say: "To observe mechanical waves on a skipping rope, you can tie one end of the rope to an object. You can hold the other end and move it up and down to create crests and troughs. This process can generate longitudinal mechanical waves." This discussion lacks cited sources.

4) Communicating Indicator

The communicating indicator involves the ability to convey one's findings to others, both verbally and in writing. This can include preparing reports, diagrams, charts, tables, and more. SPS for the communicating indicator consist of one component of the practical framework, which is "Observation Data." Observation data in the preparation of practical reports serves to explain the results of observations according to what was obtained during the experiment. The framework for observation data is found in statements 20, 21, 22, and 23. The average SPS for the communicating indicator per statement can be seen in Table 6.

Table 6. Average SPS for the Communicating Indicator Statement Item

Report Outline	Statement Number	Percentage (%)	Category
Observation Data	20	87.44	High
	21	90.42	High
	22	91.70	High
	23	86.38	High
Average		**88.98**	High

Based on Table 6, it can be seen that the highest percentage for the communicating indicator is statement number 22 of 91.70%, while the lowest percentage is for statement number 23 of 86.38%. Overall, the average percentage for the communicating indicator is 88.98%, which falls into the high category. Additionally, out of the 94 students, those assessed in this indicator are also categorized as high.

Students categorized as high are able to evaluate the data obtained by recording the data collected during the practical work and describing all variables used during the experiment. High communication skills include students who ask questions clearly, are able to describe all variables used during the preparation of the practical report, are confident, and do not deviate from the discussed content. Conversely, students categorized as low have not yet been able to describe the variables used during the practical work, have difficulty linking data to the objectives of the experiment, and so on.

For example, the observation data from the experiment on analyzing interference patterns in a Michelson interferometer to determine the refractive index of transparent materials based on the relationship between refractive index and wavelength, where the experiment was conducted by varying the number of fringes. Fringes are patterns of alternating dark and light rings. The Michelson interferometer can measure the wavelength of the He-Ne laser used. From this experiment, the theoretical wavelength for the He-Ne laser is 629 x 10^-9 meters, while the practical wavelength is (622 ± 33) x 10^-9 meters. The refractive index of the glass was found to be (1.12 ± 0.0043).

5) Hypothesis Indicator

Hypotheses are temporary answers to the formulation of assessment problems (Sugiyono, 2020). Hypothesizing is very important in learning science and is related to variables. While prediction is a process that uses observation or data in alignment with scientific knowledge to forecast future events, hypothesizing involves explaining by manipulating one variable to see if it affects another variable.

The hypothesis indicator includes one component of the practical framework: " Analysis Report". Analysis Report helps in making recommendations based on the analysis already conducted and supports decision-making based on the data obtained. The framework for reporting data analysis is outlined in statements numbered 24, 25, 26, 27, 28, and 29. The average SPS for each statement in the hypothesizing indicator can be seen in Table 7.

Table 7: Average SPS for Hypothetical Indicators Individual Statement Item

Report Outline	Statement Number	Percentage (%)	Category
Analysis report	24	73.40	High
	25	73.19	High
	26	72.76	High
	27	72.34	High
	28	73.40	High
	29	77.23	High
Average		**73.72**	High

Table 7 shows that the highest percentage for the hypothesis indicator is found in statement number 29 at 77.23%, while the lowest percentage is in statement number 27 at 72.34%. Overall, the average percentage for the hypothesis indicator is 73.72%, which falls into the high category. The number of students for this indicator is 94, also categorized as high. The analysis indicates that students have demonstrated a high level of ability in hypothesis formulation. This high capability is evident in their detailed data explanations, such as recording every data change, using units consistently, organizing observational data according to objectives, repeating data collection, and using average values obtained during practical work. A high category indicates that students understand there are multiple possible explanations for a practical activity and recognize that any explanation needs to be tested for validity with relevant evidence.

