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An Assessment of Science Process Skills in Junior High School Education: Perspectives of Students and Teachers in Indonesia

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Abstract

This study aims to assess the understanding of science process skills (SPS) of science students and teachers in Indonesia: how is the picture of SPS understanding of student groups A, B, C, and D and teacher groups A, B, C, and D?; is there a significant difference in the average score of SPS understanding between student groups A, B, C, and D and teacher groups A, B, C, and D. The research method used is descriptive-inferential. Data collection uses SPS diagnostic tests. The research sample consisted of (580) students and (132) science teachers in Indonesia. The sampling technique used purposive sampling. The results of the study found that: the average score of students' SPS understanding was higher than that of teachers, there was no significant difference in the average score of SPS understanding between student groups A, B, C, and D and teacher groups A, B, C, and D; there is no significant difference in the average SPS understanding score between student groups A, B, and C. The descriptive analysis found that the average SPS understanding score of all student groups A, B, C and D was higher than all teacher groups A, B, C, and D. Factors of practical experience or access to SPS materials influenced this result; inferential statistical analysis found that there was no significant difference in the average SPS understanding score between all student groups A, B, C, and D and all teacher groups A, B, C, and D. Students and teachers still need to be trained in SPS with the application of project-based learning models or inquiry-based learning methods that directly involve SPS.

Keywords: science process skills, science teachers, students, understanding

INTRODUCTION

Science Process Skills (SPS) in this study is closely related to the purpose of the study, namely, to assess the SPS of students and teachers. This variable is very urgent to be studied in the 21st century, considering that in the current century, human resources who have high-level thinking talents (HOTs) are greatly needed and this SPS is one of these skills and also for the development of science, SPS is urgently needed to find various natural phenomena that are very important for human life, for example discoveries in various fields of technology and science, namely Artificial Intelligence (AI). SPS is crucial for students' success in the rapidly developing industrial revolution 4.0 era, especially in preparing them for scientific literacy, critical thinking, and problem solving. This can be strengthened by highlighting how SPS directly supports competencies that are essential for innovation and adaptability in the fields of science and technology. Increased SPS may contribute to higher PISA

scores or better prepare students for complex problem solving, emphasizing the practical outcomes of addressing these educational needs.

The Teacher Education Program (TPE in Job) or TPE is a professional education program, with level 7 in the Indonesian National Qualifications Framework. In the industrial revolution 4.0 in the 21st century era, the development of science and technology is very fast, for the sustainability of science and technology, SPS is needed for students and teachers to support scientific investigations. This is in line with Prisecaru's (2016) statement, saying that in the 21st century entering the platform of the industrial revolution 4.0 requires science process skills (Prisecaru, 2016). This statement is supported by the results of Elvanisi's research, in Indonesia which concluded that the SPS of high school students is still low, the average score of students' science process skills is 51.93% of the six SPS indicators, namely observing, classifying, interpreting, predicting, formulating hypotheses, planning experiments, and communicating (Harlen & Elstgeest, 1993; Karamustafaoğlu, 2011; Elvanisi et al., 2018). In addition, research conducted by students of science education at the Makassar State University shows that the SPS of junior high school students in junior high schools in Indonesia is very low, but after they are given learning with a practicum approach, their SPS increases (Bonga et al., 2017). The research subjects included all junior high school teachers in Indonesia who were taking professional teacher education and all students in Indonesia who were taught by these teachers.

Several research results reported that the average score of SPS students in Indonesia was 45.68 in the low category and the skills of junior high school teachers in practicing SPS were also still lacking (Biswal & Biswajit, 2023; Kamarudin et al., 2022). The problem in this research is: what is the description of the understanding of SPS by teachers and students in Indonesia? This study aims to assess the understanding of SPS of science students and teachers in Indonesia: how is the picture of SPS understanding of student groups A, B, C, and D and teacher groups A, B, C, and D?; is there a significant difference in the average score of SPS understanding between student groups A, B, C, and D and teacher groups A, B, C, and D.

The results of a survey conducted by the Program for International Student Assessment (PISA) in 2018 showed that the scientific literacy of Indonesian children was still low. This is shown by the results of the study which found that 40% of Indonesian students had just reached level 2 with an average score of 396, while the average for the Organization for Economic Co-operation and Development (OECD) was 489. Even though at level 2, students can remember and know known scientific phenomena to identify simple cases, but they cannot reason in compiling scientific explanations, so they have not been able to make conclusions. Meanwhile, to be able to think scientifically, students must be at level 5, where they can use scientific concepts to explain phenomena or events that involve various causal relationships and arguments (OECD, 2019). Scientifics Process Skills are well developed in lab activities during science phenomena observation and investigation. Based on previous research, it can be stated that Scientific Process Skills (SPS) are an important aspect of science learning (Chabalengula & Mbewe, 2011; Sukarno et al., 2013; Maison et al., 2019; Irwanto et al., 2020; and Ramli et al., 2022).

