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Comparison of Science Process Skills of Students at SMAN 16 Samarinda Based on Gender

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Abstract

Science process skills (SPS) are essential competencies in chemistry learning that support development of scientific thinking and evidence-based problem solving. This study aimed to analyze differences in students' SPS based on gender in chemistry learning at a public senior high schools in Samarinda. The study used a retrospective comparative quantitative approach. The SPS data were collected by using documentation technique involving 65 SPS of eleventh grade students (31 males and 34 females) who programmed chemistry subject. SPS data were analyzed descriptively and inferentially using the Mann-Whitney U test ($\alpha = 0.05$). The results showed that there was no significant difference in overall SPS between male and female students ($p = 0.333$) and in most indicators ($p > 0.05$), except for the observation indicator ($p = 0.004$), with female students having a slightly higher descriptive mean. These findings confirm that mastery of SPS is more influenced by the quality of the learning process than by gender factors, thus contributing empirically to the application of inclusive science learning oriented towards scientific activities.

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1. INTRODUCTION

Science education plays an important role in helping students understand natural phenomena scientifically while developing rational and critical thinking skills (Robbia & Fuadi, 2020). Science learning not only emphasizes mastery of concepts, but also equips students with problem-solving and evidence-based decision-making skills that are relevant to everyday life (Muslimin & Pertiwi, 2025). This is in line with the (OECD, 2019) statement which emphasizes that science education contributes to improving science literacy, namely the ability to use scientific knowledge to explain phenomena and solve problems. In addition, effective science education plays a role in fostering scientific attitudes and preparing students to participate in a science and technology-based society (Saba, 2024). To that end, science learning needs to involve scientific practices such as observing, questioning, reasoning, and concluding in order to build a deeper and more applicable conceptual understanding (Selamat, 2021). In this context, students also need to be equipped with critical thinking, problem-solving, data analysis, communication, and collaboration skills so that the learning process is meaningful (Hutagalung & Meiliasari, 2025; Widodo, 2016). Developing these skills is really important because it helps students get ready for the difficulties and changes they will face in the 21st century.

The skills used by students in conducting systematic scientific investigations, from observation to drawing conclusions based on data, are referred to as Science Process Skills (SPS) (Kurniawati, 2021). The application of SPS in science learning helps students understand concepts more deeply, increases active engagement, and develops critical thinking, creative, and scientific communication skills (Damopolii et al., 2018; Ginting et al., 2022; Sinta & Agustina, 2024). Various

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studies show that the integration of SPS with learning models such as inquiry and guided discovery learning models, and learning methods such as experiments, can improve students' science learning outcomes and critical thinking skills (Angelia et al., 2022; Boling & Fauziah, 2024; Irmi et al., 2019; Jannah, 2025; Saputra, 2025; Suwardani et al., 2021; Toyibah et al., 2024; Wahyuni et al., 2017; wiratman et al., 2023). So, developing SPS is a key part of learning science because it helps make the learning experience more relevant and connected to students' real lives (Maulida et al., 2025).

Gender is often studied as a factor that influences students' SPS due to differences in learning characteristics, experiences, and responses to science learning between male and female students (Muliani et al., 2023; Tawil & Muhiddin, 2024). A number of studies show differences in SPS based on gender, where female students tend to excel in observing, interpreting data, and communicating results compared to male students (Abadi et al., 2017; Darmaji et al., 2022; Rahmawati et al., 2018). However, other findings state that these differences are not always significant and are influenced by the learning model applied in the classroom (Fernando et al., 2020). Therefore, it is important to conduct a study of SPS based on gender to gain a more comprehensive understanding in designing inclusive and effective science learning.

A study of SPS based on gender is important to understand the differences in characteristics and learning needs of students in science education. Gender-based analysis provides an overview of the strengths and weaknesses of male and female students in certain aspects of SPS, such as observing, interpreting data, and communicating results (Ramlawati & Rampean, 2024). This information can be used by teachers in designing learning strategies that are more equitable, inclusive, and responsive to individual differences among students (Santoso et al., 2023). In addition, Gender-based SPS studies have the potential to reduce learning gaps and increase the effectiveness of science learning in the classroom because male and female students often demonstrate different profiles in scientific inquiry competencies, cognitive processing, and engagement in science learning. Understanding these differences allows educators to design gender-responsive instructional strategies that create more equitable learning environments and optimize learning outcomes for both groups (Budiarti et al., 2022a; Darmaji et al., 2024; Ervina et al., 2018; Salma & Umami, 2024).

