Radiasi: Jurnal Berkala Pendidikan Fisika
Vol. 19 No. 1 (2026) pp. 26 - 33
http://jurnal.umpwr.ac.id/index.php/radiasi/index
p-ISSN: 2302-6111 e-ISSN: 2549-0826

The Influence of Learning Motivation on Students' Science Process Skills in Physics Learning From a Gender Perspective

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Abstract

Physics learning emphasizes not only conceptual mastery but also the development of science process skills (SPS), which are essential for fostering critical, logical, and creative thinking. Previous studies have examined the influence of gender or motivation separately, but little attention has been given to their combined effect. This study aimed to investigate the influence of learning motivation and gender, both individually and interactively, on students' SPS in physics learning. A quantitative survey with a comparative design was conducted involving 200 ninth-grade students (92 male and 110 female) at SMPN 4 Singkawang, selected using saturated sampling. Data were collected through a 22-item learning motivation questionnaire and a 10-item SPS test, and analyzed using two-way ANOVA after normality (Sig. = 0.200) and homogeneity (Sig. = 0.340) assumptions were met. The descriptive results showed a mean SPS score of 40.07 with a standard deviation of 13.47. The ANOVA results indicated that learning motivation (F = 1.866, Sig. = 0.137) and gender (F = 2.465, Sig. = 0.118) did not significantly affect SPS when considered separately. However, the interaction between motivation and gender was significant (F = 4.559, Sig. = 0.004), demonstrating that the combination of these variables influences students' SPS outcomes. In conclusion, individual factors alone do not determine SPS, but their interplay shapes students' scientific abilities. Therefore, instructional strategies in physics learning should integrate motivational and gender-responsive approaches to effectively enhance SPS.

Keywords: *Learning motivation; Science process skills; Gender perspective*

Article Info:
Recieved:
02/08/2025
Revised:
08/04/2025
Accepted:
21/04/2025

1. Introduction

Physics is a branch of natural science that aims to develop logical, critical, creative and rational thinking skills in students so that they can contribute to the world of education. In learning physics, there is not only a collection of theories and concepts but also a process for discovering something [1]. One of the things that is often used in a study or research to find something such as a concept, principle, theory or law related to science is science process skills (SPS). Science process skills are important abilities needed to understand and learn concepts in natural science [2]. These skills are needed to acquire, develop and apply scientific concepts, principles, laws and theories, both in the form of mental, physical and social abilities [3]. SPS also makes students actively involved and creates interactions between facts, concepts and scientific principles [4]. SPS also can be influence by various things, such as learning motivation and gender.

Learning motivation plays an important role as an indicator of student success in participating in the educational process. Learning motivation is an internal and external drive for students who are learning to make changes in behavior [5]. SPS as one of the important elements in education can not only be influenced by students' learning motivation but can also be influenced by other things such as gender. Gender plays a role in shaping how individuals make decisions, because gender differences influence tendencies in thinking and reasoning [6]. In the context of physics learning at schools, many students still struggle to develop science process skills (SPS). Instead of engaging in scientific inquiry, students often rely heavily on memorizing formulas and theoretical concepts, which limits their ability to observe, classify, measure, and interpret data effectively. This lack of engagement is closely linked to low learning motivation, which reduces students' participation in experiments and classroom discussions. Previous studies have emphasized that learning motivation is a strong predictor of academic achievement; students with higher motivation are more capable of overcoming challenges in science learning compared to those with lower motivation. However, in practice, many junior high school students demonstrate moderate to low motivation, which hinders the optimal development of their SPS in physics education.

