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The Implementation of Practicum Method as a Strategy to Strengthen Science Process Skills at Secondary School Level

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Science process skills are an important aspect in science learning and play a role in training students' scientific thinking skills. However, facts in the field show that students still have difficulties in making systematic observations, formulating hypotheses, designing and conducting experiments, and interpreting data appropriately. This condition is exacerbated by the lack of practicum activities that can train science process skills. The purpose of this study was to describe the implementation of the practicum method on the science process skills of secondary school students. This type of research is a quasi-experiment with a non-equivalent control group research design. The study population was 115 students and the sample was 46 students. The sampling technique used random sampling which was grouped into control and experimental classes. The data analysis technique used N-gain and Mann Whitney test. The results showed that there was no increase in science process skills in the control and experimental classes. In addition, there was no significant difference between the science process skills of the control and experimental classes. It can be concluded that the practicum method in this study did not have an impact on students' science process skills.

Keywords: Practicum Method; Science Process Skills; Secondary School

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INTRODUCTION

Natural Sciences or science is a field of study that focuses on natural phenomena and symptoms that occur in the environment around humans. Science learning does not only aim to transfer knowledge, but also develop scientific thinking through the process of observation, experimentation, and drawing conclusions based on data. In understanding scientific concepts, students are required not only to be able to understand phenomena through the use of the senses and an understanding of the nature of nature as a whole but also to be able to discover knowledge independently. Understanding science requires the application of a scientific perspective, involvement in the scientific process, and the achievement of scientifically testable results. Through active involvement in science learning, students not only gain knowledge, but also develop skills that enable them to learn independently and sustainably (Fauziah, 2022).

Knowledge and skill competencies are the two main components that are taught directly in science learning. Knowledge competence refers to students' ability to understand and apply learning materials in accordance with predetermined learning outcomes. Meanwhile, skill competence emphasises students' mastery in carrying out scientific activities, especially in experiments or practicum activities known as science process skills (Nurlaelah et al., 2022). The success of science learning is highly dependent on the understanding of scientific ideas and subconcepts accompanied by the development of science process skills and employability. Science process skills include various basic abilities such as observing, describing, categorising, measuring, estimating and drawing conclusions. In addition, these skills are also closely related to work skills, namely the ability to use and maintain laboratory tools and materials, follow work procedures systematically, and carry out practical activities physically according to scientific principles (Candra & Hidayati, 2020).

Science process skills include the ability to conceptualise, construct, and confirm or refine scientific ideas. These skills not only involve cognitive aspects, but also include manual and social abilities that support the implementation of scientific activities as a whole. Therefore, it is important for every student studying science to have strong science process skills to support concept understanding and active involvement in the learning process (Yunus et al., 2021). One of the main objectives of developing science process skills is to encourage students to participate actively and efficiently in the learning process and be able to communicate the results of their observations or experiments scientifically. Students who master the steps of the scientific method in practical activities tend to have a higher sense of responsibility for their learning process. In addition, they are also better able to understand and appreciate the value of the scientific method as an important pedagogical tool in the development of scientific thinking and problem-solving skills (Elvanisi et al., 2018).

Science process skills consist of two main categories: basic skills and integrated skills. Basic skills include the ability to observe, measure, classify, estimate, communicate and make inferences. Meanwhile, integrated skills include more complex abilities, such as developing procedures, conducting experiments, evaluating data, controlling variables, and building and using models. Both categories are very important in supporting students' mastery of the scientific process as a whole and meaningful (Hayati et al., 2019). This shows that mastery of science process skills cannot be separated from learning experiences that are direct and contextualised. Direct involvement of students with data and natural phenomena is the key to understanding the scientific method as a whole. Thus, science learning needs to emphasise experimental activities that encourage students to observe, collect and analyse data independently. Previous research has shown that engaging students in hands-on scientific practices can increase their academic, physical and social participation and make learning more meaningful (Afsas et al., 2023).

