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Analysis of Students' Motivation in Learning Chemistry: Descriptive and Comparative Studies

Utari Aulia Tianda Saputri [a,1*], Ogi Danika Pranata [b,2], Dinyah Rizki Yanti Zebua [c,3]

[a,c] Chemistry Education, State Islamic Institute of Kerinci, Jambi, 37112, Indonesia
[b,c] Physic Education, State Islamic Institute of Kerinci, Jambi, 37112, Indonesia

[1]utari.saputri17@gmail.com ,
*corresponding author

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Abstract

This research analyzes high school students' motivation in learning chemistry, investigating its determinants and inter-school differences. Using a quantitative descriptive and comparative approach, data were collected from 207 students across two high schools via a motivation questionnaire, with 156 valid responses retained for analysis. Results revealed a moderate overall level of motivation, with self-efficacy, active learning strategies, and achievement goals emerging as significant factors. Comparative analyses indicated differences in self-efficacy and performance goals between the two schools. The findings underscore the importance of understanding students' motivation in chemistry learning and its implications for educational practice. Future research could explore contextual and longitudinal influences on motivation, informing evidence-based interventions to enhance students' learning experiences and outcomes. This study contributes to the literature on student motivation in science education and provides insights for educators, policymakers, and researchers seeking to promote student engagement and achievement in chemistry.

1. INTRODUCTION

In secondary education, particularly within Senior High Schools, science education, encompassing subjects such as biology, chemistry, physics, and mathematics, plays a pivotal role. Referred to as Natural Sciences, this curriculum is designed to equip students with critical thinking skills and the ability to respond to societal challenges stemming from scientific and technological advancements (OECD, 2018). Among these subjects, chemistry often emerges as particularly challenging for many high school students, leading to a lack of enthusiasm and reluctance to engage deeply with learning (Kind & Aston, 2022; Ristiyani & Bahriah, 2016).

The initial study conducted regarding the most challenging subject in the context of science education (biology, chemistry, physics, and mathematics) also revealed that chemistry ranks first as the most difficult (38.65%), followed by physics (37.20%). This study involved interviews with 207 Senior High School students. The other study also shows that the perception of students who find

chemistry challenging can lead to a lack of motivation to learn chemistry (Ang & van Reyk, 2013). Students' perception and interest in science and technology are important in learning. It can significantly influence their future development, esepcially their careers in these fields (A. L. Putri et al., 2024). The factors influencing chemistry learning can be categorized into three main groups: teachers, content or learning materials, and students. These factors include teaching methods, learning media, and the learning environment, significantly impacting students' motivation and success in learning (Anisa et al., 2017).

Motivation, the driving force behind an individual's actions, is crucial in achieving educational goals (Pratiwi, 2021). Motivation is rooted in self-awareness and self-regulation (Pranata, Sastria, et al., 2023; W. Wulandari & Pranata, 2023). These factors are primary indicators of personal competence within an individual's emotional intelligence (Goleman, 2006). The presence of motivation within an individual can evoke and enhance enthusiasm in the learning process. Learning motivation involves achieving educational goals, such as understanding the material and developing learning skills. Furthermore, learning motivation serves as a driving force or achievement drive that captures one's interest, commitment, initiative, and optimism in the learning process, urging them to consistently strive and study diligently.

Learning motivation varies among students, particularly in science education. While some students demonstrate high levels of motivation, others exhibit moderate and lower levels, which can significantly affect their learning experience (Hermiati et al., 2024; B. Wulandari & Surjono, 2013). Motivation is pivotal in enhancing students' abilities, directly influencing content mastery, focus, and active participation in chemistry learning (Aeni, 2016). Low learning motivation can negatively impact students by reducing the quality of their learning outcomes. In contrast, high motivation fosters improved learning outcomes, demonstrating a strong positive correlation between motivation and academic success (Dinatha & Laksana, 2017).