SPS is an approach that integrates SPS into an integrated material presentation system. This approach emphasizes the process of seeking knowledge rather than transferring knowledge, students are seen as learning subjects who need to be actively involved in the learning process, in order to find facts, build concepts, and can influence the development of knowledge and can apply scientific methods in understanding, developing and In finding knowledge, the teacher is only a facilitator who guides and coordinates learning activities (Tawil & Liliasari, 2014; Sardinah et al., 2012; Sugiyarti et al., 2015).

Several studies have reported that approaches such as practicums and inquiry-based learning are approaches that can be applied to improve SPS for students and teachers in Indonesia (Athiyyah et al., 2020; Saputra et al., 2021; Syamsidar et al., 2021). There are several basic SPS indicators, namely: observation, inferring, measuring, communicating, classifying, predicting. While the integrated SPS includes controlling variables, operationally defining, making conclusions, determining the types of variables, giving suggestions, making deductive hypotheses, making inferences, identifying and formulating hypotheses, interpreting data, experimenting and formulating models (Elstgeest, 1993; Karamustafaoğlu, 2011; Tawil & Liliasari, 2014; Rahayu & Anggraeni, 2017; Harlen et al., 2018).

METHODS

The Research Method

This survey research aims to explore the understanding of SPS for students and natural science teachers in Indonesia: 1) how the description of the understanding of the SPS group of students and teachers is, 2) the average score of SPS understanding is significantly different between students and teachers, 3) the mean score of SPS understanding there was no significant difference between groups of students, and 4) the mean score of SPS understanding there was no significant difference between groups of teachers.

Participants

The sample of this study was 580 ninth grade students of State Junior High Schools and 32 science teachers throughout Indonesia who participated in the Teacher Professional Program (PPG in Position) at Makassar State University in 2021. The division of research sample groups can be seen in TABLE 1.

TABLE 1. Research Sample

Group A				Group B			
No.	**Province**	**Amount**		**No.**	**Province**	**Amount**	
		Teacher	**Students**			**Teacher**	**Students**
1.	Jawa Tengah	2	10	1.	Kalimantan Tengah	7	35
2.	Jawa Barat	1	5	2.	Kalimantan Timur	3	15
3.	Sumatera Selatan	4	20	3.	Kalimantan Barat	7	35
4.	Sulawesi Selatan	28	140	4.	Kalimantan Selatan	2	10
				5.	Kepulauan Riau	10	50
				6.	Gorontalo	1	5
				7.	Sulawesi Barat	2	10
				8.	Sulawesi Tengah	1	5
				9.	Sulawesi Utara	1	5
				10.	Jawa Tengah	1	5
Total Number		35	175	Total Number		35	175
Group C				**Group D**			
No.	**Province**	**Amount**		**No.**	**Province**	**Amount**	
		Teacher	**Students**			**Teacher**	**Students**
1.	Jawa Timur	3	15	1.	Jawa Timur	3	15
2.	Jawa Barat	8	40	2.	Kalimantan Barat	2	10
3.	Jakarta	1	5	3.	Kalimantan Timur	1	5
4.	Kalimantan Timur	2	10	4.	Sulawesi Selatan	3	15
5.	Kalimantan Tengah	2	10	5.	Sulawesi Barat	2	10
6.	Kalimantan Selatan	1	5	6.	Nusa Tenggara Timur	3	15
7.	Kalimantan Barat	2	10	7.	Jawa Barat	3	15
8.	Sumatera Utara	2	10	8.	Riau	2	10
9.	Riau	2	10	9.	Halmahera	1	5
10.	Jambi	1	5	10.	Lombok	1	5
11.	Lampung	1	5	11.	Jakarta	4	20
12.	Aceh	1	5	12.	Sumatera Selatan	2	10
13.	Sulawesi Selatan	2	10	13.	Bali	1	5
14.	Sulawesi Tenggara	1	5	14.	Jawa Tengah	1	5
15.	Bali	1	5	15.	Mataram	1	5
16.	Nusa Tenggara Timur	1	5	16.	Lampung	1	5
Total Number		31	115	Total Number		31	115

Students as research samples were divided into four groups, each consisting of 175 students in group A, 175 students in group B, 115 students in group C, and 115 students in group D. For the research sample, science teachers were also divided into four groups, namely 35 teachers in group A, 35 teachers in group B, 31 teachers in group C, and 31 teachers in group D. The research sampling technique used

purposive sampling. The research sampling technique used purposive sampling. This was done because it was adjusted to the area of origin of junior high school teachers who participated in teacher professional education.

