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Analysis of Science Process Skills to Application of Module Practicum Ethno-STEM for Senior High School

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Abstract

Science process skills are essential for 21st century learning. The science process skills of senior high school students in many cities are still relatively low. The purpose of the research is to analyze science process skills that involve the environment or culture around students as a learning medium using the Ethno-STEM practicum module. The method used was quasi-experimental with a one-group pretest-posttest design. The research subjects were selected from Islamic Senior High School 2 Semarang, totaling 108 students. The sampling technique employed was purposive sampling. Data collection was in the form of observation, science process skills, and posttest. Data analysis used a validity test, reliability test, and N-gain test. The research results show an analysis of each indicator of science process skills for each practicum, and there is an increase in learning outcomes. Evidenced analysis of the results of each indicator of science process skills obtained 70.29% (observation), 58.49% (interpretation), 53.86% (hypothesizing), 75.62% (experimentation), 75.15% (collaboration), and 62.50% communication. Meanwhile, the results of studying the N-Gain test, which obtained a value of 0.7 in the high category.

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INTRODUCTION

The 2013 curriculum aims to produce resource capabilities high quality human resources. This capability is expected to enable students to compete in the 21st century and the Industry 4.0 era of globalization (Rochman & Hartoyo, 2018). The ability of students to be able to compete in the 21st century is a demands and challenges for education which has led to changes in the educational learning patterns in Indonesia (Lepiyanto, 2017). To address these demands, education is designed to enhance high-quality performance through the learning process. This indicates that besides mastering theories, laws, principles, and physics concepts, students are also expected to comprehend and apply concepts, possess analytical skills, and engage in scientific processes (Elnada *et al.*, 2016). Therefore, the curriculum of 2013 emphasizes not only cognitive aspects but also incorporates skill-assessment in the learning process.

Learning physics is not solely about content requires practical application, as evidenced by studies Shana & Abulibdeh (2020) and Bhakti *et al.*, (2020). Physics education is not merely knowledge transfer; it facilitates students in honing skills, building their cognitive abilities, and fostering positive attitudes (Lestari & Diana, 2018). Students can do science process skills by doing practicum or experiments. The essence of practical activities lies in discovering or proving learned theories, where students indirectly engage in scientific behavior.

The process of carrying out activities related to science activities is commonly called Science Process Skills (SPS). To develop the SPS, it needs to be known and analyzed in advance the profile of science process skills of learners to determine the initial state SPS (Lestari & Diana, 2018). The SPS can be trained and built through practicum (Wati *et al.*, 2018; Lee *et al.*, 2020). This is in accordance with Nuryani's opinion in Suryaningsih (2017) research that practicum is the best means to develop science process skills, because in practicum students are trained to develop all their senses. Basically in practicum activities, science process skills are obtained by observing, interpreting data, forecasting, using tools and materials, planning practicum, communicating practicum results and asking questions.

Surveys conducted at Islamic Senior High School 2 Semarang investigated the use of learning media during practical activities. Findings indicated that much of the learning process remains teacher-centered, limiting student development, including the capacity for self-directed learning. The dominant teacher-centered approach often emphasizes rote memorization over encouraging students' curiosity in laboratory or real-world environments (Sudarmin *et al.*, 2019). Limited time during post-pandemic learning makes teachers carry out simple practical activities or demonstrations.

The results of research conducted by Yolanda (2022) stated that students' SPS in optical instruments has not yet appeared so they need to be trained with the SPS approach. The weaknesses of SPS in students can be a basic foundation for students to prepare potential skills by developing scientific process skills in seeking knowledge and obtaining scientific truth.

Current education trends emphasize STEM for its global relevance and alignment with 21st-century technological perspectives (Shernoff *et al.*, 2017). The STEM approach, integrating Science, Technology, Engineering, and Mathematics, is essential to global education, with various models and methods applied worldwide, particularly in Asia (Wahono *et al.*, 2020). Integrating STEM with ethnoscience leads to etno-STEM, focusing on culturally-rooted interdisciplinary learning (Priyani & Nawawi, 2020). This approach harnesses students' collaborative abilities to explore scientific concepts within their environment (Risdianto *et al.*, 2020; Azis & Yulkifli, 2021). Etno-STEM aims to connect indigenous culture with scientific learning, fostering problem-solving, logical thinking, and cultural understanding in students. Ethno-STEM is culture based STEM or local wisdom approach that aims to incorporate local culture into the STEM learning process.

Based on the description above, the aspects that need to be emphasized in students during physics learning is science process skills related to the topic of optical instruments. This aspect is crucial as it supports the development of students as learners who can construct meaningful knowledge through hand on activities. Practicum work that involves objects from the surrounding environment is essential for fostering SPS. This study is needed to analyze science process skills through the application of the Ethno-STEM practical module to high school students which is measured using predetermined standard indicators.

METHODS

This study uses a quantitative approach with experimental methods and quasi-experimental design. The type of quasi-experimental design used is one group pretest and posttest. The data form is the form of an observation sheet and an essay test, both in written form. Data collection uses observation sheet, tests and documentation.

This research was conducted in Semarang on August 17-29, 2023. As for the subjects in this study are students of Class XII majoring in science from schools MAN 2 Semarang who have obtained material optical instruments. The sampling technique used purposive sampling : XII MIPA 1, XII MIPA 2 and XII MIPA 3. The initial problem test and operational field test were conducted in two different schools. Test questions conducted in MA Al-Ishlah Lamongan with a total of 28 students. Operational field test was conducted in MAN 2 Semarang with 108 students.