Motivation has emerged as a critical issue in science teaching in the 21st century, requiring special attention from educators (Zeyer, 2018), particularly in post-pandemic education (D. H. Putri & Pranata, 2023). Issues such as student interest, boredom, emotion, mental health challenges, and motivation have gained prominence in educational research (Utami et al., 2024; World Health Organization, 2021). Investigating learning in high schools is crucial for understanding the unique challenges and strategies related to post-pandemic changes in education, particularly in senior high schools. Initial studies conducted at Senior High School 1 Sungai Penuh and Senior High School 5 Kerinci have provided preliminary insights. Addressing this gap can contribute to developing tailored approaches to enhance student motivation and engagement in science education.

Students' motivation to implement learning becomes highly crucial because motivation significantly impacts the context of learning and education. Success in achieving learning goals depends on how much students actively engage in learning. Motivation plays a crucial role as a driving force for students to attain their learning objectives. It is important to acknowledge that the success of learning relies heavily on the level of student involvement and motivation. Understanding that motivated learning is a key element in effective teaching delivery. Therefore, student motivation can be considered a key learning element (Filgona et al., 2020).

Given the significant impact of motivation on education, understanding and enhancing student motivation is critical for effective teaching and learning, especially in secondary education (Hermiati et al., 2024; Satrianti et al., 2024). Thus, investigating student motivation in the context of chemistry learning becomes imperative. Despite the acknowledged importance of chemistry education in preparing students for the challenges of the modern world, many students perceive chemistry as challenging, leading to a lack of motivation and engagement. This phenomenon raises critical questions regarding the factors influencing student motivation in chemistry learning and its implications for educational outcomes.

Therefore, this research aims to analyze and investigate how various factors, including teacher strategies, learning materials, and student characteristics, influence student motivation in chemistry learning at Senior High School 1 Sungai Penuh and Senior High School 5 Kerinci. These schools were chosen due to their diverse student population and varying school environments. By exploring the nuances of student motivation within the specific context of chemistry education at these schools, this study seeks to provide insights that can inform the development of effective strategies to enhance student engagement and improve learning outcomes in chemistry.

2. METHOD

This study employed quantitative descriptive and comparative methods with a non-experimental approach (Creswell & Creswell, 2023). This approach was chosen to observe and analyze existing motivational levels without manipulating variables. The quantitative descriptive and comparative methods were used to assess and compare students' motivation levels in learning chemistry across two schools. The participants included second- and third-year science students from grades 11 and 12 at Senior High School 1 Sungai Penuh and Senior High School 5 Kerinci.

Cluster random sampling was employed to select four classes from each school, resulting in a total sample size of 207 students, with 124 from Senior High School 1 Sungai Penuh and 83 from Senior High School 5 Kerinci. This sampling method ensured a representative sample of students from both schools, capturing diverse motivational profiles. The respondents, aged 16 to 18, represented a mix of academic achievement levels and socio-economic backgrounds. Some students come from rural and suburban areas, and others from urban areas, reflecting the geographic and demographic characteristics of the two schools. Science classes were specifically selected for this study because they focus on science subjects, aligning with the research objective of understanding motivation in science education.

The study provides meaningful insights into the motivational factors influencing learning by including students with varied academic aspirations, socio-cultural contexts, and school environments. The diverse profiles of the participants enhance the generalizability of the findings, offering valuable perspectives on student motivation within different educational and contextual settings.

Students' motivation in learning chemistry was collected using a motivation questionnaire (Students' Motivation Toward Science Learning or SMTSL) (Tuan et al., 2005). The questionnaire focused on six indicators related to learning motivation: self-efficacy, active learning strategies, chemistry learning values, performance targets, achievement goals, and learning environment strategies. The questionnaire comprised 35 statements, including positive (27 statements) and negative (9 statements) items. The SMTSL questionnaire has been validated and shown to have high reliability in measuring student motivation in science learning. The Cronbach alpha for the entire questionnaire was 0.89; for each scale, the alpha ranged from 0.70 to 0.89 (Tuan et al., 2005).