Data Collection Tools

The data was collected using the SPS diagnostic test of 10 items in the form of multiple choice, using a score of 1 if it was true and 0 if it was wrong. Analysis of the coefficient of internal consistency of the test using Gregory analysis and student and teacher SPS data analysis using descriptive and inferential analysis with SPSS 21. SPS is the total score obtained by students and teachers after completing the diagnostic test of SPS understanding.

Validation and Reliability of Research Instruments

The diagnostic test for SPS understanding consists of 10 items. The SPS test was validated by three science education experts. Validation analysis using Gregory analysis (Arlini et al., 2017) as shown in TABLE 2. To calculate the value of the coefficient of internal consistency (internal validation) using EQUATION (1), and to determine the category in Table The validation results show that the SPS diagnostic test, internal validation value greater than 0.75 is included in the high category, this is eligible for use in research.

TABLE 2. Gregory's validation analysis tabulation

	Expert Assessment	
	(1 or 2) score	**(3 or 4) score**
weak relevance expert assessment (item is worth 1 or 2)	A	B
strong relevance expert assessment (item is worth 1 or 2)	C	D

$$coefficient\ of\ internal\ consistency = \frac{D}{A+B+C+D} \quad (1)$$

Remarks:
A = Both experts give weak relevance
B = The first expert gives strong relevance
The second expert gives weak relevance
C = The first expert gives weak relevance
The second expert gives strong relevance
D = Both experts give strong relevance

TABLE 3. Content validation category

Interval	Category
> 0.8	high
0.4 – 0.8	medium
< 0.4	low

Analysis of the reliability of the SPS diagnostic test to calculate the level of percentages of agreements between the two raters stating "yes" or "no" used EQUATION (2) (Grinnell, as citied in Fuadi et al., 2015). The results of the reliability analysis are 99 percent, which is greater than the lower limit of the reliability coefficient of 0.75, meaning that all research instruments are reliable.

$$Percentage\ of\ Agreement = \frac{Agreement}{Disagreement-Agreement} \times 100\% \quad (2)$$

In this study, the SPS aspects assessed include indicators: observing, measuring, classifying, making hypotheses, using tools and materials, interpreting data, and concluding, and communicating (Tawil & Liliasari, 2014; Rahayu & Anggraeni, 2017).

Data Analysis and Interpretation

For the purposes of testing independent data on the SPS group average score of the student group and the teacher group, the normality test and homogeneity test were carried out using the Kolmogorov-Smirnov. The SPS normality test for the student group and the teacher group, respectively, is shown in TABLE 4, TABLE 5, TABLE 6, and TABLE 7.

TABLE 4. Normality Test on The Value of SPS at Group A

Group A	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Student	.201	35	.52	.927	35	.53
Teacher	.179	35	.73	.944	35	.75

As shown in TABLE 4, the significance values for the SPS group A data for students and teachers are 0.53 and 0.75 respectively. All significance values are above 0.05. These results indicate that the SPS data for each student and teacher in group A comes from a normally distributed population. Thus, the next *independent t test* can be applied.

TABLE 5. Normality Test on The Value of SPS at Group B

Group B	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Student	.222	35	.16	.902	35	.15
Teacher	.195	35	.12	.923	35	.17

As shown in TABLE 5, the significance values for the SPS group B data for students and teachers are 0.15 and 0.17 respectively. All significance values are above 0.05. These results indicate that the SPS data for each student and teacher in group B comes from a normally distributed population. Thus, the next *independent t test* can be applied.

TABLE 6. Normality test on the value of SPS at Group C

Group C	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Student	.218	31	.11	.909	31	.12
Teacher	.258	31	.20	.887	31	.13

As shown in TABLE 6, the significance values for the SPS group C data for students and teachers are 0.12 and 0.13 respectively. All significance values are above 0.05. These results indicate that the SPS data for each student and teacher in group C comes from a normally distributed population. Thus, the next *independent t test* can be applied.

TABLE 7. Normality test on the value of SPS at Group D

Group D	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Student	.163	31	.036	.956	31	.223
Teacher	.136	31	.152	.953	31	.192

As shown in TABLE 7, the significance values for the SPS group D data for students and teachers are 0.223 and 0.192 respectively. All significance values are above 0.05. These results indicate that the SPS data for each student and teacher in group D comes from a normally distributed population. Thus, the next *independent t test* can be applied.

The homogeneity test of the student and teacher group SPS data is shown in TABLE 8, TABLE 9, TABLE 10, and TABLE 11.

