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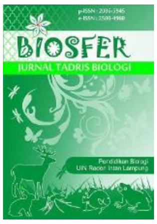

The Effect of Scientific-Based Practicum Methods on Environmental Pollution Materials on Students' Science Process Skills

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ABSTRACT

This study aims to determine the influence of scientific-based practicum methods on environmental pollution materials on students' science process skills. This research employed a quantitative method with a quasi-experimental research design. This research was carried out from January to June 2024. The sampling technique employed was simple random sampling, obtaining 60 students divided into experimental and control classes. From the results of the pretest, the initial science process skills of students in both classes were high. Furthermore, the posttest results showed that there was an increase in science process skills, which was very high. The results of the independent sample t-test on the gain score data showed that the scientific-based practicum method on environmental pollution materials affected the students' science process skills. Based on the value of n gain in the experimental class, the effect is categorized as moderate. Thus, the practicum method with a scientific approach to environmental pollution materials can be used as an alternative solution to overcome the low skills of students' science processes.

Pengaruh Metode Praktikum Berbasis Saintifik pada Materi Pencemaran Lingkungan terhadap Keterampilan Proses Sains Peserta Didik

ABSTRAK: *Penelitian ini bertujuan untuk mengetahui pengaruh metode praktikum berbasis saintifik pada materi pencemaran lingkungan terhadap keterampilan proses sains peserta didik. Penelitian ini berjenis kuantitatif dengan metode penelitian kuasi eksperimen. Penelitian ini dilaksanakan pada Januari – Juni 2024. Pengambilan sampel secara simple random sampling memperoleh 60 peserta didik yang terbagi dalam kelas eksperimen dan kelas kontrol. Dari hasil pretest, keterampilan proses sains awal peserta didik di kedua kelas termasuk tinggi, lalu hasil posttest menunjukkan adanya peningkatan keterampilan proses sains menjadi sangat tinggi. Hasil uji t-independen pada data gain score menunjukkan bahwa metode praktikum berbasis saintifik pada materi pencemaran lingkungan berpengaruh terhadap keterampilan proses sains peserta didik. Berdasarkan nilai n gain pada kelas eksperimen, pengaruh tersebut berkategori sedang. Dengan demikian, metode praktikum dengan pendekatan saintifik pada materi pencemaran lingkungan dapat dijadikan sebagai solusi alternatif untuk mengatasi rendahnya keterampilan proses sains peserta didik.*

INTRODUCTION

The learning process is a process of interaction between teachers and students towards the formation of a person's character and learning to create an atmosphere for students to learn, both in mastery of the material and skills in the learning process (Lestari et al., 2022);(Juniarti et al., 2024). One of the important subjects in education is Biology, which aims to develop students' science process skills (Fahmi et al., 2021). The lack of student involvement in learning results in poor students' science process skills. Astalini et al. (2023) state that the students' science process skills in Indonesia are in a low category because many schools are not aware of the importance of applying them during the learning process.

According to Sutiani et al. (2021), the science process skills contain components of observing, classifying, interpreting, predicting, applying, planning, and communicating. Science process skills are an inseparable part of improving the quality of the learning process and outcomes (Kriswantoro et al., 2021). Sari et al. (2021) argue that science process skills will make it easier for students to solve problems logically and rationally and can improve the ability to analyze information and the truth of a statement that is useful in daily life.

However, many teachers do not pay attention to the development of science process skills in learning and only focus on providing concept materials. Improving students' science process skills will increase their activeness in the learning process (Kamid et al., 2022). Active learning is a student activity that supports their success. It is an effort by students to develop their potential through a series of learning activities to achieve learning goals.