Participants responded to the questionnaire using a Likert scale ranging from 1 to 5, with one indicating "Strongly Disagree" and five indicating "Strongly Agree" for positive statements and vice versa for negative statements, as shown in Table 1.

Table 1. Questionnaire Answer scale

Answer Choices	Scale	
	Positive (+)	Negative (-)
Strongly Agree	5	1
Agree	4	2
Netral	3	3
Disagree	2	4
Strongly Disagree	1	5

One distractor statement was included in the questionnaire to ensure respondent attention and comprehension, excluding 51 responses that did not meet this criterion. The remaining 156 students had valid responses, comprising 85 from Senior High School 1 Sungai Penuh and 67 from Senior High School 5 Kerinci.

Quantitative data analysis was conducted descriptively to provide an overview of students' motivation levels in learning chemistry (range, mean, standard deviation, and skewness). The average scores were categorized into different motivation levels, as indicated in Table 2.

Table 2. Classification of Motivation Level

Average Score ($\bar{x}$)	Level of Students' Motivation
$4 < \bar{x} \leq 5$	Very High
$2 < \bar{x} \leq 4$	Medium
$1 \leq \bar{x} \leq 2$	Very Low

Furthermore, a comparative analysis was performed using an independent samples t-test or Mann-Whitney U-test (based on data normality) at a significance level of 5% to ascertain whether significant differences existed in students' motivation between the two schools. Similar tests were conducted to compare each motivation indicator between the schools.

3. RESULTS AND DISCUSSION

Descriptive

The results of the descriptive statistical analysis for overall student learning motivation based on schools are presented in Table 3.

Table 3. Deskriptive Statistics of Average Motivation

Average Motivation	Range	Min	Max	Mean		Std. Deviation	Skewness	
				Statistic	Std. Error		Statistic	Std. Error
All Students	2.20	2.08	4.28	3.45	0.02	0.30	-0.61	0.20
Senior High School 1	2.17	2.08	4.25	3.41	0.03	0.28	-0.96	0.26
Senior High School 5	1.67	2.61	4.28	3.54	0.04	0.32	-0.31	0.29

Overall, students have exhibited a moderate level of motivation to learn chemistry. The moderate motivation levels suggest that while students are engaged, there is room for improvement in making chemistry more appealing and motivating. The distribution of the average motivation for each student is illustrated in Figure 1.

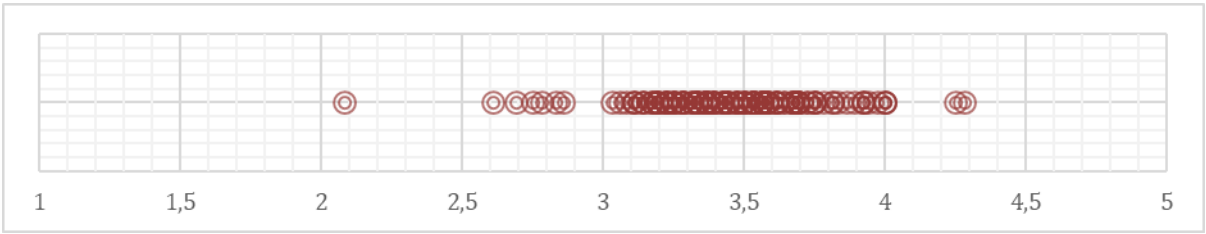

Figure 1. Distribution of Average Motivation for Each Student

The distribution data indicates that almost all students (150 out of 152) have moderate motivation to learn chemistry. The majority (143 students) fall within the range of 3.00 to 4.00 in average motivation. This group has motivation at a moderate to high level. The remaining (7 students) have lower motivation scores, ranging from 2.00 to 3.00, and can be categorized as a group with low to moderate motivation. Interestingly, there are no students with very low motivation. Conversely, only two students demonstrate high motivation in learning chemistry, constituting 1.32%.