TABLE 8. Test of homogeneity of variances of SPS group A

Levene Statistic	df1	df2	Sig.
.365	1	208	.546

As shown in TABLE 8, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next *independent t test* can be applied.

TABLE 9. Test of homogeneity of variances of SPS group B

Levene Statistic	df1	df2	Sig.
4.132	1	208	.043

As shown in TABLE 9, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next *independent t test* can be applied.

TABLE 10. Test of homogeneity of variances of SPS group C

Levene Statistic	df1	df2	Sig.
1.928	1	144	.167

As shown in TABLE 10, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next *independent t test* can be applied.

TABLE 11. Test of homogeneity of variances of SPS group D

Levene Statistic	df1	df2	Sig.
3.581	1	144	.060

As shown in TABLE 11, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next *independent t test* can be applied.

RESULTS AND DISCUSSION

Results

Descriptive Analysis Result

The results of the descriptive analysis of the mean scores of the SPS group of students and teacher groups are shown in TABLE 12 to TABLE 15, respectively.

TABLE 12. Average SPS Group A Comprehension Score

No.	SPS Indicator	Average Score	
		Student	**Teacher**
1.	Observation	18.286	25.714
2.	Prediction	30.286	20.000
3.	Creating operational definitions of variables	31.429	37.143
4.	Conclusion	16.000	22.857
5.	Specifying the variable type	21.714	25.714
6.	Giving advice	26.857	25.714
7.	Deductive hypothesis	23.429	25.714
8.	Inference	30.286	28.571
9.	Identification	28.571	17.143
Total Score Average		27.429	22.857

The results of the descriptive analysis in TABLE 12, show that the average score of the proportion of students' and teachers' SPS understanding answers in group A is 27.429 and 22.857, respectively. The average score of students is higher than the average score of teachers. The average score of the SPS understanding indicators in the group of students, starting with the highest, is: making operational definitions of variables, predictions, inferences, suggestions, identifying, giving suggestions, determining types of variables, observations, and conclusions. For groups of teachers in a row: operational definitions of variables, inferences, giving suggestions, hypotheses, observations, predictions, conclusions and identifying.

TABLE 13. Average SPS Group B Comprehension Score

No.	SPS Indicator	Average Score	
		Student	**Teacher**
1.	Observation	20.571	28.571
2.	Prediction	30.857	31.429
3.	Creating operational definitions of variables	32.000	22.857
4.	Conclusion	15.429	22.857
5.	Specifying the variable type	13.714	31.429
6.	Giving advice	28.571	25.714
7.	Deductive hypothesis	24.000	20.000
8.	Inference	24.571	25.714
9.	Identification	27.429	28.571
Total Score Average		24.713	25.999

The results of the descriptive analysis in TABLE 13 show that the average score of the proportion of students' and teachers' SPS understanding answers in group B is 24.713 and 25.999, respectively. The student's average score is lower than the teacher's average score. The average score of the SPS understanding indicators in the group of students, starting with the highest, is: creating operational definitions of variables, predictions, identifying, suggestions, inferences, deductive hypotheses, and observations. For the teacher group in a row: predictions, determining the types of variables, identifying, observations, inferences, conclusions, operational definitions of variables, and deductive hypotheses.

TABLE 14. Average SPS Group C Comprehension Score

No.	SPS Indicator	Average Score	
		Student	**Teacher**
1.	Observation	18.261	22.581
2.	Prediction	30.435	19.355
3.	Creating operational definitions of variables	28.696	25.806
4.	Conclusion	26.087	32.258
5.	Specifying the variable type	23.478	19.355
6.	Giving advice	26,957	22.581
7.	Deductive hypothesis	23.478	29.032
8.	Inference	27.826	22.581
9.	Identification	25.217	29.032
Total Score Average		26.261	24.838

The results of the descriptive analysis in TABLE 14, show that the average score of the proportion of students' and teachers' SPS understanding answers in group C is 26.261 and 24.838, respectively. The average score of students is higher than the average score of teachers. The average score of the SPS understanding indicators in the group of students, starting with the highest, is: predictions, operational definitions of variables, inferences, suggestions, conclusions, types of variables, deductive hypotheses, identification, and observations. For the teacher group in a row: making conclusions, deductive hypotheses, identification, operational definitions of variables, observations, suggestions, inferences, types of variables, and predictions.