Sukemi et al. (2025) conducted guided inquiry-based learning on determining the pH of natural acid-base indicators to strengthen students' SPS. This was done based on reports from teachers at the school who stated that SPS, especially those majoring in science (chemistry), needed to be trained and strengthened. The learning process yielded empirical data on students' mastery of SPS in various aspects: observing, classifying, interpreting, predicting, communicating, asking questions, formulating hypotheses, designing experiments, using tools/materials, applying concepts, and conducting experiments, as a result of the learning process that had taken place. The data reflects students' SPS abilities with diverse characteristics, including gender differences. However, there have been no reports or analyses of the learning outcomes regarding differences in students' SPS in terms of gender differences.

This study focuses on students' SPS in science learning by examining the differences based on gender. The study is directed at analyzing the level of mastery of male and female students' SPS in the aspects of observing, classifying, interpreting, predicting, communicating, asking questions, formulating hypotheses, designing experiments, using tools/materials, applying concepts, and conducting experiments. This study wants to find out if there are any differences in SPS between boys and girls, and also to see how well each gender is mastering SPS. The results of this study are expected to provide empirical information for educators in designing more effective, fair, and responsive science learning strategies that take into account student characteristics. Thus, this study contributes to the development of science learning that is oriented toward improving students' scientific skills and scientific processes.

2. METHOD

This study employed a retrospective comparative design, a research design that compares groups using data from past events or existing records to determine differences, relationships, or patterns (Sembiring et al., 2023), to analyze differences in SPS between male and female students using previously collected assessment data. This approach allows the

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authors to examine differences between groups without providing additional treatment, since the students' SPS data were already available from previous learning activities. The research subjects consisted of 65 students (11h grade at public senior high school in Samarinda), consisting of 31 male students and 34 female students. All students were students who took chemistry. These students were divided into two learning groups, namely classes XI-2 and XI-7, and were taught using a guided inquiry learning model on the topic of natural acid-base indicators. The students' SPS data covered various skill aspects, namely observing, classifying, interpreting, predicting, communicating, asking questions, formulating hypotheses, designing experiments, using tools/materials, applying concepts, and conducting experiments. Students' SPS data was collected using documentation techniques from data collected from previous studies. The SPS data was collected by teachers or revious researcher using test techniques (20%), observation techniques (40%), and documentation of student work on worksheets/guides (40%), using validated instruments. The data were analyzed descriptively and inferentially by first conducting a normality test Kolmogorov-Smirnov, then a difference test using the Mann-Whitney U test with a significance level of 0.05.

3. RESULT AND DISCUSSION

3.1. Result

A detailed analysis of students' SPS was carried out both as a general assessment and individually for each specific SPS indicator. These indicators included observing, classifying, interpreting, predicting, communicating, asking questions, formulating hypotheses, designing experiments, using tools and materials, applying concepts, and conducting experiments. This is done to provide a more comprehensive picture of achievement trends based on gender. Indicators analyzed. The results of the analysis are presented in Figure 1.