Based on the average motivation scores in Tabel 1, it is evident that students at Senior High School 5 (3.54) exhibit slightly higher motivation levels motivation compared to students from Senior High School 1 (3.41), potentially due to students willingness to learn, their self-confidence to achieve learning goals, and their perceptions towards learning chemistry. Other factors also factor in

potential, such as differing teaching strategies or school environments. However, it is uncertain whether this difference is statistically significant or not. Therefore, further testing is required, specifically a comparative test using an independent samples t-test or Mann-Whitney U-test. Determining the comparative test requires information about the normality of the data. Based on the skewness statistic, it is observed that the motivation data for students in Senior High School 1 (-0.96) and Senior High School 5 (-0.31) are typically distributed as the values fall within the range of -1 to +1 (Leech et al., 2005; Morgan et al., 2004). Consequently, a comparison of motivation in learning chemistry between students from both schools is conducted using an independent samples t-test.

Before proceeding to the comparative test, descriptive analysis can still be further explored for each learning motivation indicator. The analysis results for the overall students based on the average values of each indicator are shown in Figure 2. Subsequently, the values for each indicator based on schools are illustrated in Figure 3.

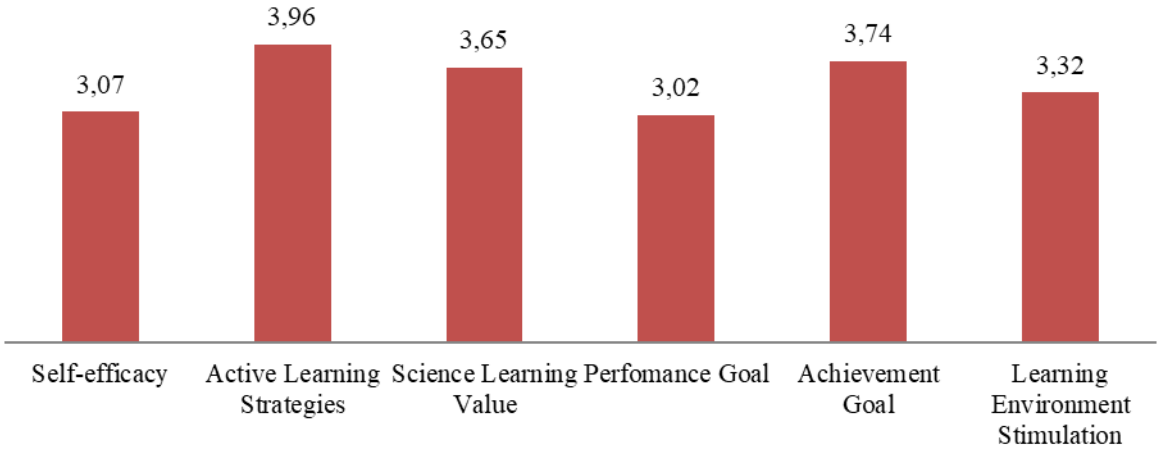

Figure 2. Average Motivation for Each Indicator

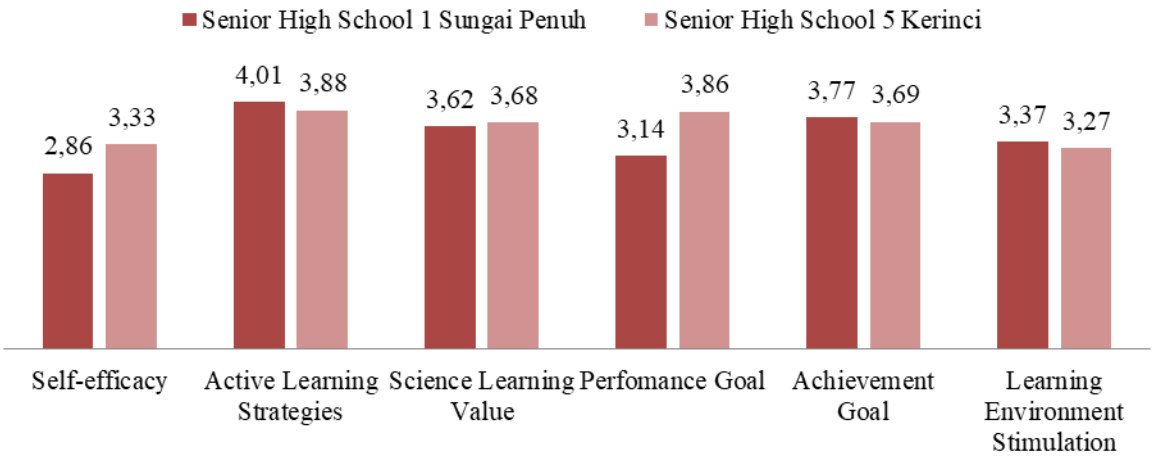

Figure 3. Average Motivation for Each Indicator Based on School

Figures 2 and 3 show the average motivation scores for each indicator. Active learning strategies (3.96), achievement goals (3.74), and science learning values (3.65) are the highest, while performance goals (3.02) are the lowest. Active learning strategies scored highest, suggesting students benefit from engaging, hands-on learning activities, such as inquiry-based learning (Pranata, 2023a), project-based learning (Pranata, Sundari, et al., 2023), and application of technological tools in learning (Pranata, 2023b, 2024). Conversely, performance goals scored lowest, indicating student only focus on the score, not the quality of their learning process. A detailed explanation of each indicator is elaborated as follows.