Science process skills have an important role in science learning because they support the development of scientific thinking skills and in-depth understanding of concepts. However, many junior high school students have not mastered these skills well. Based on research by (Setiawaty et al., 2023), the majority of students were able to answer theory-based questions, but had difficulty in applying the steps of the scientific method, such as formulating hypotheses, designing experiments, managing data, and drawing conclusions. This problem was also found in one of the Madrasah Tsanawiyah (MTs) in Kutorejo District, Mojokerto Regency. Observations showed the unavailability of science laboratory facilities and the absence of practicum activities in learning. As a result, students are less trained in conducting experiments and do not have the opportunity to build scientific skills directly. This has an impact on their low understanding of science concepts.

The results of the science process skills test given to MTs students reinforce this finding. Of the eight indicators of science process skills tested, most students gave incorrect answers on important aspects such as hypothesis formulation, classification, planning and conducting experiments, data interpretation, prediction, and scientific communication. The lack of practice-based learning is the main cause of weak mastery of the scientific method. Interviews with some students also revealed low interest in scientific materials, especially those related to theories and formulas. To overcome these problems, it is necessary to develop practicum methods in science learning. Direct scientific experiments are believed to increase student involvement, strengthen mastery of science process skills, and make the learning process more meaningful and contextualised.

According to (Lestari & Diana, 2018) students can develop their science process skills through practical experiences in real-world situations. Practicum is considered an effective approach to train skills such as observation, classification, experiment design, data analysis, and interpretation. The idea that hands-on experience is essential for a thorough understanding of scientific concepts is in line with Jerome Bruner's discovery learning theory. By integrating classroom learning and practical activities such as experiments and observations, students gain a deeper understanding of the material studied. Laboratory activities in science learning provide excellent opportunities for students to test and develop their science process skills (Candra & Hidayati, 2020). Through activities such as formulating questions, designing experiments using equipment, collecting and analysing data, and writing up findings, students are trained to engage directly in the scientific process. In addition, practicum can improve students' memory by maximising the function of the five senses, so that understanding of concepts becomes easier and can be stored longer in memory (Rosdiani & Erlin, 2022).

Practicum-based learning not only improves students' ability to apply science process skills, but also encourages them to think critically about scientific concepts (Putri et al., 2022). When teachers are able to present the learning process in an interesting way and relevant to students' daily lives, the mastery of science process skills will be optimised. Students' involvement in practical activities allows them to apply the knowledge they have acquired and build a deeper conceptual understanding. These skills in the scientific method are an important component in science education and are used by scientists, educators, and students in the process of scientific enquiry (Wola et al., 2023). Scientific exploration and investigation are activities that require a deep understanding of scientific concepts and procedures so that only individuals with good scientific process skills are able to use them effectively in research activities and data interpretation.

According to (Nisa, 2017), practicum activities provide various benefits for students, including: (1) honing skills through direct experience; (2) encouraging the real application of knowledge and skills; (3) proving scientific concepts through evidence and investigation; and (4) increasing students' awareness of the importance of knowledge and inquiry skills in science learning. Several studies have shown that the application of practical methods in science learning not only improves science process skills, but also students' laboratory work skills. Students are able to plan experiments, use laboratory equipment correctly, and process and analyse data systematically. Direct experience gained during practical activities is proven to improve students' memory and conceptual understanding compared to auditory-based learning alone. Practicum encourages students to actively and creatively apply the knowledge they have learned to real-world situations, so it is very effective in improving science process skills (Candra & Hidayati, 2020). Practicum-based learning also encourages students to relate science concepts to everyday life (Rahman, 2014), helps students understand science concepts concretely and increases learning motivation (Nuai & Nurkamiden, 2022), and has a positive effect on students' critical thinking skills (Hamidy et al., 2023).