TABLE 15. Average SPS Group D Comprehension Score

No.	SPS Indicator	Average Score	
		Student	**Teacher**
1.	Observation	18.261	29.032
2.	Prediction	27.826	58.065
3.	Creating operational definitions of variables	22.609	32.258
4.	Conclusion	47.826	38.710
5.	Specifying the variable type	37.391	41.935
6.	Giving advice	34.783	51.613
7.	Deductive hypothesis	21.739	32.258
8.	Inference	24.348	29.032
9.	Identification	18.261	19.355
Total Score Average		28.521	37.096

The results of the descriptive analysis in TABLE 15 show that the average score of the proportion of students' and teachers' SPS understanding answers in group D is 28.521 and 37.096, respectively. The student's average score is lower than the teacher's average score. The average score of the SPS understanding indicators in the group of students, starting with the highest, is: conclusions, types of variables, suggestions, predictions, inferences, operational definitions of variables, deductive hypotheses, observations, and identification. For the teacher group in a row: predictions, suggestions, types of variables, conclusions, operational definitions of variables, deductive hypotheses, inference, observation, and identification.

Inferential Analysis Results

Furthermore, the results of the independent test of the SPS variable the average score of SPS understanding in the student group and teacher group is shown in TABLE 16, TABLE 17, TABLE 18, and TABLE 19.

TABLE 16. The Result of Independent Samples t-test at Teacher Group A

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.365	.546	-.563	208	.574
Equal variance not assumed			-.540	46.782	.592

TABLE 16 shows the results of the independent sample t-test of SPS understanding of students and teachers in group A with a value a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between students and teachers in group A. In other words, there is no difference in the mean score of SPS understanding between students and teachers. in group A.

TABLE 17. The Result of Independent Samples t-test at Teacher Group B

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	4.132	.143	-1.321	208	.188
Equal variance not assumed			-1.692	66.868	.095

TABLE 17 shows the results of the independent sample t-test of SPS understanding of students and teachers in group B with a value of sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between students and teachers in group B. In other words, there is no difference in the mean score of SPS understanding between students and teachers in group B.

TABLE 18. The result of Independent Samples t-test at Teacher Group C

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	1.928	.167	.377	144	.707
Equal variance not assumed			.417	55.273	.678

TABLE 18 shows the results of the independent sample t-test of SPS understanding of students and teachers in group C with a value a sig. (2-tailed) is greater than 0.05, which means that there is a significant difference in the average SPS understanding score between students and teachers in group C. In other words, there is no difference in the average SPS understanding score between students and teachers in group C.

TABLE 19. The Result of Independent Samples t-test at Teacher Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	3.581	.060	-2.728	144	.070
Equal variance not assumed			-2.378	40.552	.052

TABLE 19 shows the results of the independent sample t-test of SPS understanding of students and teachers in group D with a value a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between students and teachers in group D. In other words, there is no difference in the mean score of SPS understanding between students and teachers in group D.

Furthermore, the results of the independent test of the SPS variable the average score of SPS understanding between groups of students is shown in TABLE 20 to TABLE 25.

TABLE 20. The Result of Independent Samples t-test at Student Group A and Group B

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.000	.990	1.076	348	.283
Equal variance not assumed			1.076	347.602	.283

TABLE 20 shows the results of the independent sample t-test of SPS understanding between group A students and group B students with a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between group A students and group B students. In other words, there is no difference in the average score of SPS understanding between group A students and group B students.

TABLE 21. The Result of Independent Samples t-testat Student Group A and Group C

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.359	.549	-1.141	288	.255
Equal variance not assumed			-1.163	259.116	.246

TABLE 21 shows the results of the independent sample t-test of SPS understanding between group A students and group C students with a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between group A students and group C students. In other words, there is no difference in the mean score of SPS understanding between group A students and group C students.

TABLE 22. The Result of Independent Samples t-testat Student Group A and Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.009	.924	-2.121	288	.035
Equal variance not assumed			-2.111	239.919	.036

TABLE 22 shows the results of the independent sample t-test of SPS understanding between group A students and group D students with a sig. (2-tailed) is greater than 0.05, which means that there is a significant difference in the mean score of SPS understanding between group A students and group D students. In other words, there is no difference in the mean score of SPS understanding between group A students and group D students.

TABLE 23. The Result of Independent Samples t-test at Student Group B and Group C

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.330	.566	-2.103	288	.036
Equal variance not assumed			-2.158	264.276	.032

TABLE 23 shows the results of the independent sample t-test of SPS understanding between group B students and group C students with a sig. (2-tailed) is greater than 0.05, which means that there is a significant difference in the mean score of SPS understanding between group B students and group C students. In other words, there was no difference in the mean score of SPS understanding between group B students and group C students.

TABLE 24. The Result of Independent Samples t-test at Student Group B and Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.006	.937	-3.024	288	.003
Equal variance not assumed			-3.031	245.751	.003

TABLE 24 shows the results of the independent sample t-test of SPS understanding between group B students and group D students with a sig. (2-tailed) is smaller than 0.05, which means that there is a significant difference in the mean score of SPS understanding between group B students and group D students. In other words, there is a difference in the average score of SPS understanding between group B students and group D students.