Among the six motivation indicators, it is notable that students believe in their ability to excel in learning tasks in the self-efficacy indicator. With an average score of 3.07 for this indicator. Seven questionnaire statements represent self-efficacy. The highest-weighted statements are

statement 1 ("not depending on the difficulty or ease of chemistry material, I am confident I can understand it") and statement 3 ("I am confident I can perform well in chemistry exams"), both with an average score of 3.6. Conversely, the lowest-weighted statement is statement 4 ("No matter how much effort I put in, I cannot learn chemistry"), with an average score of 3.

Previous studies have indicated that when students possess a high level of self-efficacy, they tend to strive for achievement, maintain optimism, and actively seek solutions for challenging tasks. Self-efficacy in learning chemistry is defined as students' belief in their ability to perform specific chemistry tasks (Cheung, 2015). Previous studies have also revealed that effort, persistence, and punctuality create differences in motivation among middle school students in science learning (Hermiati et al., 2024). Self-efficacy influences motivation through its impact on goal selection. Confident students are more likely to be motivated, complete tasks efficiently, and successfully achieve their targets. Conversely, students with low self-efficacy tend to opt for more manageable tasks and avoid challenging assignments. They may give up easily, reducing learning motivation and potentially poorer academic performance (Kurbanoglu & Akin, 2010).

In the following indicator, active learning strategies indicate that students actively employ various strategies to construct new knowledge based on their prior understanding. With the highest weighted score of 3.96, this indicator comprises eight questionnaire statements. The highest-weighted statements are statement 10 ("When I do not understand a chemistry concept, I seek relevant sources to help me") and statement 13 ("When making a mistake, I try to find out the reasons or sources of the mistake"), both with an average score of 4.2. Conversely, statements 9 ("When learning new concepts in chemistry, I relate them to previous learning experiences") and 12 ("During the chemistry learning process, I try to find relationships between the concepts learned") have the lowest weighted score of 3.7. Implementing active learning strategies is pivotal in enhancing students' learning outcomes. Active learning strategies involve engaging students in activities and fostering active participation in the learning process, with teachers serving as guides, motivators, and facilitators (Nasrulloh, 2015).