Teachers are not only required to master the material in the curriculum. Still, they must also have the ability to manage quality learning to present interesting, creative, and fun learning for students (Feiyue, 2022). From the results of the teacher's initial observation, many obstacles present in teaching biology. In learning activities, the teacher does not pay attention to the process, both at the beginning of learning and during the learning process. Still, the teacher immediately asks for the material and continues with the new material. The learning method carried out is still dominant in the lecture method, where the teacher talks more informative facts or concepts from the material so that students are not actively involved in learning. Teachers rarely invite students to do practicum so that the ability and skills in the students' thinking process cannot be developed optimally (Akhmedov et al., 2024);(Feiyue, 2022).

The scientific approach is intended to provide students with an understanding of various materials. The scientific approach states that information can come from anywhere, anytime, without relying on unidirectional information from the teacher (El-Sabagh, 2021). Therefore, the expected learning conditions are directed to encourage students to find out from various sources of knowledge. According to Ichsan et al. (2023), learning a scientific approach is better than direct learning in improving biology learning outcomes and science process skills.

Scientific-based learning methods through practicum to improve science process skills are learning that integrates science process skills into an integrated material presentation system (Nugraha, 2023). This model emphasizes the process of students seeking knowledge rather than the transfer of knowledge from teachers. The application of biology learning process science skills can be integrated into students' practicum activities (Rini & Aldila, 2023). Through this strategy, student participants are actively encouraged to find and conclude the results but are still given direction by the teacher (Wola et al., 2023). Through this learning, students are expected to master concepts, increase creativity and awareness in understanding and solving real problems, and actively respond to natural phenomena in the surrounding environment. Efendi & Sartika (2021) argue that students gave positive responses to practicum-based learning and influenced the mastery of science concepts and skills. Zulyusri et al. (2023) in his research also said that learning activities with practicum can improve the abilities of high school students.

In relation to scientific learning, the impact of pollution on life is an appropriate material if taught in practicing science process skills because the material on the impact of pollution on life is a process of environmental change that has a negative impact, and it is necessary to investigate pollution. The impact of pollution and efforts to overcome it through practicum so that learning the material on the impact of pollution on life will be easier for students to understand (Amin et al., 2022);(Setiawan et al., 2021). Process skills can be trained from this practicum activity. The science process skills that will be trained include formulating problems, making hypotheses, identifying variables, interpreting experimental data, and concluding experimental results (Idris et al., 2022). Saputri et al. (2024) argue that scientific-based learning in the practicum method is not monotonous and not boring and fun and can increase motivation and learning outcomes. Therefore, the researcher wanted to find out the influence of the scientific-based practicum method on environmental pollution materials on students' science process skills.

METHOD

The research method employed was quantitative. Quantitative research sees the relationship of variables to the objects it studies. Therefore, there are independent variables and dependent variables in this type of research (Taherdoost, 2022). It further seeks the influence of the independent variable on the dependent variable. This research employed the quasi-experimental method. The reason for using this pseudo-experiment method was to find out the effect of the experiment or treatment on the characteristics of the subject to be studied (Candra et al., 2023).

The design of this research was a pretest-posttest non-equivalent control group design. In this design, a pretest instrument was administered before giving treatment. The posttest was administered after giving the treatment to find out whether or not there was an influence. The formula for the pretest-posttest non-equivalent control group design is shown in Table 1.

Table 1. The Formula of the Pretest-Posttest Non-equivalent Control Group Design

No.	Class	Pretest	Treatment	Posttest
1.	E	O_1	X	O_2
2.	C	O_3	Y	O_4

Source: (Bulus, 2021)

Information:
E : Experimental class
C : Control class
O_1 : Pretest of the experimental class
O_2 : Posttest the experimental class
X : Treatment of practicum methods with a scientific approach
Y : Treatment of case study methods with a scientific approach
O_3 : Pretest control class
O_4 : Posttest control class

This research was carried out at SMAN 36 Jakarta from January to June 2024. Simple random sampling obtained 60 students who were divided into experimental and control classes. Data was collected through tests, observation of teacher learning implementation, and documentation.

The research instrument consisted of twelve description questions. Each question item was given a score of 0 – 3, depending on the completeness and accuracy of the answer. The values obtained were then grouped based on the categorization displayed in Table 2.