TABLE 25. The Result of Independent Samples t-test at Student Group C and Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.401	.527	-.974	228	.331
Equal variance not assumed			-.974	225.055	.331

TABLE 25 shows the results of the independent sample t-test of SPS understanding between group C students and group D students with a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between group C students and group D students. In other words, there was no difference in the mean score of SPS understanding between group C students and group D students.

Furthermore, the results of the independent test of the SPS variable the average score of SPS understanding between groups of teachers is shown in TABLE 26 to TABLE 31.

TABLE 26. The Result of Independent Samples t-test at Teacher Group A and Group B

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	5.968	.017	-.090	68	.928
Equal variance not assumed			-.090	59.155	.928

TABLE 26 shows the results of the independent sample t-test of SPS understanding between group A teachers and group B teachers with a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between group A teachers and group B teachers. In other words, there is no difference in the mean score of SPS understanding between group A teachers and group B teachers.

TABLE 27. The Result of Independent Samples t-test at Teacher Group A and Group C

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	66.356	.000	-1.631	64	.108
Equal variance not assumed			-1.734	34.000	.092

TABLE 27 shows the results of the independent sample t-test of SPS understanding between teachers in group A and teachers in group C with a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between group A teachers and group C teachers. In other words, there is no difference in the mean score of SPS understanding between group A teachers and group C teachers.

TABLE 28. The Result of Independent Samples t-test at Teacher Group A and Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	1.322	.255	-2.582	64	.012
Equal variance not assumed			-2.550	58.084	.013

TABLE 28 shows the results of the independent sample t-test of SPS understanding between group A teachers and group D teachers with a sig. (2-tailed) is smaller than 0.05, which means that there is a significant difference in the mean score of SPS understanding between group A teachers and group D teachers. In other words, there is no difference in the mean score of SPS understanding between group A teachers and group D teachers.

TABLE 29. The Result of Independent Samples t-test at Teacher Group B and Group C

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	.298	.587	.329	64	.743
Equal variance not assumed			.328	61.514	.744

TABLE 29 shows the results of the independent sample t-test of SPS understanding between group B teachers and group C teachers with a sig. (2-tailed) is greater than 0.05, which means that there is no significant difference in the mean score of SPS understanding between group B teachers and group C teachers. In other words, there is no difference in the mean score of SPS understanding between group B teachers and group C teachers.

TABLE 30. The Result of Independent Samples t-test at Teacher Group B and Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	11.419	.001	-2.886	64	.006
Equal variance not assumed			-2.791	45.050	.008

TABLE 30 shows the results of the independent sample t-test of SPS understanding between group B teachers and group D teachers with a sig. (2-tailed) is smaller than 0.05, which means that there is a significant difference in the mean score of SPS understanding between group B teachers and group D teachers. In other words, there is a difference in the average score of SPS understanding between group B teachers and group D teachers.

TABLE 31. The Result of Independent Samples t-test at Teacher Group C and Group D

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	t	df	Sig. (2 tailed)
Equal variance not assumed	7.992	.006	-2.923	60	.007
Equal variance not assumed			-2.923	48.538	.007

TABLE 31 shows the results of the independent sample t-test of SPS understanding between group C teachers and group D teachers with a sig. (2-tailed) is smaller than 0.05, which means that there is a significant difference in the mean score of SPS understanding between group C teachers and group D teachers. In other words, there is a difference in the average score ofSPS understanding between group C teachers and group D teachers.

Discussion

This article provides insight and highlights regarding the ability of natural science teachers in Indonesia to carry out science process skills activities. It is very urgent for teachers to have this ability to face the 21st century towards the 5.0 era, where science and technology are progressing very quickly, especially in the field of science learning media. In this regard, it is urgent to conduct an assessment of science teachers' readiness to face these developments. Below we will reveal the results of the findings related to insights and highlights.

Based on data analysis and findings, the following is a discussion of the research results. SPS consists of nine indicators: observation, prediction, operational definition of variables, conclusions, types of variables, giving suggestions, making deductive hypotheses, inferences, and identification. The average score of the SPS understanding indicator in the student group starts from the highest, namely: making operational definitions of variables, predictions, inferences, suggestions, identifying, giving suggestions, determining types of variables, observations, and conclusions. This is because the SPS indicators do not follow Bloom or Anderson's taxonomy, students may find it easier to create operational definitions of variables, predictions, inferences, suggestions, identifying, but have difficulty creating observations and conclusions. This finding is in accordance with the teacher's ability to also more easily create operational definitions of variables, give suggestions, hypotheses, observations, predictions, but it is difficult to create conclusions. According to Ozgelen (2012) argues that SPS is unique, namely there are many different theories with different views, so that measuring and assessing SPS is difficult. In this study, innovation was carried out to simplify the development of diagnostic instruments to understand SPS by using nine SPS indicators adopted from (Elstgeest, 1993; Gizaw & Solomon, 2023; Karamustafaoğlu, 2011; Tawil & Liliasari, 2014; Rahayu & Anggraeni, 2017; Harlen et al., 2018).