In the following indicator, the value of science learning entails allowing students to acquire problem-solving competencies, engage in inquiry activities, stimulate their critical thinking, and recognize the relevance of science to everyday life. Understanding these essential values motivates students to learn science. In this indicator, the weighted score is 3.65, with five statements. The highest-weighted statement is statement 20, with a score of 3.9, while the remaining statements receive a weighted score of 3.6. Previous research suggests that high intrinsic motivation and science learning values demonstrate that most eleventh-grade students in all high schools possess high intrinsic motivation and science learning values (Lestari et al., 2023). Previous studies have also revealed that task value in learning is the main factor that creates differences in motivation among middle school students in science learning (Satriani et al., 2024).

In the subsequent indicator, the performance goal targets students' aims in learning chemistry to compete with their peers and gain attention from the teacher. This indicator's lowest weighted score is 3.02, comprising four statements. Statement 23 has the highest-weighted score of 3.7, while statement 21 has the lowest weighted score of 2.1. Performance goals are associated with self-efficacy. Both indicators can directly predict students' learning goals differently (Liem et al., 2008).

Another indicator, achievement goal, focuses on the satisfaction perceived by students as they enhance their competencies and achievements during chemistry learning. In this indicator, the average motivation score for students is 3.74, with six questionnaire statements. The highest-weighted statement is statement 27, with a score of 4.1, while the lowest score is found in the trap question for students who read the statement, which is statement 30, with a weighted score of 2. Motivation is influenced by the performance goal, where goals are directed toward activities that encourage continuous learning. The Achievement Goal Framework outlines students' motivation based on their perceptions of competency assessment, elucidating two goal orientations: mastery and performance. Students' goal orientations in this framework can be categorized into three types: task-based, self-based, and other-based (Lewis, 2018).

In the final indicator, stimulating the classroom learning environment, such as the curriculum, teacher instruction, and student interactions, influences students' motivation to learn chemistry. In this indicator, the average motivation score for students is 3.32, comprising six questionnaire statements. Statements 32 and 33 have the highest-weighted score of 3.5, while

statements 34 and 35 have the lowest weighted score of 3.1. Previous research indicates that learning environment strategies play a pivotal role in learning, emphasizing the need to optimize factors influencing chemistry learning to ensure its efficacy (Anisa et al., 2017).

Figure 2 demonstrates that the most significant contribution to students' overall motivation in learning Chemistry comes from active learning strategies (3.96), achievement goals (3.74), and science learning values (3.65)—figure 3 highlights differences in the two schools' average scores for each motivation indicator. Senior High School 5 Kerinci students tend to score higher in three motivation indicators: self-efficacy, science learning value, and performance goals. Conversely, Senior High School 1 Sungai Penuh students score higher in the other three indicators: active learning strategies, achievement goals, and learning environment stimulation. Similar conclusions apply to the overall average motivation scores; however, the differences require confirmation of significance through comparative tests. A comprehensive statistical analysis for each motivation indicator based on school needs to be presented to determine the appropriate test, as shown in Table 4.

Table 4. Descriptive Statistics of Average Motivation for Each Indicator

Indicator	Mean		Std. Devotion	Swakness	
	Statistic	Std. Error		Statistic	Std.Error
Senior High School 1 Sungai Penuh					
1. Self-efficacy	2.86	0.049	0.454	0.376	0.216
2. Active Learning Strategies	4.01	0.055	0.511	-1.615	0.216
3. Science Lerning Value	3.62	0.074	0.684	-0.655	0.216
4. Perfomance Goal	3.14	0.075	0.691	-0.138	0.216
5. Achievement Goal	3.77	0.070	0.642	-1.199	0.216
6. Learning Environment Stimulation	3.37	0.064	0.588	-0.555	0.216
Senior High School 5 Kerinci					
1. Self-efficacy	3.33	0.086	0.706	-0.145	0.293
2. Active Learning Strategies	3.89	0.057	0.465	-0.852	0.293
3. Science Lerning Value	3.68	0.078	0.635	-0.716	0.293
4. Perfomance Goal	2.87	0.090	0.740	0.019	0.293
5. Achievement Goal	3.70	0.081	0.659	-0.229	0.293
6. Learning Environment Stimulation	3.26	0.088	0.723	-0.669	0.293