Based on the urgency of mastering science process skills in science learning, research on the implementation of the practicum method is important to do. This method not only provides concrete learning experiences, but is also proven to improve students' ability to observe, classify, design experiments, and analyse and conclude data scientifically. However, the reality in the field shows that the implementation of practicum is not optimal, both due to limited facilities and teacher skills. This study aims to describe the implementation of the practicum method on junior high school students' science process skills.

METHOD

The type of research is qualitative with a research design non-equivalent control group desain (Table 1).

[Table 1 about here.]

The research was conducted in the 2023-2024 school year at Mts Al Mas'udy Mojokerto Regency. The study population was class VIII of 115 students and the study sample was 46 students who were divided into two groups, namely the control group and the experimental group. The research instrument was a science process skills test in the form of essay questions totalling 24 items. The materials used were elements, compounds and mixtures. Indicators of science process skills used include: 1. observing; 2. categorising; 3. formulating hypotheses; 4. planning experiments; 5. conducting experiments; 6. interpreting 7. predicting; and 8. communicating (Lestari & Diana, 2018). The science process skills test was given twice, namely pretest and posttest. The data analysis technique used N-gain to determine the improvement of students' science process skills. To get the N-gain score using the following formula.

$$\text{N-Gain} = \frac{Skor\ posttest - Skor\ pretest}{Skor\ maximal - Skor\ pretest}$$

The provisions for the average value of N-Gain are described in Table 2. The next data analysis is the Mann Whitney test to determine the effect of the practicum method on students' science process skills. The assumption underlying this test is the null hypothesis (Ho) that the two groups do not vary significantly (Mubarok et al., 2021).

[Table 2 about here.]

RESULT AND DISCUSSION

This study aims to examine the use of practical methods in science learning to improve students' science process skills and analyse the effect of practical methods on students' science process skills. The data for this study are the results of the initial and final tests that measure the science process skills of the experimental and control groups. Table 3 shows the results of the initial and final tests of scientific process skills for the experimental and control classes.

[Table 3 about here.]

Table 3 shows the experimental and control groups' pretest and posttest results, means, and standard deviations. In the experimental group, the lowest pretest score was 25, the highest score was 55 with an average of 46.57 and a standard deviation of 6.99. This figure shows that students' science process skills are still not good, but have a fairly varied distribution of values. After being given the treatment of science learning using the practicum method, there was an increase in the average post-test score to 51.91 and a standard deviation of 12.39. The average increase of 5.34 points indicates the effectiveness of the practicum method. The greater spread of scores indicates that some students obtained a very significant increase compared to others. The increase in average can also illustrate the positive impact of the practicum method on students' science process skills but the results vary between students.

In the control group, the lowest pretest score was 45, the highest score was 60 with an average of 51.35 and a standard deviation of 4.03. This figure shows that the science process skills in the control class are better than the experimental class. However, after getting science learning using methods that are often used by teachers there was a decrease in post-test scores. The lowest score was 39, the highest score was 55, the average was 48.43, and the standard deviation was 4.95. The average decrease of 2.92 points indicates that the learning method used by the teacher is less effective in maintaining students' science process skills.

In the experimental class, there was an increase in the average student science process skills so that the N-gain test was needed to determine the category of improvement. The N-gain test results for the experimental and control classes are presented in Table 4.

[Table 4 about here.]

In the experimental class, it is known that the N-gain value is 0.11 which is in the low category (N-gain <0.30). Although in the low category, the practicum method makes a positive contribution in improving students' science process skills. In the control class, the N-gain value is 0.07 which is in the low category. This shows that the learning method used by the teacher is not effective in teaching students' science process skills. Based on the N-gain values of both groups, it is known that the practicum method is more effective than the method used by the teacher, although its implementation needs to be maximised to get better results.

Science process skills consist of eight indicators. Each indicator has a role to strengthen students' ability to conduct scientific investigations. To determine the amount of improvement in each indicator of students' science process skills in experimental and control classes, the N-gain formula was calculated. The results of the calculation of each indicator of science process skills are presented in Table 5.