Table 2. The Categorization of Science Process Skills

Value Range	Category
X ≤ 25	Poor
25 < X ≤ 42	Low
42 < X ≤ 58	Moderate
58 < X ≤ M + 75	High
X > 75	Excellent

Source: (Suswati & Subhan, 2021)

Description:
X = Grades obtained by students

The data analysis techniques included descriptive statistics and prerequisite tests in the form of normality tests (Kolmogorov-Smirnov) and homogeneity tests (Levene) in the SPSS 27 program. Then, a hypothesis test was carried out using the independent sample t-test in the SPSS 27 program, and the normalized gain value was calculated using the Hake formula.

$$\text{n-gain value} = \frac{\text{posttest scores} - \text{pretest score}}{100 - \text{pretest score}}$$

The n-gain value obtained was then categorized based on Table 3 (Wahab et al., 2021).

Table 3. Categorization of N-Gain Values

N-Gain Value	Category
g > 0,7	High
0,3 < g ≤ 0,7	Moderate
g ≤ 0,3	Low

RESULTS AND DISCUSSION

The results of science process skills were obtained from pretest and posttest. Table 4 showed that students in the experimental class and control class had almost equivalent initial science process skills.

Table 4. The Descriptive Statistics of the Pretest and Posttest

Information	Experimental Classes (Scientific-Based Practicum)		Control Classes (Scientific-Based Case Study)	
	Pre	Post	Pre	Post
Low Score	47.22	58.33	41.67	52.78
High Score	91.67	100.00	88.89	91.67
Value Range	44.45	41.67	47.22	38.89
Standard Deviation	12.81	11.68	11.78	10.06
Average	71.67	82.22	67.12	75.09
Gain Score	10.55		7.96	

Harefa et al. (2023) mentioned that the science process skills can be influenced by experience and the ability to understand a topic. These experiences and abilities can arise because of previous biology materials, namely biodiversity, classification of living things, and viruses. Teachers applied various learning methods or strategies that indirectly contribute to honing science process skills, such as observation in the school environment, window shopping, observation using a microscope, reviewing articles or news, and educational videos.

The high level of science process skills in environmental pollution material can be caused by students having knowledge and experience that they did not or unknowingly relate to environmental pollution material. Supported by the statement of Siddiqui et al. (2022) that environmental pollution material is a biological topic that is closely related to the situation in the surrounding environment. The provision of knowledge and experience can be obtained from environmental problems in the students' residences, such as floods, air pollution, drought, or environmental issues that are going viral on social media, for example, the One Day One Trash Bag movement campaign by the Pandawara Group on the TikTok platform, which is able to have a positive influence on the attitude of caring for the environment towards students who are generation Z (Swarga, 2024);(Nugroho et al., 2024).

According to Kasih et al. (2021), students are more creative in finding a concept through examples given to them, which will cause curiosity and motivation in students and enable them to be motivated independently to predict existing problems.

From the results of the posttest (Table 4), it can also be seen that students in both classes improved their science process skills with the excellent category. This result shows that the practicum method and the case study method influenced students' science process skills.

This statement is supported by Hujjatusnaini et al. (2022), who state that practicum activities involve students carrying out scientific activities that can indirectly hone their science process skills. Juniar et al. (2021) also concluded that the case study-based learning method can train students to develop scientific process skills. Case studies train students to think critically about a problem and encourage them to get used to applying the indicators of science process skills.

However, a bigger improvement was achieved by the students in the experimental class based on the gain scores. The posttest in the experimental class produced nine students with a high science process skills category (30%) and twenty-one participants with a very high category (70%). On the other hand, two students in the control class obtained the medium science process skills category (7%), thirteen students in the high category (43%), and fifteen students in the very high category (50%).

The findings showed that the application of the practicum method in the experimental class was better in increasing the value of students' science process skills than the case study method in the control class. The findings are supported by the activeness of all students when carrying out practicum. In addition, the evenly divided tasks for each group member rewarded them with excellent results. Khannatus et al. (2022) argue that students in the experimental class can work together. They gain equal experience and knowledge at the end of learning and can answer the posttest better than the pretest.