The research was conducated using validation of observation sheet of SPS with 6 indicators. The data analysis used in this study includes test and non-test. Data analyzed using non-test data analysis techniques is data obtained from the observation sheet. Data processing for tes and non test uses the help microsoft excel software. Initial test trials are conducted to obtain valid questions. The percentage of SPS ability using the score obtained from the observation sheet of students using:

$$P = \frac{f}{n} \times 100\% \quad (2)$$

The SPS index according to Fitriana et al. (2019) can be seen in Table 1.

Table 1. Percentage Analysis of SPS

Achievement level (%)	Qualification
$80 < P \leq 100$	Highly Feasible
$60 < P \leq 80$	Feasible
$50 < P \leq 60$	Less Feasible
$P \leq 50$	Not Feasible

The pretest and posttest scores were compared in order to determine the improvement in student learning outcomes. The gain test is a formula for comparing pretest and posttest results**.** The gain test formula can be seen as

$$g = \frac{(\%<S_f> - \%<S_i>)}{(100 - \%<S_i>)} \quad (3)$$

There are three level criteria in the gain calculation, can be see in Table 2.

Table 2. Normalized Gain Rate

Normalized Gain	Qualification
(g) < 0.3	Low
0.3≤(g)≤0.7	Medium
(g) >0.7	High

RESULTS AND DISCUSSION

SPS measurement is carried out by the observer by filling in the SPS observation sheet. Each observer assesses one practicum group. On the observation sheet there is a scoring scheme to analyze and assess students SPS, so that it can make it easier for observers to include values to obtain an objective assessment. The Observer accompanies and assesses the students during the practicum starting from the beginning of the activity until the exposure of the practicum results by the group of students. The results of the analysis of SPS observation sheet are stated in Table 3.

Table 3. The Average Results of each Observation Sheet Practicum

Practicum	Mean (%)	Categories
I	40.74	Less Feasible
II	68.86	Feasible
II	88.35	Highly Feasible

Based on the results of the analysis in Table 3 obtained science process skills of students the results of the first practicum get an average percentage of 40.74 %, in the second practicum obtained an average of 68%, and in the practicum obtained an average percentage of 88.35%. The results of the first practicum to the third practicum can be seen there is an increase. Skills will only be mastered by students if the students do the practice or practice repeatedly (Sinulingga *et al.*, 2015).

Then the observation results of SPS three times practicum analyzed each aspect of SPS. Indicators of science process skills used there are 6 aspects, namely observing, interpretation, hypothesizing, experimenting, collaborating and communicating. The results of the analysis of each aspect of SPS can be seen in Table 4.

Table 4. The results of the analysis of indicator SPS

Aspect SPS	Score (%)
Observation	70.29
Interpretation	58.49
Hypothesized	53.86
Experiment	75.62
Collaborate	75.15
Communicate	62.50

After knowing there is an increase in practicum, further analysis is carried out to find out each aspect. In the analysis of each indicator obtained observation skills of 70.29%, interpretation skills of 58.49%, hypothesizing skills of 53.86%, experimental skills of 75.62%, collaboration skills of 75.15% and communication skills of 62.50%. Based on Table 4, it can be said that the one with the highest average score value is in the indicator experiment with a percentage value of 75.62%. The lowest indicator value is in the hypothesis and the percentage of indicators is 53.86%. In line with reseach Ahmadi *et al.*, (2019) this study said if no experiment is done then at least an increase in learning outcomes. Involving aspects of local culture by combining local wisdom, science, technology, engineering and mathematics can help train students' science process skills.

The explanation for the indicator that obtained the highest average is evidenced by the involvement of learners in data retrieval, preparing tools and materials that have been brought. The low percentage of hypothesis indicators is caused because many learners do not answer the hypothesis column. SPS assessment based on observation sheet conducted to determine the ability of students in the practical activities of optical devices, how students are able to perform the stages of practice well, able to obtain data from the tools and materials provided, how students are able to process data to draw conclusions from the activities undertaken.

In addition to using observation sheets, SPS is also followed by essay writing test questions. Essay writing test questions have been prepared in accordance with SPS indicators. The number of questions done by students is 6 questions with a time of 45 minutes. Work on essay questions by students is done after class hours are complete. The results of post-test scores of SPS students if analyzed are presented in Table 5.

Table 5. Result Posttest SPS

No Question	Mean	Result (%)	Categories
1	3.86	96.53	Highly Feasible
2	3.31	82.87	Highly Feasible
3	3.45	86.34	Highly Feasible
4	3.66	91.44	Highly Feasible
5	3.5	87.50	Highly Feasible
6	2.97	74.31	Feasible
Mean		86.50	Highly Feasible

For the pretest value obtained from the results of daily tests. Based on the value of posttest and pretest analysis to determine there is an increase in the field of SPS. The analysis is done by calculating the value of N-Gain. Using the equation 3 obtained information that after doing practicum average value of posttest learners have increased. The increase in the value is calculated using the N-gain Test equation to obtain a score of 0.7 with a high category. Result can see in Table 6.

Table 6. N-Gain Test Result

Class	N-Gain	Qualification
XII MIPA 1	0.75	High
XII MIPA 2	0.72	High
XII MIPA 3	0.61	Medium
Average	0.7	High

There is an increase in the value of students through the N-Gain test shows that the research conducted is able to have an influence on the ability of students ' skills, especially SPS. It can be concluded that the application of ethno-STEM practicum module in optical instrument-style practicum activities can make learners more active in building their skills.

CONCLUSION

The research results on students' science process skills when using the Ethno-STEM module showed that each indicator obtained the following percentages: 70.29% for observation, 58.49% for interpretation, 53.86% for hypothesis, 75.62% for experimentation, 75.15% for collaboration, and 62.50% for communication. The learning outcomes were categorized as high based on test results. The n-gain test results obtained a score of 0.7, indicating a high category. The application of the Ethno-STEM practical module in optical instrument experiments enables students to be more active in developing their skills.

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