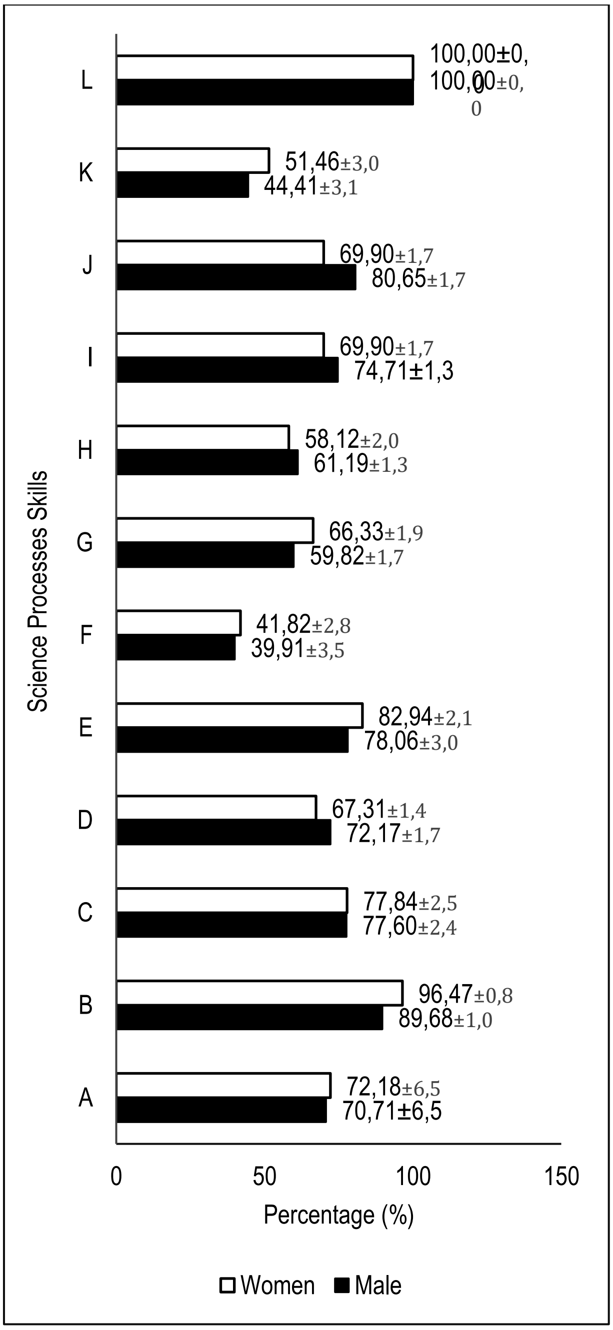

Figure 1. Science Process Skills Based on Gender, A = Overall Science Process Skills, B = observing, C = classifying, D = interpreting, E = predicting, F = communicating, G = asking questions, H = formulating hypotheses, I = designing experiments, J = using tools and materials, K = applying concepts, and L = conducting experiments.

Figure 1 shows that the students' SPS scores are in relatively the same category between the two gender groups. The SPS score for male students (70.71±10.8) is slightly lower than that for female students (72.18±10.8). Although visually there appears to

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be a difference between the SPS scores of male and female students in terms of both total SPS and each skill indicator, this difference is not statistically significant. This is reinforced by the results of the Mann-Whitney test, which shows no significant difference in SPS based on gender (see Table 1).

To ensure the suitability of the inferential analysis procedure used, students' SPS data were first analyzed using a normality test. After doing this test, another test called the Mann-Whitney U test was used to see if there was a difference. A summary of the results from the normality test and the difference test is shown in Table 1.

Table 1. Normality Test and Difference Test Results

Code	Sig. Normality (Male)	Sig. Normality (Women)	Sig. Mann-Whitney (2-tailed)
A	0,001	0,027	0,333
B	0,000	0,000	0,004
C	0,000	0,000	0,688
D	0,000	0,000	0,886
E	0,000	0,000	0,906
F	0,000	0,000	0,580
G	0,000	0,000	0,061
H	0,000	0,000	0,931
I	0,000	0,000	0,903
J	0,000	0,000	0,444
K	0,000	0,000	0,438
L	-	-	1,000

Based on Table 1, the results of the Kolmogorov-Smirnov normality test show that the SPS data, as overall and for most indicators, do not follow a normal distribution ($p < 0.05$). Because of this, the analysis continued with the Mann-Whitney U test. The results of the difference test show that the overall SPS is not significantly different between male and female students ($p = 0.333$). Most SPS indicators include grouping, interpreting, predicting, communicating, asking questions, forming hypotheses, designing experiments, using tools and materials, applying concepts, and carrying out experiments, also showed significance values greater than 0.05, so there were no significant differences based on gender. However, a significant difference was found between male and female students in the indicator of observing ($p = 0.004$). Even though similar results have been reported in previous studies, examining this issue remains important to confirm whether such patterns are consistent across different schools, learning environments, and instructional practices. This study therefore contributes empirical evidence that SPS development is more closely related to the quality of learning activities than to gender differences (Darmaji et al., 2022; Fernando et al., 2020).