The above statements are reinforced by Hidayati et al. (2023) and Rini & Aldila (2023), who stated that practicum is an important element in science that is closely related to the development of science process skills. The students are directly involved in the use of tools and materials in the laboratory. They are guided to work in accordance with scientific procedures in order to be able to answer the problems raised in the students' worksheets appropriately according to the observation process.

In the control class, there was a group that lacked the initiative to divide tasks and find answers to questions presented in student worksheets. Therefore, they did not play an active role in carrying out case studies. Also, some students only focused on the tasks given to them. As a result, these students lacked the same knowledge and experience as active students. Then, there was a group that was incorrectly associating the answer with an example of a case picture.

According to Helo & Hao (2022)), the case study method is a presentation of learning that utilizes real cases and involves various sources of information to be discussed together in order to obtain solutions to problems that arise from the case and be able to take lessons from these problems.

However, some students in the control class were not active in seeking information, discussing, and miscommunication during the implementation of case studies (Pondalos et al., 2022). This issue caused the posttest score in the control class to be lower than that of the experimental class.

Table 5 shows that the control class, on the indicator of evaluating and reflecting, obtained an n-gain value of 0.00 with an average pretest-posttest score of 85.56. These findings show that the indicator has not improved. However, with this average score, evaluating and reflecting indicators in the control class was in the excellent category. As referred to by Erlangga (2022), every student has indicators of science process skills in themselves, and the learning process plays an important role in training and exploring these indicators. Therefore, students can apply them in their daily lives.

Table 5. Assessment Results of Science Process Skills Indicators

Indicator	Experimental Class (Scientific-Based Practicum)			Control Classes (Scientifically Based Case Study)		
	Pretest	Posttest	N-Gain	Pretest	Posttest	N-Gain
Observe	82.78	90.56	0.45	77.78	85.56	0.35
Questioning and predicting	73.89	80.56	0.26	61.11	70.00	0.23
Planning and conducting investigations	65.00	78.33	0.38	63.89	72.22	0.23
Processing and analyzing data and information	42.78	56.67	0.24	38.33	47.78	0.15
Evaluate and reflect	85.56	96.67	0.77	85.56	85.56	0.00
Communicating results	80.00	90.56	0.53	76.11	89.44	0.56

The indicators of successive science process skills, ranked from highest to lowest based on the posttest scores in the experimental class, are evaluating and reflecting, communicating results, observing, questioning and predicting, planning and conducting investigations, and processing and analyzing data and information. In contrast, the indicators in the control class are communicating results, observing, evaluating and reflecting, planning and conducting investigations, questioning and predicting, and processing and analyzing data and information. Alam & Mohanty (2023) argue that the differences in scores can occur because the abilities possessed by each student are different from each other, so the posttest scores on each indicator will also be different.

The processing and analyzing data and information indicator had the lowest score in both classes with the moderate category. Thus, this indicator must be stimulated and improved again so that students can gain broader knowledge and experience, especially in understanding the data presented. According to Gardenia et al. (2021), the low indicator occurs because students are not used to being taught how to read and analyze tables and graphs.

Both learning methods used a scientific approach with a syntax consisting of five components. These components include observing, questioning, gathering information, reasoning, and communicating (Supena et al., 2021). According to Cooper (2023), a scientific approach makes the learning process more memorable and meaningful because students can independently acquire new knowledge and information that comes from anywhere without relying on teachers.

Students in the experimental class achieved the observing component through the introduction of practicum tools and materials, reading the practicum guide, and observing practicum objects. At the same time, in the control class, the observation component was seen when students in the group looked at three sample images of randomly taken cases. In this component, the observing indicator improved.

The questioning component in the two classes was achieved through the provision of questions by teachers and the student worksheet. In this component, the skills of the science process that were stimulated were questioning and predicting. Furthermore, the component of collecting information was achieved when students started practicum activities and case studies.

