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Comparison of Students Science Process Skills on Measurement Material Based on Gender

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Abstract

This study is a survey study conducted because of the different tendencies between male and female students. In addition, there has been no study that specifically examines each SPS indicator of male and female students with the aim of showing weaknesses and strengths between them based on the SPS indicators. Based on this statement, this study aims to describe and compare the profiles of basic science process skills of male and female students. This study uses tests as instruments and quota sampling techniques to select grade X students from State Senior High Schools in Singkawang. Data were analyzed using a combination of quantitative descriptive analysis and comparative statistical tests. The results of the study showed that overall, most of the basic science process skill indicators were in the 'moderate' category for both genders. However, the communication indicator stood out in the 'high' category. Female students had an advantage in basic science process skills compared to male students, although both genders showed the same weaknesses. On the other hand, male students were only superior to female students in the measurement indicator.

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1. Introduction

In the field of education, teachers should not only be able to develop students' cognitive skills but also nurture their psychomotor and affective abilities. Science process skills (SPS) are one of the elements that can train these three abilities, because SPS also makes students actively involved and creates interaction between facts, concepts, and principles of science [1]. SPS refer to the abilities involved in collecting and processing acquired data, enabling researchers to discover and develop new concepts, theories, principles, and facts. SPS separated into basic science process skills and integrated science process skills, basic SPS consists of observing, making inferring, measuring, communicating, classifying, and predicting, while integrated SPS consists of activities to control variables, define operationally, formulate hypotheses, interpret data, design experiments, formulate models of environment or physical phenomena [2].

SPS as one of the important elements can be influenced by various things, one possibility is influenced by gender. Because gender can influence a person in thinking and determining the solution to the problem taken [3]. The SPS studied in this study is basic SPS, according to the Ministry of Education and Culture about Learning Outcomes and Learning Objectives Flow, that the minimum SPS level must be mastered by grade X high school students is basic SPS [4].

The material used to measure students SPS is measurement, the measurement material was chosen because it covers the entire basic SPS indicator.

Relevant research conducted by Budiarti *et al*., [5] explored the SPS of seventh-grade students, they specifically investigated the relationship between SPS and students interest, student interest and SPS have a significant effect on success, increase learning outcomes, and affect student achievement. Additionally, Darmaji *et al*., [6], their study delved into critical thinking abilities alongside SPS. Interestingly, female students emerged as the standout performers in both areas. Finally, research by Hadi *et al*., [7] explored the differences between two academic tracks: MIA (Science) and IIS (Social Studies). Their investigation revealed that students in the MIA track outperformed those in the IIS track in terms of learning outcomes and scientific process skills. Interestingly, gender did not significantly influence these outcomes [7]. Based on this statement, it can be said that previous research has shown that male and female students have different tendencies, especially in studying SPS. However, only a few studies have specifically examined and compared students' basic SPS profiles by gender. Furthermore, no studies have examined each SPS indicator for male and female students with the aim of showing weaknesses or strengths between them based on SPS indicators. From that description, the purpose of this study is to profile the SPS of students, compare them across each basic SPS indicator based on gender, and identify which indicators demonstrate greater proficiency in male students compared to female students and vice versa.

2. Methods

This study is a survey study using comparative method as the approach. This type of research was selected due to its flexibility, which simplifies the research process, particularly with the integration of digital technology. Additionally, survey research is effective in capturing relevant conditions in real time. This study involved 467 respondents (198 male and 269 female). The respondents were selected using quota sampling from all Grade X students in a public high school Singkawang. To collect data on students SPS, the researcher used a test instrument adapted from Widia Sari [8]. The test consists of 18 multiple-choice questions, with each question representing one of the indicators SPS (observation, classification, prediction, measurement, inference, and communication).

Data collection began by providing a Google form link to physics teachers at each school, who then shared the link with their students. This approach was chosen to facilitate administration and analysis of responses from participants. Prior to distributing the test, students were informed that their responses would not directly affect their academic grades. The purpose was to encourage natural and honest responses from the students. A total of 882 tests were distributed, and 467 tests were successfully completed. The data was collected between March 5th and March 25th, 2024.

To obtain the profile of students SPS and determine whether there are differences in SPS between male and female students, a combination of quantitative descriptive analysis and comparative statistical tests is used. The descriptive analysis provides an overview of the SPS scores by assessing them based on SPS indicators and dividing them into three groups, with score (n) > 70 in high category, 30 ≤ (n) ≤ 70 is medium category, and less than 70 is low category [9]. Meanwhile, the comparative statistical tests (Mann-Whithey) evaluate whether there are significant differences in SPS performance based on gender.