[Table 5 about here.]

Based on Table 5, it is known that there are six indicators that have decreased in the experimental group. It can be interpreted, that the implementation of the practicum method is not optimal. The observation indicator has an N-gain of -0.25. The decrease in observation ability can be caused by the lack of emphasis on direct observation activities during practicum. The grouping indicator has an N-gain of 0.15 (low category). This increase can be caused by practicum activities that provide opportunities to classify practical objects. The hypothesis proposal indicator has an N-gain of 0.33 (medium category). It is the highest indicator that has increased. This shows that the practicum method plays a role in encouraging students to think predictively and logically. The indicator of planning an experiment has an N-gain of -2.18 which is the indicator with the highest decrease. This shows that the practicum has not provided opportunities for students to design their experiments independently. The indicator of conducting an experiment has an N-gain of -0.13. There was a decrease which could be caused by several factors including: lack of time to conduct experiments, lack of experimental tools and materials, lack of cooperation between members, and low student motivation to conduct experiments. The interpreting indicator has an N-gain of -1.89. This decrease shows that students still have difficulty in interpreting the results of the experiment. The predicting indicator has an N-gain of -0.20. The communicating indicator has an N-gain of -0.51. This shows that students are not used to presenting lab results systematically.

In the control class, there were two indicators that decreased, namely the indicator of planning the experiment with an N-gain value of -0.08 and the indicator of communicating with an N-gain value of -0.66. The decrease in the indicator of planning experiments shows that students are not directly involved in planning experiments and using experimental procedures that have been prepared by the teacher. The decrease in the communicating indicator shows the lack of scientific communication activities in learning. The indicator that has the highest N-gain is interpreting at 0.50 in the medium category. The next indicator that has increased is proposing hypotheses with an N-gain of 0.39, grouping indicators with an N-gain of 0.29, predicting indicators with an N-gain of 0.15, observing indicators with an N-gain of 0.08, and the indicator of conducting experiments has not increased.

The next test is to determine the effect of practicum method on science process skills. The normality test aims to determine whether the research data is normally distributed. The normality test uses the Kolmogorov-Smirnov method. Data is considered to come from a normally distributed population if the significance value is greater than 0.05. The calculation of the normality test is presented in Table 6.

[Table 6 about here.]

Based on the Kolmogorov-Smirnov test results, all data groups show a significance value above 0.05, which indicates that the data is normally distributed. However, in the Shapiro-Wilk test, the experimental class pretest data has a significance value of 0.010 smaller than 0.05, so it can be concluded that the data is not normally distributed. While the experimental class posttest data as well as the control class pretest and posttest showed a significance value greater than 0.05. It can be interpreted that the data is normally distributed. There is one group of data that does not fulfil the assumption of normality, so the inferential statistics used next are non-parametric statistics.

The next prerequisite test is the homogeneity test which aims to determine whether the variances of the two data groups (experimental class and control class) are similar or homogeneous According to (Suparno et al., 2019) if the significance level (Sig) is less than 0.05, it means that the variance of two or more population groups is not homogeneous. Conversely, if the value (sig) is more than 0.05, it means that the variance of the group is uniform or homogeneous. The calculation of the homogeneity test is presented in Table 7.

[Table 7 about here.]

Based on the results of the Levene test, a significance value (Sig.) of 0.000 was obtained. This significance value is smaller than 0.05. It means that there is a significant difference in variance between the two groups. The data obtained did not fulfil the assumption of homogeneity so that further testing used non-parametric statistics, namely Mann Whitney.