Another important issue in schools is the role of gender differences in shaping students' scientific abilities. Several studies have reported that female students tend to find in observation and interpretation skills, while male students often show stronger performance in measurement and spatial reasoning tasks. Conversely, other research has found no significant differences between male and female students, creating uncertainty about the extent to which gender influences SPS. This inconsistency poses challenges for teachers in designing fair and effective instructional strategies, as student characteristics cannot be considered in isolation. Therefore, it is crucial to examine the combined influence of learning motivation and gender on SPS, providing a more comprehensive understanding of the factors that shape students' success in physics learning at school. Relevant research conduct by Bayu et al., [7] explored the Basic SPS of tenth-grade students, they delved into the relationship between SPS and gender, the result was female student had an advantage almost on every indicator except measurement which is male student had advantage on, although both share the same weakness. Additionally, Putri et al., [8], their study explored influence of gender on misconceptions about substance pressure. Interestingly, according to their study there is no difference in misconceptions between male and female students on the material on substance pressure, so there is no chance of experiencing misconceptions in studying the material. Lastly, research by Utami et al., [9] stated that students' academic abilities can be influenced by gender. Differences in self-confidence between men and women in completing academic assignments also impact students' academic abilities. Differences in brain structure between men and women can also lead to differences in thought patterns, especially among junior high school students who are still developing. These findings suggest inconsistencies in the role of gender and motivation when studied separately. However, there is a lack of research that simultaneously investigates the interaction effect of learning motivation and gender on SPS. This gap leaves unanswered questions about whether these factors, when combined, exert a stronger influence on students' scientific abilities in physics learning.

Based on this statement, it can be said that all of the previous study has shown that male and female students are difference on a lot of aspect at studying, especially on studying SPS. This study conducted to continue previous study which is explored about relationship between SPS and gender. There many studies that talk about relationship between SPS and only one variable (gender, etc), but lack of SPS and two variables. This study explored on influences of learning motivation and gender to SPS, the reason is to compare if there are difference between individual influence and combine influence.

2. Methods

This study is a survey type with a comparative design and uses a quantitative approach to analyze the relationship between variables. This study approach was chosen because of its adaptability, making the study process easier, especially when using digital tools. Additionally, survey study is effective in collecting relevant data in real time. This study involved 200 responders (92 male and 110 female). The respondents were selected using saturated sampling technique for all grade IX students in SMPN 4 Singkawang. The instruments that used to collect data is a learning motivation questionnaire and a science process skills test, for a leaning motivation questionnaire researcher using questionnaire adapted from Sri Esterina [10] that consist of 22 statements and for a science process skills test researcher using test adopted from Putu Dias Maretha Surya [11] that consist of 10 expanded multi-choice questions.

Data collection began by going to school to meet Science teachers at SMPN 4 Singkawang and make a schedule to go to each class in grade IX consist of 8 classes. Researcher attended to all of 8 classes according to the schedule, with the purpose of sharing to all students grade IX a Google Form link and provide instructions for filling out the Google Form. A total 240 students informed and provide with google form links, and 200 responders were successfully collected each for questionnaire and test. The data were collected between May 15th and May 23rd, 2025. To draw conclusions regarding whether or not there are differences in students' science process skills based on student learning motivation and gender, as well as the influence of the interaction between student learning motivation and gender on students' science process skills. Two-way ANOVA has several prerequisite tests to ensure the results are valid. These include verifying the data meets assumptions of normality and homogeneity of variance.

3. Results and Discussion

The results of this research have produced a description of overall students SPS, Between-Subject Factors, Descriptive Statistics and Tests of Between-Subjects Effects, which can be observed as follows: In this study, a two-way Analysis of Variance (ANOVA) statistical technique was used to analyze the results. Two-way ANOVA is used to calculate more than two mean differences. The data to be processed using two-way ANOVA is the research data that the researcher has conducted at SMP Negeri 4 Singkawang. Below is a descriptive table of the Student KPS research data (Table 1).

Table 1. Data Descriptive

N	200
Mean	40.07
Median	42.5
Std. Deviation	13.473
Variance	181.533
Range	62.5
Minimun	12.5
Maximum	75

The descriptive statistics (Table 1) provide an overview of students' science process skills (SPS). With a sample size of 200 respondents, the mean SPS score was 40.07, the median was 42.5, and the standard deviation was 13.47. The variance of 181.53 and a wide score range of 62.5 (minimum = 12.5, maximum = 75) indicate substantial variability in students' SPS performance.