3. Results and Discussion

The research has produced a profile of students SPS and its comparison based on gender, which can be observed as follows:

3.1. Students Science Process Skills

Figure 1 shows that all student SPS indicators have scores above 30, and one indicator has a score above 70. In other words, there are no indicators categorized as low, most fall into the 'medium' category. However, the communication indicator stands out with a 'high' category, making it the most mastered indicator. On the other hand, the prediction indicator is the least mastered by students. Figure 1 shows the profile of SPS possessed by students based on its indicators:

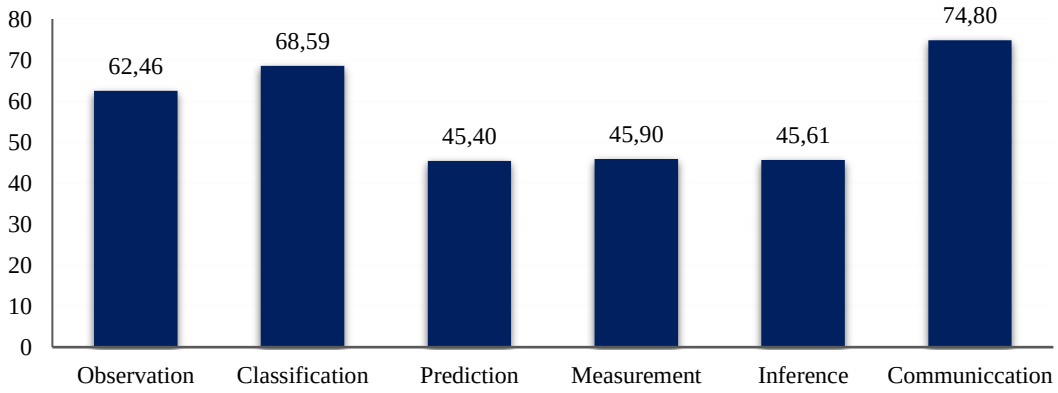

Figure 1. Profile of Students Science Process Skills

There are several factors that can influence students achievement levels in each indicator, such as: On the observation indicator, most students tend to focus on quantitative observation during their experiments and overlook qualitative observation. Quantitative and qualitative observations play different roles, quantitative observation is designed to establish standardization (using a numerical scale) and control, while qualitative observation is more naturalistic and not restricted by quantitative (numeric) categorization [10]. Based on this statement, it can be said that it is important to use both quantitative and qualitative observation because not all student experiments will yield quantitative data alone, there may be qualitative data or perhaps only qualitative data. In the classification indicator, teachers are lacking in providing assignments that train creative thinking skills.

As a result, students remain fixated on the criteria consistently used by previous teachers and do not attempt to use other criteria that allow for more creativity. This is in line with previous research on creative thinking abilities [11]-[13]. In the prediction indicator, students struggle to predict outcomes based on their observations, which are primarily quantitative data. Often, they overlook qualitative data [10], leading to difficulties in identifying patterns for prediction. As a result, most students find it challenging to envision what will happen. In the measurement indicator, students tend to focus only on quantitative measurements and lack proficiency in using qualitative measurements. Measurement is part of the SPS, involving the collection of information both quantitatively and qualitatively [14]. Based on this statement, students have not yet fully optimized their measurement skills. In the inference indicator, students lack understanding of the material taught, because students comprehension of the material is insufficient, it can lead to poorly formed conclusions [8]. Finally, in the communication indicator, students are often trained by teachers to create reports, give presentations, or engage in discussions after practical sessions under the guidance of their teachers. Through the application of the Think-Talk-Write learning model, students communication skills can be enhanced [15].

In summary, it can be said that there are no significant obstacles to students SPS, but there is room for improvement, particularly in the areas of prediction, measurement, and inference. This aligns with the findings of previous research conducted by Widia Sari [8].

3.2. Students Science Process Skills based on Gender

Based on Figure 2, that shows that all indicators for male students fall into the 'medium' category, while female students have 2 indicators in the 'high' category. The indicator most mastered by both male and female students is communication. However, the least mastered indicators differ: for male students, it is inference, whereas for female students, it is measurement.