In the experiment titled "The Effect of Glass Shape on the Index of Refraction and Critical Angle in Light Refraction Experiments," the data and calculations obtained demonstrate Snell's Law, which states that in the phenomenon of light refraction, the ratio of the sine of the angle of incidence to the sine of the angle of refraction is constant. This is because the refractive index obtained from the experiment is relatively constant or the values are close to each other. The refractive index itself can be understood as the ratio of the angle of incidence to the angle of refraction. However, the relative errors observed in the experiment can be attributed to factors such as the practitioner's lack of precision in determining the angle of refraction, inaccuracies in positioning the incident light, and other factors.

6) Indicators of Applying Concepts

The ability to apply concepts involves practicing a theory, method, or other elements used to achieve a specific goal. SPS for this indicator consists of 1 component in the practical framework, namely "Discussion". In the preparation of a practical report, the Discussion section is used to present an analysis and review of the research results aimed at drawing conclusions to meet the research objectives. The Discussion is intended to provide a sharper picture of the findings, so that the researcher not only reiterates the data but also provides analysis, interpretation, and meaning of the findings. The framework for the Discussion in the report includes items 30, 31, 32, 33, 34, 35, and 36. The average KPS for the concept application indicator per statement can be seen in Table 8.

Table 8. Average SPS for the Concept Application Indicator Statement Item

Report Outline	Statement Number	Percentage (%)	Category
Applying concepts	30	79.15	High
	31	80.21	High
	32	77.66	High
	33	74.89	High
	34	77.02	High
	35	82.34	High
	36	80.85	High
Average		**78.88**	High

Based on Table 8, it can be seen that the highest percentage for the concept application indicator is statement number 35, with 82.76%, while the lowest percentage is for statement number 33, with 74.89%. Overall, the average percentage for the concept application indicator is 78.88%, which falls into the high category. Students in the high category are able to compare in detail between supporting data and the results of the practical implementation, and they complete the discussion by explaining the data obtained from the supporting data. In the discussion section, students describe in detail the challenges encountered during the practical work and use a variety of sentence structures: simple, complex, active, and passive. Students are trained to write the results of the discussion in accordance with the practical work carried out, where the obtained data is described in detail in the discussion.

The discussion component applies two indicators: comparing practical results with other supporting data and explaining the comparison between the two. The students' ability in this component is categorized as high, as they are able to compare in detail between supporting data and the results of the practical implementation. Additionally, students describe in detail the challenges encountered during the practical work. During discussions, students are able to express their opinions with group members and other students, which facilitates two-way communication and makes the learning process more effective.

Different levels of ability can be seen in students' ability to generate arguments. This ability can be interpreted as the difficulty in finding the main ideas in each paragraph. In the experiment using the Melde method to determine the tension in the string, the formula $T = m \cdot g$ was used, at a load mass of 10 grams the resulting tension in the string was 0.098 N. When the load increased to 20 grams, the tension in the string became 0.196 N, and when the load increased to 30 grams, the tension in the string was 0.294 N.

7) Summarizing Indicator

Summarizing skill the preparation of a practical report involves the ability to make decisions about the state of an object or event based on known facts, concepts, and principles. This activity aims to summarize the results of the experiment based on the patterns of relationships between different observations. Drawing conclusions is considered successful if it includes three indicators: drawing conclusions from specific to general, and being able to formulate decisions that will be evaluated based on those decisions (Rahmawati et al., 2016). The ability to draw conclusions is applied to four components of the practical work: equipment and materials, observational data, discussion, and analysis reports, in order to obtain accurate conclusions based on the conducted experiment. The conclusions drawn must be justified by including logic as a review of the obtained results.

The SPS for the conclusion indicator consists of two components in the practical framework: the "Conclusion" section and the "References" section. The "Conclusion" section includes statements 37, 38, 39, 40, and 41, while the "References" section includes statements 42, 43, 44, and 45. The average SPS for the conclusion indicator can be seen in Table 9.

