The Implementation of Google Sheets–Assisted Guided Discovery Learning to Analyze Students' Interest and Learning Outcomes in the Basic Laws of Chemistry

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Article Info	Abstract
	This study aimed to analyze the implementation of Guided Discovery Learning (GDL) assisted by Google Sheets in exploring students' interest and learning outcomes in the Basic Laws of Chemistry for 11th-grade students. The research was conducted at a senior high school in Semarang, involving 45 students from classes XI Fearless and XI Genuine, selected using convenience sampling. An explanatory sequential design was employed, beginning with quantitative data collection on students' learning outcomes and interest in chemistry, followed by qualitative interviews to explain unexpected findings. Descriptive analysis showed that the average student interest score was 96.13 (75%), with the highest indicator being "students' attitude toward assigned tasks" (81%) and the lowest being "independent awareness in learning chemistry" (47%). Knowledge outcomes averaged 54.67, with only five students surpassing the Minimum Mastery Criteria. In the affective dimension, higher achievement was observed, particularly in levels A1 (receiving, 78%) and A3 (valuing, 76%). Critical thinking skills remained low, with 73% of students categorized as "very low." Interviews revealed that difficulties in understanding the material, a preference for conventional learning, and external factors contributed to the gap between high interest and low learning outcomes. These findings suggest that while GDL assisted by Google Sheets effectively enhances students' interest, additional instructional support and reinforcement are necessary to translate high interest into improved learning achievement.

INTRODUCTION

Education has become an integral part of human life. The objectives of Indonesian education, as stated in Article 3 of Law No. 20 of 2003 concerning the National Education System, are to develop individuals who are cognitively competent, humane, faithful to God, and aware of their roles as responsible citizens. In line with these goals, the integration of information and communication technology (ICT) in education is considered an essential strategy to adapt learning to the demands of the times while simultaneously fostering students' 21st-century skills (Sumardi et al., 2020). One form of ICT utilization in education is the use of Google Sheets. Google Sheets can support computer-supported collaborative learning (CSCL), for instance, when used as a medium for group-based electronic student worksheets (e-LKPD). One major advantage of Google Sheets–based e-LKPD compared to traditional paper-based worksheets is that all group members can simultaneously view, edit, and contribute content in real time (Andrew, 2019). This feature promotes collaboration, active participation, and shared knowledge construction among students. From a theoretical perspective, constructivist learning theory posits that learning is a process of constructing and expanding new knowledge based on prior knowledge. Learning is most effective when learners actively build their own understanding (Pritchard, 2009). One instructional model aligned with this theory is Guided Discovery Learning (GDL). According to Eggen and Kauchak (2016), GDL consists of several stages, namely Introduction and Review, Open-ended Phase, Convergent Phase, Closure, and Application.

Through these stages, students are guided to discover concepts independently while still receiving structured support from the teacher.

Previous studies have shown that Guided Discovery Learning can help students develop conceptual understanding more effectively and tends to increase students' learning interest (Rahmawati et al., 2022; Sunendar, 2016). Interest is both a cognitive and affective state (Duchesne et al., 2022). Learning interest can be defined as students' attraction toward a particular subject or learning topic and can be described through four dimensions: feelings of enjoyment, interest, attention, and student involvement (Slameto, 2003). High learning interest enables students to receive information more effectively and develop their knowledge more deeply (Budiariawan, 2019), which in turn positively influences learning outcomes. Learning outcomes refer to the abilities or behavioral changes acquired by students after participating in learning activities (Hamalik, 2003; Sudjana, 2009). Bloom classifies learning outcomes into three domains: cognitive, affective, and psychomotor (Woolfolk, 2020). Learning interest is particularly important in subjects or topics that are conceptually demanding, such as the basic laws of chemistry (Hidayat et al., 2015; Laliyo et al., 2020).

Observations conducted at SMA Kristen YSKI revealed several learning problems. Some students appeared less enthusiastic during chemistry lessons. This finding was supported by student responses to a questionnaire item stating, "I feel bored when learning chemistry," to which 47 out of 100 students agreed. In addition, a number of students perceived chemistry as an uninteresting subject, as indicated by responses to the statement, "Chemistry is enjoyable because it balances memorization and formulas," where 41 out of 100 students disagreed. When compared with the indicators of learning interest proposed by Slameto (2003), these findings suggest that students' interest in learning chemistry remains relatively low. This issue requires attention, as low learning interest can lead to ineffective learning processes and consequently low learning achievement (Rozikin et al., 2018). Based on the identified problems and observational findings, this study assumes that an effort is needed to analyze students' learning interest and learning outcomes, particularly in the topic of the basic laws of chemistry, in order to determine appropriate follow-up actions. Therefore, this study is entitled "The Implementation of a Google Sheets–Assisted Guided Discovery Learning Model to Analyze Eleventh-Grade Students' Interest and Learning Outcomes in the Basic Laws of Chemistry." The objectives of this study are to analyze students' interest in learning chemistry, examine students' learning outcomes on the topic of the basic laws of chemistry through Guided Discovery Learning, and investigate the relationship between students' learning interest and their learning outcomes in the basic laws of chemistry.