3.2. Discussion

Research on SPS from a gender perspective can help minimize learning disparities and improve the effectiveness of science instruction in classrooms. This is because male and female students may display different patterns in inquiry skills, cognitive processing, and levels of engagement in science learning. Recognizing these variations enables educators to develop gender-responsive teaching strategies that foster more equitable learning environments and support improved learning outcomes for all students (Budiarti et al., 2022; Darmaji et al., 2024; Ervina et al., 2018; Salma & Umami, 2024)

The absence of significant gender-based differences in SPS scores in this study may suggest that the science learning process implemented in the classroom provides relatively equitable learning opportunities for all students. It may further indicate that the teacher has effectively implemented instructional strategies that promote balanced participation and the development of SPS among both male and female students. Previous studies have shown that well-designed instructional strategies, particularly those that emphasize inquiry, active participation, and collaborative learning, can minimize gender disparities in science learning outcomes and process skills. For example, inquiry-based and student-centered learning approaches encourage all students to engage in observation, experimentation, and reasoning activities that foster the development of science process skills regardless of gender (Lederman & Abell, 2014).

Both male and female students gained the same learning experiences in learning activities, such as observing, classifying, interpreting, predicting, communicating, asking questions, formulating hypotheses, designing experiments, using tools/materials, applying concepts, and conducting experiments. This condition allows both groups of students to develop SPS in a balanced manner without any gender-based discrimination. This is in line with the principle of inclusive learning, which emphasizes equal opportunities for all students (Sunandar & Baidowi, 2026; Tawil & Muhiddin, 2024).

This study also shows that things like the way students learn and the methods they use are more important than just being male or female when it comes to developing their ability to think scientifically. Science learning that focuses on student activities and active participation usually helps develop scientific thinking skills in a balanced way. When students take part in activities like looking at information, understanding what they see, and sharing their findings, things like their gender don't stand out as much. Thus, the quality of learning is a key factor in the achievement of SPS (Kamilah & Louise, 2025; Subekti & Ariswan, 2016).

SPS can be improved through practical experience because students feel more involved in the process or activities they are doing (Septiani, 2024). SPS is not an innate ability inherent to a particular gender, but rather a skill that grows through practice, habituation, and active involvement in science learning. This could be the reason why studies find no big differences between boys and girls in their performance. If students have equal chances to learn and are exposed to the same things, they are likely to develop their SPS skills in a similar way.

The learning environment and culture at school also play a role in minimizing gender-based differences in scientific literacy. A conducive learning environment, teacher support, and a classroom atmosphere that encourages active participation from all students can help develop scientific literacy optimally (Budiarti et al., 2022b). A school culture that does not differentiate students' roles based on gender allows students to participate freely in scientific activities. This contributes to the equal distribution of SPS among students.

This study's findings agree with many earlier studies that show differences in SPS between genders are not always big and are mostly affected by the learning environment (Afriana et al., 2016; Fernando et al., 2020; Tawil & Muhiddin, 2024; Widyastuti & Sahal, 2023). This study's findings support the idea that gender alone does not decide how much students develop their SPS. This study's findings suggest that students' SPS is more affected by how good the learning process is, rather than by their gender. Using the guided inquiry learning model helps give both boys and girls the same chance to learn, which allows their understanding of SPS to develop in a balanced way (Puspito et al., 2021). Previous research has also found that there is no significant difference in SPS between male and female students, confirming that gender is not a dominant factor as long as learning is carried out fairly and inclusively (Darmaji et al., 2022). Therefore, teachers need to focus learning on scientific activities that actively involve students without distinguishing gender. However, this study has limitations in terms of sample size and the use of a posttest-only design. Further research is recommended to involve a broader sample and examine other variables, such as learning models and students' initial characteristics, which have the potential to influence SPS.

4. CONCLUSION

The results showed that overall there was no significant difference in science process skills (SPS) between male and female students ($p = 0.333$), although descriptively female students had a slightly higher average SPS (72.18 ± 10.8) than male students (70.71 ± 10.8). Most SPK indicators also showed no significant differences, except for the observation indicator, which showed a significant difference between the two groups ($p = 0.004$). These findings indicate that SPS mastery is largely not determined by gender factors, but is more influenced by the quality of the learning process that provides equal learning opportunities to all students. Thus, the application of science-based learning activities such as guided inquiry has the potential to develop SPS in a balanced manner, although in certain aspects (e.g., observing) small differences between genders may arise.

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