TABLE 12 shows that the average score of the proportion of students' and teachers' understanding of SPS in group A is 27.429 and 22.857. TABLE 13 shows that the average score of the proportion of students' and teachers' understanding of SPS in group B is 24.713 and 25.999. These results are due to students and teachers jointly exploring and discussing SPS concepts.

TABLE 14 shows that the average score of the proportion of students' and teachers' understanding of SPS in group C is 26.261 and 24.838. TABLE 15 shows that the average score of the proportion of students' and teachers' understanding of SPS in group C is 28.521 and 37.096. This finding indicates that the understanding of SPS between students and teachers still needs training and in-depth study in the learning process, for example, discovery, and inquiry related to SPS. According to Ozgelen (2012) and Azhar et al. (2021) that students' and teachers' understanding of SPS is very different and still low in all SPS indicators. Students' and teachers' understanding of SPS in the operational definition indicators of each variable is the highest among the other indicators.

The independent sample t-test was used to test statistically significant differences in SPS understanding scores with SPSS Version 21 software. Before the independent variable t-test was conducted, first the normality assumption test and homogeneity test were carried out for the student and teacher group SPS understanding scores using the Kolmogorov test. -Smirnov. As shown in TABLE 4 to TABLE 7, the significance values for the SPS group: A, B. C, and D. These results indicate that the SPS data for each student and teacher in group A, B, C, and D comes from a normally distributed population. Thus, the next independent t test can be applied.

Furthermore,as shown in TABLE 8, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next independent t test can be applied. In TABLE 9, the significance value for the SPS data is above .05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next independent t test can be applied. In TABLE 10, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next independent t test can be applied. TABLE 11, the significance value for the SPS data is above 0.05. These results indicate that the SPS data of the two samples is homogeneous. Thus, the next independent t test can be applied.

TABLE 16 to TABLE 21 show the results of the independent sample t-test of students' and teachers' understanding of SPS with sig. (2-tailed) greater than 0.05, which means that there is no significant difference in the average score of SPS understanding between students and teachers in group A. In other words, there is no difference in the average score of SPS understanding between students and teachers in group A. This finding indicates that students' and teachers' understanding of SPS in all groups is the same, a science teacher should have a better understanding of SPS compared to students in order to produce junior high school graduates who have better science process skills, so that students can carry out scientific activities in the science laboratory and can understand the concepts, principles, and laws of science correctly. This factor is thought to be that students and teachers are not used to practicing solving SPS problems. According to Chebii et al. (2012) and Luo et al. (2020) argue that by training students in SPS, it will improve their understanding of the concepts, principles, and laws of science.

TABLE 20, shows the results of the independent sample t-test of students' SPS understanding with a sig. (2-tailed) value smaller than 0.05, which means there is no significant difference in the average score of SPS understanding between groups A, B. Likewise between groups A and C (TABLE 21) and Groups A and D (TABLE 22). In TABLE 23, the same thing was found for groups B and C and also groups B and D (TABLE 24). Likewise between groups C and D (TABLE 25). The meaning of these results shows that student groups still really need continuous SPS training using various learning methods, for example, problem-based learning that can improve SPS understanding well. Thus, TABLE 26, shows that the results of the independent sample t-test of teachers' SPS understanding with a sig. (2-tailed) value greater than 0.05, which means there is no significant difference in the average score of SPS understanding between teacher groups A and B. Likewise, teacher groups A and C (TABLE 27), and group B and C (TABLE 29). The meaning of this finding is that junior high school teachers in some areas in Indonesia still lack understanding of SPS, this causes the average score of students' SPS to be low, this is in accordance with the findings of students' SPS in the area being relatively low. While teachers in Groups A and D (TABLE 28); Groups B and D (TABLE 30), and Groups C and D (TABLE 31), found differences in the average scores of their SPS understanding. The meaning of this finding is that some junior high school teachers in several areas in Indonesia have mastered SPS. This is reflected in the results of the average scores of student groups in the area, the average scores are also different. This finding is in accordance with the theory put forward by which states that skills can be improved through practice in the learning process by applying various methods,

for example discovery learning, inquiry, problem solving, and project-based learning (AlKhamaiseha, 2022; Depari & Hasruddin, 2019; Diana et al., 2021; Aththibby et al., 2021; Fikriyati et al., 2022; Koomason, 2021).