Table 9. Average SPS for the Conclusion Indicator Statement item

Report Outline	Statement Number	Percentage (%)	Category
Conclusion	37	87.87	High
	38	89.79	High
	39	89.36	High
	40	86.17	High
	41	85.74	High
References	42	86.59	High
	43	85.95	High
	44	87.23	High
	45	87.02	High
Average		**87.30**	High

Table 9 shows that the highest percentage for the conclusion indicator is statement number 39, with 89.36%, while the lowest percentage is for statement number 40, with 86.17%. Overall, the average percentage for the conclusion indicator is 87.30%, which falls into the high category. Additionally, 94 students fall into this high category for this indicator. Students in the high category are capable of writing conclusions about the practical work that align with the theoretical basis and objectives of the practical work

The implementation of future practical work, students should write suggestions and express conclusions in their own words. For example, a conclusion from the practical experiment on "coupled oscillations" could be based on the analysis of relative errors, precision, deviations, and accuracy, it is found that the experimentally obtained spring constant value closely approaches the theoretical value of the spring constant. However, there are still significant relative errors and deviations due to frictional forces with the surrounding air (although very small). The spring constants measured in vertical and horizontal positions also differ. This difference arises because, in the vertical position, the spring stretches when a weight is hung from it, and then it finds its equilibrium before oscillation can occur. In contrast, in the horizontal position, both ends of the spring must be stretched until equilibrium is achieved, and the setup is lifted about 10 cm above the surface to allow oscillation. The presence of gravitational forces on each setup and potential errors or inaccuracies in the data are influenced by the equilibrium of the spring.

Students categorized as moderate in improving the implementation of the practicum continued only "sometimes" in writing suggestions. Students evaluate the writing of reference sources used, by adjusting between reference sources (in the theoretical basis and discussion), examining which ones are suitable for use or not in the article references used. The bibliography used is in accordance with the provisions and national/international indexed articles as references. But the student can write the references used for the practicum report in accordance with the provisions, where it is stated that the references used must be in accordance with APAstyle. One of the things that causes students to be in the low category is that students are unable to write practical conclusions based on the objectives of the practicum. The resulting conclusions must be justified by including logic as a review of the results obtained. Students in the medium and low categories are mostly not careful in choosing reference sources and do not analyze other sources that support articles supporting practicum data and evaluate the expertise of the reference book author.

Based on Table 10, it can be seen that the highest percentage for the indicator of categorizing is 88.32%, while the lowest percentage for the hypothesis indicator is 73.72%. Overall, the average percentage of SPS for the preparation of the wave practical report is 81.92%, which falls into the high category. Additionally, among the students, 94 are categorized as high. This is consistent with the research conducted by Ogan et al. (2014), which found that inquiry can enhance students' SPS skills without altering their conceptual knowledge if they are already familiar with the content.

Table 10. Overall Percentage of SPS for the Preparation of the Practical Report

No	Indicator	Average (%)	Category
1	Classification	88.32	High
2	Interpretation	80.79	High
3	Prediction	80.74	High
4	Communicating	83.77	High
5	Hypothesis	73.72	High
6	Applying concepts	78.88	High
7	Summarizing	87.24	High
	Average	**81.92**	High

The research conducted by Sulistiyono (2020) on the effectiveness of the guided inquiry learning model to improve SPS in calorimetry indicates that the completeness of the SPS indicators and learning outcomes, with n-gain values of 0.87 and 0.64 respectively, are categorized as high and moderate. This shows that the guided inquiry model is highly effective in enhancing SPS. Several points that educators need to consider when implementing this learning model include preparing and managing time effectively to ensure that the learning process is both efficient and effective.

CONCLUSION

The SPS in the preparation of the wave practical report for UNNES second semester students are categorized as high, with an average of 81.92% across all indicators. Students have met the required SPS syntax and have the potential to further develop their SPS in the preparation of practical reports.

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