This suggests that while some students demonstrated strong scientific abilities, others struggled considerably, reflecting heterogeneous skill levels across the students'. Based on Table 2, it is shown that the sample size is exceeds 50; therefore, the normality test used is the Kolmogorov-Smirnov test.

Table 2. Normality Test Result

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
SPS	.053	200	.200

Based on Table 2, the Kolmogorov-Smirnov Sig. value for students SPS data is 0.200. Based on the established guidelines for normality assessments, a p-value below 0.05 suggests that the data does follow a normal distribution pattern. The normality test results (Table 2) using the Kolmogorov-Smirnov test yielded a significance value of 0.200, which is greater than 0.05. This confirms that the SPS data were normally distributed, meeting one of the key assumptions for parametric analysis. Similarly, the homogeneity of variance test (Table 3) using Levene's statistic produced a significance value of 0.340 (> 0.05), indicating that the data variances were equal across groups. These findings validate the use of two-way ANOVA for further analysis.

Table 3. Homogeneity Test Result

	Levene Statistic	df1	df2	Sig.
Based on Mean	1.140	7	192	.340
Based on Median	1.037	7	192	.407
Based on Median and with adjusted df	1.037	7	175.805	.407
Based on trimmed mean	1.157	7	192	.330

Based on the Table 3 sig. Based on mean value for the SPS variable, we can make the following conclusions: Sig. value (0.340) > 0.05, according to the decision criteria for homogeneity tests, the variance data is equal or homogenous. Given that the normality test results normal distribution, and the homogeneity test result showed equal variance, the next appropriate step is to perform two-way ANOVA test.

Table 4. Two-Way ANOVA Test Result

	Type III Sum of Squares	df	Mean Square	F	Sig.
Motivation	947.420	3	315.807	1.866	.137
Gender	417.217	1	417.217	2.465	.118
Motivation*Gender	2314.602	3	771.534	4.559	.004

The two-way ANOVA results (Table 4) reveal three important findings. First, learning motivation did not significantly influence SPS (F = 1.866, Sig. = 0.137), meaning that differences in motivation levels (very good, good, moderate, poor) did not correspond to significant differences in SPS scores. Second, gender also did not significantly affect SPS (F = 2.465, Sig. = 0.118), suggesting that male and female students performed similarly in terms of scientific skills.

However, the third finding is critical: the interaction between motivation and gender was statistically significant (F = 4.559, Sig. = 0.004). This indicates that while motivation and gender individually did not predict SPS outcomes, their combination produced meaningful differences. In other words, the effect of motivation on SPS varied depending on gender, and vice versa. Quantitatively, the study achieved several important outcomes. It confirmed that neither motivation nor gender alone is a sufficient predictor of SPS, but their interaction plays a decisive role. This highlights the complexity of student learning characteristics, where multiple factors must be considered simultaneously. The significant interaction effect demonstrates that instructional strategies should not treat motivation and gender as isolated variables; instead, they must be integrated to design effective, responsive learning environments. The study's achievement lies in providing empirical evidence that the interplay of affective (motivation) and demographic (gender) factors shapes students' scientific abilities in physics learning.

From the results of the Two-Way ANOVA test (Table 4), there is 3 conclusions that can be draw according to the hypothesis research. First hypothesis, it showed in Motivation column Sig. value > 0.05 therefore it can be said there are no difference Students' SPS based on Learning Motivation, this is supported with research conduct by Utami et al., [9] which who found that learning motivation did not significantly influence science process skills. Second hypothesis, it showed in Gender column Sig. value > 0.05 it can be said there are no difference SPS between male and female, interestingly contrast to research that conducted by Budiarti *et al*., [12] which states that differences in interests and responses between genders have an impact on learning outcomes and science process skills. Some studies suggest that female students outperformed male students [7][13]. Research indicates that in some instances, male students exhibit a propensity to demonstrate greater aptitude in tasks requiring spatial reasoning than their female peers [14][15]. Third hypothesis, when we look at the Motivation*Gender column it showed Sig. value < 0.05, therefore there is a significant interactive influence between learning motivation and gender on students' science process skills. This is supported with research by Harso et al., [16] which states that the integration between affective and gender factors results in variations in students' ways of thinking and acting in completing scientific tasks.