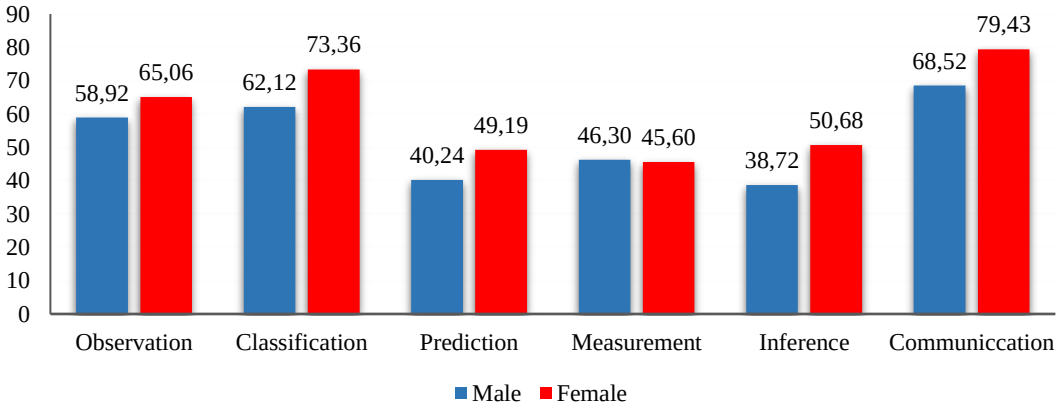

Figure 2. Profile of Students Science Process Skills Based on Gender

To further investigate whether there are differences in SPS between male and female students and examine the results of the following statistical test (Table 1).

Table 1. Data Descriptives

	Male	Female
N	198	269
Min	0	6
Max	94	100
Range	94	94
Mean	52.47	60.55
Median	55.56	61.11
Std. Deviation	22.338	21.862
Skewness	-.072	-.102
Kurtosis	-.994	-.838
Variance	498.966	477.960

Based on Table 2, it is shown that the sample size exceeds 50; therefore, the normality test used is the Kolmogorov-Smirnov test.

Table 2. Normality Test Result

	Gender	Kolmogorov-Smirnov[a]		
		Statistic	df	Sig.
SPS	Male	.105	198	.000
	Female	.086	269	.000

Based on results Table 2, the Kolmogorov-Smirnov Sig. value for both male and female students SPS data is 0.000. According to the decision criteria for normality tests, when the p-value is less than 0.05, its concluded that the data are not normally distributed.

Table 3. Test of Homogeneity of Variances

	Levene Statistic	df1	df2	Sig.
Based on Mean	.563	1	465	.453
Based on Median	.514	1	465	.474
Based on Median and with adjusted df	.514	1	465.000	.474
Based on trimmed mean	.577	1	465	.448

Based on the Table 3 sig. based on mean values for the SPS variable in male and female students (which is 0.453), we can make the following conclusions: Since the Sig. value (0.453) is greater than 0.05, according to the decision criteria for homogeneity tests, we conclude that the variance of SPS scores for male and female students is equal or homogenous. Given that the normality test results indicate non-normal distribution, and the homogeneity test results suggest equal variance, the next appropriate step is to perform a non-parametric test such as the Mann-Whitney U test.

Table 4. Mann-Whitney Test Result

	SPS
Mann-Whitney U	21456.000
Wilcoxon W	41157.000
Z	-3.600
Asymp. Sig. (2-tailed)	.000

From the results of the Mann-Whitney test (Table 4), it is evident that the Asymp. Sig. (two-tailed) value is 0.000, which is smaller than the significance level of 0.05. Therefore, it can be said there are SPS difference between male and female students. Based on the comparison of scores for each SPS indicator and the results of the statistical test (Mann-Whitney), it is evident that female students outperform male students. This difference may be attributed to the fact that female students exhibit greater interest in learning compared to male students. Female students can have higher science process skills because they demonstrate higher enthusiasm and curiosity during practical activities [6]. Interestingly, this finding contrasts with research conducted by Gasila *et al*. [16] , which indicates that male students have higher average scores than female students. Some studies also suggest that male students tend to be more dominant in utilizing spatial abilities compared to their female counterparts [17], [18].

4. Conclusion

The profile of SPS among female students is higher than male students. For male students, all SPS indicators at the medium category, whereas female students have 2 indicators classified as high and 4 indicators as medium. Both male and female students share the same weaknesses in SPS, specifically in the areas of prediction, measurement, and conclusion. Almost across all indicators, female students outperform male students, except in the measurement indicator, where male students excel over female students.

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