Based on the skewness statistic data in Table 4, it is observed that the data for indicators 1, 3, 4, and 6 are generally distributed for both schools. However, indicators 2 and 5 data, especially for Senior High School 1 Sungai Penuh students, are generally not distributed as the values are smaller than -1 (Morgan et al., 2004). Therefore, a comparative test is conducted using both tests. An independent samples t-test is used to compare indicators 1, 3, 4, and 6 between the two schools, while indicators 2 and 5 are compared using the Mann-Whitney U-test.

Comparative

The results of the comparative tests follow a consistent pattern and sequence. Firstly, a comparison of students' learning motivation between different schools was conducted using an independent samples t-test, as presented in Table 5. Secondly, the comparison of students' learning motivation between different schools for indicators 1, 3, 4, and 6 is performed using an independent samples t-test, as shown in Table 6. Thirdly, the same comparison for indicators 2 and 5 is conducted using the Mann-Whitney U-test, and the results are displayed in Table 5.

Table 5. Independent Samples t-test Results

	Levene's Test		t-test for Equality of Means						
	F	Sig.	t	df	Sig (2-tailed)	Mean Dif.	Std. Error Dif.	95% Confidence Interval of the Difference	
								Lower	Upper
Ev assumed*	2.29	0.29	0.27	150	0.786	-0.013	0.045	-0.110	0.083
Ev not assumed*			0.27	133	0.789	-0.013	0.050	-0.111	0.085

***Ev = Equal variances**

Table 6. Independent Samples T-test Results Per Indicator

	Levene's Test		t-test for Equality of Means						
	F	Sig.	t	df	Sig (2-tailed)	Mean Dif.	Std. Error Dif.	95% Confidence Interval of the Difference	
								Lower	Upper
1. Self-efficacy									
Ev assumed*	17.22	0.00	-4.97	150	0.000	-0.47	0.094	-0.657	-0.283
Ev not assumed*			-4.73	107	**0.000****	-0.47	0.099	-0.667	-0.273
3. Science Learning Value									
Ev assumed*	0.02	0.89	-0.56	150	0.580	-0.06	0.108	-0.274	0.154
Ev not assumed*			-0.56	146	0.577	-0.06	0.107	-0.272	0.152
4. Perfomance Goal									
Ev assumed*	1.00	0.32	2.36	150	**0.019****	0.27	0.117	0.045	0.506
Ev not assumed*			2.35	137	0.020	0.27	0.118	0.043	0.508
6. Learning Environment Stimulation									
Ev assumed*	2.88	0.09	1.00	150	0.316	0.11	0.106	-0.103	0.317
Ev not assumed*			0.98	125	0.328	0.11	0.109	-0.109	0.323

*Ev = Equal variance; **Significant differences

The analysis results in Table 5 involve comparing two data groups and assessing homogeneity through the F value in Levene's test. The findings of Levene's test, with a significant value of 0.29, indicate that the difference is insignificant because $\rho>0.05$. Consequently, the assumption of equal variance is accepted. Therefore, the independent samples t-test results refer to the first row (Ev assumed). The outcomes suggest that this variance is deemed insignificant despite a difference in motivation scores of 0.013. In other words, no significant distinction is observed in the learning motivation in chemistry among students from Senior High School 1 Sungai Penuh and Senior High School 5 Kerinci.