The findings of this study revealed that gender, when considered independently, did not significantly affect students' science process skills (SPS). However, the interaction between gender and learning motivation produced a significant effect, suggesting that gender differences may manifest more strongly when combined with other factors such as motivation. This aligns with previous research indicating that gender differences in learning outcomes are often subtle and context-dependent rather than absolute. For instance, [1] reported that female students tended to excel in observation and interpretation skills, while male students showed advantages in measurement tasks. Such differences reflect variations in cognitive tendencies, where female students may demonstrate stronger verbal and analytical reasoning, while male students often exhibit higher spatial reasoning abilities [14], [15].

From a psychological perspective, gender can influence self-confidence, risk-taking, and persistence in problem-solving, all of which are critical in physics learning. Morever, [3] emphasized that differences in self-confidence between male and female students affect their academic performance. Female students may approach scientific tasks with greater caution and thoroughness, while male students may rely more on spatial visualization and direct experimentation. These tendencies can shape how students engage with SPS tasks, particularly in physics, which requires both conceptual reasoning and practical measurement skills. Furthermore, [4] highlighted that motivational factors interact with gender, meaning that male and female students respond differently to motivational stimuli in learning contexts.

The significant interaction effect found in this study underscores the importance of considering gender not as an isolated variable but as part of a broader set of student characteristics. While gender alone may not determine SPS outcomes, its interplay with motivation creates meaningful differences in how students perform scientific tasks. This suggests that instructional strategies in physics should adopt a gender-responsive approach, ensuring that both male and female students are equally supported in developing SPS. For example, teachers could design activities that balance spatial reasoning tasks with analytical reasoning tasks, thereby accommodating diverse strengths across genders. Ultimately, the study contributes to a more nuanced understanding of how gender influences physics learning, highlighting that effective pedagogy must integrate both motivational and gender-sensitive considerations.

This study, while providing valuable insights into the interaction between learning motivation and gender on students' science process skills (SPS), is not without limitations. First, the research was conducted in a single school (SMPN 4 Singkawang) with ninth-grade students, which restricts the generalizability of the findings to broader populations. The sample size of 200 respondents, although adequate for statistical analysis, may not fully capture the diversity of student backgrounds, learning environments, and cultural contexts that could influence SPS. Second, the instruments used—a motivation questionnaire and a multiple-choice SPS test primarily measured self-reported motivation and cognitive outcomes. These tools may not fully reflect the complexity of students' affective and behavioral engagement in physics learning. Third, the study employed a cross-sectional survey design, which limits the ability to establish causal relationships between motivation, gender, and SPS. Longitudinal or experimental designs would provide stronger evidence of how these variables interact over time.

Future research should address these limitations by expanding the scope of participants to include students from different schools, grade levels, and cultural contexts, thereby enhancing the external validity of the findings. Researchers are also encouraged to employ mixed-methods approaches, combining quantitative measures with qualitative interviews or classroom observations, to capture a more holistic picture of how motivation and gender influence SPS. Additionally, longitudinal studies could track changes in motivation and SPS development across academic years, while intervention-based research could test specific teaching strategies designed to integrate motivational and gender-responsive elements. Such follow-up studies would not only strengthen the theoretical understanding of SPS but also provide practical recommendations for teachers to design inclusive and effective physics learning environments.

4. Conclusion

In conclusion, (1) There is no difference in students' science process skills based on learning motivation, The results of the two-way ANOVA test showed that students' learning motivation (very good, good, moderate and not good) did not have a significant influence on science process skills. (2) There is no difference in students' science process skills based on gender, both male and female students have equal scientific process skills abilities in the context of physics learning. (3) There is a significant interaction effect between learning motivation and gender on students' science process skills, this means that the combination of learning motivation and gender together influences the results of students' science process skills, although separately they do not have a significant influence. Thus, it can be said that individual student characteristics cannot be seen separately in influencing science process skills, but must be considered simultaneously so that the learning strategies implemented are more effective and responsive to student needs.

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