Mann Whitney test to ascertain whether the means of two groups are statistically different and to determine the effect of learning using the practicum method on students' science process skills. According to (Mubarok et al., 2021), the Mann-Whitney test is used with the following decision-making guidelines:

a. The alternative hypothesis (Ha) is accepted and the null hypothesis (Ho) is rejected if the Asymp sig value is smaller than 0.05.
b. The null hypothesis (Ho) is accepted and the alternative hypothesis (Ha) is rejected if the Asymp sig value is greater than or equal to 0.05.

Decision making in this study is based on the following hypothesis:

Ho: There is no significant difference between the science process skills of experimental and control class students in the sense that there is no effect of using the practicum method on students' science process skills.

Ha: There is a significant difference between the science process skills of experimental and control class students in the sense that there is an effect of using the practicum method on students' science process skills.

The results of the Mann Whitney test calculation are presented in Table 8.

[Table 8 about here.]

Based on table 8, the Asymp. Sig. (2-tailed) of 0.44 is greater than 0.05. It means that Ho is accepted and Ha is rejected. This indicates that there is no significant difference in science process skills between the experimental and control classes. The U-value of 229.500 and the Z-value of -0.770 support the conclusion that the difference between the two groups is not statistically strong enough to be significant. Thus, the treatment given in the experimental class has not shown a significant improvement in science process skills compared to the control class.

The results obtained contradict a number of previous studies which show that learning through practicum methods can improve students' science process skills. The results of these studies include the use of practicum worksheets that can effectively improve students‘ science process skills (Dewi & Firman, 2019), the application of a direct learning approach through practicum activities can have a positive impact on improving science process skills (Royani et al., 2018), and the implementation of practicum activities on sensory system material significantly improves students' scientific process skills (Mawarda et al., 2023). Thus, the results obtained in this study are an important basis for further evaluation of the implementation of the practicum method, both from the aspects of planning, implementation, and the intensity of practical activities provided to students.

The low increase in science process skills in this study can be caused by several important factors that influence the effectiveness of learning. First, the implementation of the practicum has not been fully optimal. In the learning process, practicum activities are carried out with a focus on achieving procedures, but do not provide enough space for students to think critically, reflect on experiences, and develop understanding independently. Research by (Royani et al., 2018) confirms that meaningfully designed practicums, which involve active student involvement in the scientific process, are very important to support the development of science process skills. Second, the limited duration and intensity of the practicum implementation are also obstacles. The practicum in this study was only carried out in a relatively short time, namely for several days, so that the implementation and evaluation process through the science process skills test took place in a rushed condition. This limit students' opportunities to develop skills gradually. As stated in (Wola et al., 2023) that sufficient practicum implementation time plays a significant role in the success of science process skills-based learning. If the practice is carried out in a hurry or only a few times, then students do not have enough time to experience the scientific process completely and deeply. Third, the lack of seriousness of students in doing the test, as well as the existence of dishonest practices such as cheating, also contributed to the low results of science process skills. During the implementation of the pretest and posttest, it was found that a number of students from the experimental and control classes copied each other's answers, even though they had been reprimanded by the teacher and researcher. This practice causes the test results not to represent the actual abilities of the individual, which ultimately affects the low N-Gain scores obtained. Research (Riantoni & Nurrahman, 2020) shows a very strong relationship between students' honest character and science learning outcomes. This finding reinforces that integrity in the learning and evaluation process greatly influences the learning outcomes achieved.

This study reveals that the implementation of the practicum method did not have a significant effect on improving junior high school students' science process skills. This is supported by the results of the Mann-Whitney test, which produced a significance value of 0.441 (> 0.050), indicating that there was no statistically significant difference in science process skills between the experimental and control classes. Moreover, the N-Gain scores from the pretest and posttest were 0.11 for the experimental class and 0.07 for the control class, both of which fall into the low category. The N-Gain analysis by indicator also showed that most indicators in the experimental class remained in the low category, with several even showing negative values. In contrast, although the control class was also categorized as low, most of its indicators showed positive gains.