Motivation is important in every teaching and learning process (Maria et al., 2016). Its presence significantly impacts students' learning enthusiasm, rendering learning experiences more enjoyable, enhancing confidence in their abilities, and instilling a sense of responsibility toward the learning process (Bryan et al., 2011). Previous research indicates that students with high motivation tend to be more actively involved and achieve better results in school assessments. Motivation plays a pivotal role in creating effective learning experiences, with the level of student motivation

influenced by their personal beliefs and the perceived relevance of the learning material to their lives (Glynn et al., 2007).

The independent samples t-test results for indicators 1, 3, 4, and 6 provide insights into the significance of differences observed. Notably, significant differences (**) were only detected in indicators 1 (self-efficacy) and 4 (performance goal). Consequently, three key conclusions can be drawn from these findings. Firstly, Senior High School 5 Kerinci students exhibit higher self-efficacy scores than those from Senior High School 1 Sungai Penuh. Prior research has consistently demonstrated that students' self-efficacy significantly influences and correlates with their level of achievement motivation. This linear relationship suggests that higher levels of self-efficacy are associated with heightened achievement motivation, while a decline in self-efficacy may adversely affect students' motivation to achieve (Amir, 2020). The observed difference of 0.47 is not only noteworthy but also statistically significant.

Secondly, Senior High School 1 Sungai Penuh students demonstrate higher performance goal scores than their Senior High School 5 Kerinci counterparts. This discrepancy, with a difference of 0.27, is also deemed statistically significant. The higher self-efficacy in senior high school five students may be attributed to more supportive teaching practices to enhance students' willingness to learn chemistry and their perception of chemistry learning. The higher performance goals in Senior High School 1 students suggest focusing on competition and recognition from their teacher and peers.

Lastly, no significant differences were identified between students from the two schools regarding science learning value and learning environment stimulation. These findings underscore the importance of considering factors influencing students' motivation and learning experiences beyond school affiliation.

The other two indicators (active learning strategies and achievement goals) were compared using the Whitney U Test. The comparison test results in Table 7 indicate no significant difference in the indicators of active learning strategies and achievement goals between students from the two schools.

Table 7. Mann Whitney Test Results

	2. Active Learning Strategies	5. Achievement Goal
Mann-Whitney U	2402	2602
Wilcoxon W	4680	4880
Z	-1.67	-0.92
Asymp. Sig. (2-tailed)	0.10	0.36

The lack of significant differences in active learning strategies and achievement goals indicates that these factors are consistently emphasized across both schools, highlighting their importance in student motivation regardless of the school environmenta.

The relationship between active learning strategies and learning motivation can influence students' roles in the learning process and, ultimately, may impact learning outcomes (Dadach, 2013). Active learning strategies allow students to actively engage in the teaching-learning process. Active learning is commonly described as a process in which students directly participate in learning activities while reflecting on and considering what they do in the classroom. Thus, active learning strategies can create an environment that stimulates student motivation and positively impacts learning outcomes (Cicuto & Torres, 2016).

4. CONCLUSION

The descriptive analysis revealed that students generally exhibit a moderate level of motivation in learning chemistry, with few showing low motivation. While there were differences in the average motivation scores between students from Senior High School 5 Kerinci and Senior High School 1 Sungai Penuh, comparative tests revealed no significant overall differences in motivation between the two schools, despite variations in specific indicators such as self-efficacy and performance goals. Senior High School 5 Kerinci students showed higher self-efficacy, and Senior

High School 1 Sungai Penuh students demonstrated higher performance goals. Other indicators, including active learning strategis, science learning value, achievement goals, and learning environment stimulation, showed no significant differences. The similar overall motivation levels across schools suggest a need for further research to identify factors that enhance student motivation in chemistry.

It is recommended to delve deeper into the factors influencing students' motivation to learn chemistry. Future studies should explore qualitative methods to understand students' experiences and perceptions. Longitudinal studies could examine how motivation evolves, and comparative studies across educational settings could identify best practices. Interdisciplinary research could provide a comprehensive understanding of motivation in education.

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