These activities could hone indicators of planning and conducting investigations.

The reasoning component was achieved when students filled out student worksheets after observing, discussing, reading books, and browsing the internet. At this stage, the indicators that were honed were processing and analyzing data and information**.** Finally, the communicating component was achieved when students in the group presented student worksheets and did the question-and-answer sessions. During these activities, the indicators that were honed were communicating, evaluating, and reflecting.

The average learning implementation by teachers in the experimental class was 100%, while in the control class was 94.44%. These results showed that the practicum method and case study method guided by a scientific approach were achieved splendidly. Rini & Aldila (2023) argue that the observation results in the control class were lower due to the dominance of the group that had not finished conducting the case study. Therefore, the teacher could not ask the students to conclude. Furthermore, the classroom atmosphere was no longer conducive to asking students to express their reflections because they were busy discussing.

Saimon et al. (2023) state that there is a very close relationship between the implementation of the approach in learning and the skills of the science process. Doyan et al. (2020) add that a scientific approach can be used to help students develop indicators of science process skills. Zulyusri et al. (2023) also agree that a scientific approach is a solution to overcome students' low science process skills because the five components contained in the scientific approach have the same meaning and purpose as the indicators of the science process skills.

This study aims to determine the influence of scientific-based practicum methods on environmental pollution materials on students' science process skills. Based on the results of the prerequisite tests, pretest, posttest, and gain score data in the experimental class and control class, a significance value of 0.17 > 0.05 has been obtained. Thus, the data can be declared to be normally distributed and homogeneous. Based on the independent sample t-test, the significance value (2-tailed) in the gain score data was 0.019 < 0.05. This means that the scientific-based practicum method on environmental pollution material has a significant influence on students' science process skills. The experimental class obtained an n-gain value of 0.42 with a moderate category level. This result shows that students understood the steps in conducting investigations during practicum with their groups. They dared to communicate various information they knew.

The results of the study show that the practicum learning method with a scientific approach can be used by teachers as an alternative method in learning activities to develop students' science process skills, especially in environmental pollution materials. Teachers need preparation to develop science process skills. Teachers analyze materials that are in accordance with the chosen learning model. The next activity is for the teacher to design the learning that will be carried out. This idea is in line with Korucu-Kış (2021) that practicum learning with a scientific approach is effectively used to prepare future teachers to design and regulate a learning environment that can develop science process skills.

Although the results of this study show that the practicum learning method with a scientific approach has succeeded in having a positive impact on developing science process skills, several limitations need to be noted. First, the number of students (60 students from one school) limited the generalization of the results to a broader context. In addition, the study has not considered other factors that may affect science process skills, such as educational background, previous experience in learning, and social conditions. These limitations may affect the interpretation of the results and make it difficult to draw more general conclusions. Therefore, further research with a larger and more diverse sample is essential to reinforce these findings and explore other factors that contribute to the improvement of science process skills.

CONCLUSIONS AND SUGGESTIONS

Based on the results of the study, the completeness of students' science process skills has increased from the average pretest score of 71.67 to 82.22 in the posttest. Based on the normality test of the pretest value (0.17 > 0.05), the data can be declared normally distributed and homogeneous. The t-test obtained a significance value (2-tailed) of 0.019 < 0.05 with an n-gain score of 0.42. therefore, the science process skills increased to the medium category. The results state that the practicum learning method with a scientific approach can develop students' science process skills.

The results of this study produce several recommendations. First, it is suggested that further research involve a larger sample and cover a wide range of schools to obtain more general and representative results. In addition, future research may explore other factors that may play a role in improving students' science process skills, such as learning styles and educational backgrounds. Second, teachers need to continue to improve learning methods so that the learning process becomes better. There is a need for collaboration between teachers and practitioners to create learning resources that support practicum learning with a scientific approach so that students' science process skills can continue to be improved continuously.

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