These findings indicate that the practicum method used in this study was not effective in significantly enhancing students' science process skills, either overall or in specific skill areas. Therefore, the practicum implementation needs to be evaluated and redesigned to be more meaningful, and should be supported by additional learning strategies such as inquiry-based learning or problem-based learning. Schools and teachers are encouraged to provide proper supporting facilities and adopt more appropriate teaching methods so that practicum activities can truly contribute to the development of students' science process skills.

CONCLUSION

The implementation of the practicum method has not successfully improved students' science process skills significantly, as indicated by an N-Gain score of 0.11. There was no improvement in the SPS indicators in either the experimental or control class, with both showing N-Gain values in the low category. In other words, the practicum method did not have a meaningful impact on the development of SPS among Grade VIII students at Al Masudy. This is supported by the results of the Mann-Whitney statistical test, which yielded a significance value of 0.441, indicating no significant difference in SPS test results between the experimental and control groups. This suggests that the practicum method has not been effective in comprehensively enhancing students' science process skills.

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Conflict of Interest Statement: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

LIST OF TABLES

TABLE 1 / Research Design Non-Equivalent Control Group Design

Pretest	Treatment	Postest
O1	X1	O2
O3	X2	O4

TABLE 2 / Average N-Gain Score Criteria

N-Gain	Category
0,70 ≤ n ≤ 1,00	High
0,30 ≤ n < 0,70	Medium
0,00 ≤ n < 0,30	Low

TABLE 3 / Description of Pre-Test and Post-Test Values of Experimental Class and Control Class in Science Process Skills Test

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Pre test Eksperimen	23	25	55	46.57	6.992
Pos test Eksperimen	23	31	71	51.91	12.387
Pre test Kontrol	23	45	60	51.35	4.030
Post test Kontrol	23	39	55	48.43	4.953
Valid N (listwise)	23				

TABLE 4 / N-Gain Test Results Data Pre-Test Post-Test Science Process Skills Experimental Class and Control Class

				N-Gain		
	N	Minimum	Maximum	Pretest Average	Postest Average	Average N-Gain
N-Gain Score Eksperimen Class	23	38	71	47	52	0,11
N-Gain Score Control Class	23	39	55	51	48	0,07

TABLE 5 / N-Gain Values of Experimental and Control Classes on Each Science Process Skills Indicator

Indicator	N-Gain Eksperimental Class	Category	N-Gain Control Class	Category
Observing	-0,25	Low	0,08	Low
Categorising	0,15	Low	0,29	Low
Formulating hypotheses	0,33	Medium	0,39	Medium
Planning experiments	-2,18	Low	-0,08	Low
Conducting experiments	-0,13	Low	0,00	Low
Interpreting	-1,89	Low	0,50	Medium
Predicting	-0,20	Low	0,15	Low
Communicating	-0,51	Low	-0,66	Low
Average N-Gain	-0,59	Low	0,08	Low

TABLE 6 / Normality Test Results

Tests of Normality

		Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Class	Statistic	df	Sig.	Statistic	df	Sig.
Science Process Skills Outcomes	Experimental class pretest	.172	23	.077	.881	23	.010
	Experimental class postest	.136	23	.200*	.933	23	.126
	Control class pretest	.101	23	.200*	.968	23	.653
	Control class postest	.146	23	.200*	.931	23	.114

*. This is a lower bound of the true significance.

a. Lilliefors Significance Correction

TABLE 7 / Homogeneity Test Results

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Science Process Skills Outcomes	Based on Mean	24.605	1	44	.000
	Based on Median	20.340	1	44	.000
	Based on Median and with adjusted df	20.340	1	33.417	.000
	Based on trimmed mean	24.683	1	44	.000

TABLE 8 / Mann Whitney Test Results

Test Statistics[a]

	Science Process Skills Outcomes
Mann-Whitney U	229.500
Wilcoxon W	505.500
Z	-.770
Asymp. Sig. (2-tailed)	.441

a. Grouping Variable: Class