CONCLUSION

In this study, we have explored the SPS understanding of students and teachers in Indonesia and found that the mean score of student group understanding is higher than that of the teacher group as Several indicators of the SPS average score of the student group are higher than the teacher group, including: making operational definitions of variables, making predictions, and making conclusions. The mean score of SPS understanding is not significantly different between the student group and the teacher group. Given that mean SPS scores showed no significant difference between students and teachers, collaboration between the two groups in a learning environment may enhance overall SPS understanding. Activities such as joint projects, collaborative research, or laboratory experiments where teachers and students work side by side can provide concrete examples of the scientific problem-solving process. This recommendation aims to improve the mastery of SPS for both teachers and students, so that both can develop together in a strong understanding of scientific process skills in the era of modern science learning. Increased SPS may contribute to higher PISA scores or better prepare students for complex problem solving, emphasizing the practical outcomes of addressing these educational needs.

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APPENDIX

Science Process Skills Diagnostic Test

Question instructions: Choose one of the most correct answers by putting a red mark or a cross (X) on the choices.

1. Which of the following is an observation only?
   A. That piece of metal is red, so it must be hot
   B. The road is wet, so it must be raining
   C. The table looks like it is made of wood.
   D. The child's block is orange

2. Which of the following represents a prediction about a snowman in front of the school?
   A. The snowman is made of three large balls.
   B. The students at school make snowmen
   C. The snowman will melt in five days
   D. The snowman has red scratches on his neck

3. Choose a definition that is not an operational definition.
   A. An acid is a substance that changes the color of litmus paper to pink
   B. Ice is frozen water
   C. Araser is a material that when rubbed on a pencil mark makes it disappear
   D. A telephone is a device used to talk to someone who is not physically present

4. Recently, Beth heard sirens blaring on a nearby street. The next day when he went to school he saw a house filled with wide black spots and smoke. The most reasonable conclusions regarding the above that he could make when describing what he saw were:
   A. The house was destroyed by a hurricane
   B. The house was destroyed by wild animals
   C. The house was destroyed by fire
   D. The house was destroyed by the storm

5. The written statement of the hypothesis must contain or strongly imply which of the following variables?
   A. Only independent variable or respond
   B. Only dependent variable or manipulated
   C. Manipulated and responding variables
   D. Both manipulated and responding variables, as well as all controlled variables

6. A student wants to know the effect of acid rain on fish populations. He took two jars and filled each jar with the same amount of water. He added fifty drops of vinegar (acid) to two jars and added nothing to the other. He then placed 10 similar fish in each jar. Both groups of fish were treated (oxygen, food, etc.) in the same way. After observing the behavior of the fish for a week, he came to a conclusion. What willdo you suggest improving the quality of this experiment?
   A. Prepare more jars with different amount of vinegar
   B. Add more fish to the two used jars
   C. Add more jars with different types of fish and different amount of vinegar in each jar
   D. Add more vinegar to the used jar

7. Which of the following statements is a deductive hypothesis?
   A. The higher the ambient temperature, the higher the frog's body temperature.
   B. The colder the temperature, the slower the plant grows.
   C. Algae are living organisms
   D. Leaves make food, stems carry food, and roots store food.

8. Suppose, you are taking photos in the neighborhood where you live. Boundary with your neighborhood are some farmer fields, you see some domesticated cows sharing space with some wild antelope.

Which of the following statements is an inference is…
   A. The cow and the deer are standing still there
   B. The cow and the deer don't attack each other
   C. Not a single animal in this area attacks each other
   D. Some of the cows are eating grass

9. Like question no. The following 8 statements that are included in identification are…
   A. The cow and the deer are standing still there
   B. Some of the cows are eating grass
   C. Grass is food for cows and deer
   D. Most of the grass in this area is eaten by cows

10. Suppose you heat five vessels containing different volumes of water using a Bunsen. The heating time is made the same, namely 1 minute each. The results are recorded as in Table 1 below.

TABLE 1. Data Results of Water Heating Observations

Water volume (ml) (manipulation variable)	Warm-up time (minutes) (control variable)	Temperature rise (response variable)
20	1	10
30	1	8
40	1	6
60	1	4
80	1	2
100	1	1

Based on the data in Table 1 above, the conclusion that can be made is to inductively formulate a hypothesis about what effect the volume of water has on the increase in water temperature!
   A. The greater the volume of water, the smaller the temperature rise required to heat thewater in 1 minute.
   B. The greater the volume of water, the greater the temperature rise required to heat the water in 1 minute.
   C. The smaller the volume of water, the smaller the temperature rise required to heat the water.
   D. The smaller the volume of water, the greater the increase in temperature required to heat the water.