METHODS

This study was conducted at a senior high school in Semarang, Indonesia. The school was selected based on the identification of research-relevant issues, particularly indications of low student interest in learning chemistry as revealed through preliminary observations. The population of this study consisted of all eleventh-grade students at the selected senior high school. The research sample comprised students from two eleventh-grade classes, selected using convenience sampling, as these were the only classes receiving chemistry instruction during the research period. The study employed an explanatory sequential mixed-methods design. The research began with the collection of quantitative data, including students' learning outcomes on the topic of the basic laws of chemistry and their interest in learning chemistry. Based on the results of the quantitative analysis, specific findings requiring further exploration were identified. Subsequently, qualitative data were collected through interviews. The qualitative data served to support and deepen the interpretation of the quantitative findings, particularly in explaining results that did not align with initial expectations (Creswell, 2015).

Three variables were examined in this study. Two were quantitative variables: students' learning outcomes on the basic laws of chemistry, measured across the dimensions of knowledge, skills, and attitudes, and students' interest in learning chemistry. The third variable was qualitative, consisting of interview data obtained from students. Learning outcomes in the knowledge and skills dimensions were measured using written tests, while learning outcomes in the attitude dimension and students' learning interest were measured using questionnaires. Quantitative data were first analyzed descriptively using the Statistical Package for the Social Sciences (SPSS). The data were also classified into relevant categories to facilitate interpretation. The relationship between students' learning interest and their learning outcomes was then examined using **Pearson's correlation coefficient**, calculated with the assistance of SPSS. To provide a more comprehensive understanding of this relationship, the quantitative findings were further analyzed using qualitative interview data. The interviews aimed to explain unexpected or inconsistent patterns observed in the relationship between students' interest in learning chemistry and their learning outcomes on the basic laws of chemistry.
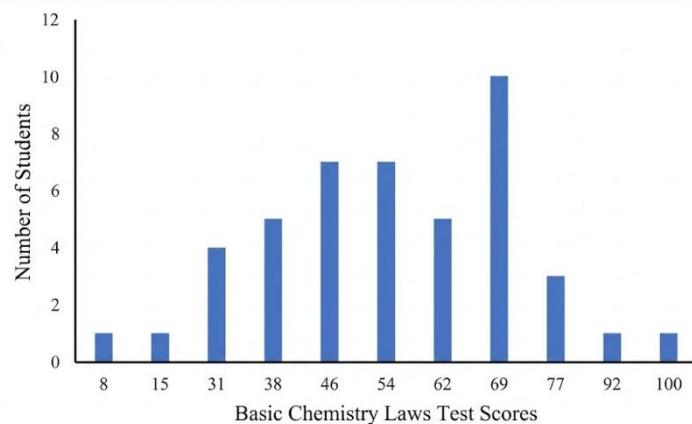
RESULT AND DISCUSSION

Descriptive Analysis of Learning Outcomes in the Knowledge Dimension on the Basic Laws of Chemistry

The results of the descriptive analysis of students' learning outcomes on the Basic Laws of Chemistry in the knowledge dimension are presented in **Table 1**. The analysis includes measures of central tendency, variability, and data distribution characteristics, namely the mean, standard deviation, minimum and maximum scores, skewness, and kurtosis.

Table 1. Statistic Descriptive

Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
54,67	18,573	8	100	-0,129	0,341

**Figure 1.** Distribution of Students' Learning Outcome Scores on the Basic Laws of Chemistry

The distribution of students' test scores on the Basic Laws of Chemistry is shown in **Figure 1**. Learning outcomes in the knowledge dimension were obtained from a written test, with descriptive statistics indicating a mean score of 54.67 (SD = 18.573). The wide range between the lowest and highest scores reflects substantial variability in students' achievement. The skewness value shows a slight left-skewed distribution, suggesting that several students obtained scores far below the average. Furthermore, only 5 out of 45 students (11%) achieved scores above the Minimum Mastery Criterion (KKTP) of 70, indicating that most students had not yet met the expected learning objectives in the knowledge dimension.

Each test item was grouped according to the levels of knowledge based on Bloom's taxonomy, and students' scores for each level were calculated. The distribution of learning outcomes across the different cognitive levels is presented in Figure 2. It can be observed that only a small proportion of students (7%) achieved at least a "Sufficient" score at the C4 level (Analyzing). This is unfortunate, as the implemented guided discovery learning model has not yet fully developed students' critical thinking skills as expected (Rahmawati et al., 2022). At the C3 level (Applying), 27% of students achieved at least a "Sufficient" score, which is still far from the expected mastery. The C2 level (Understanding) showed the highest percentage of mastery among the three levels, reaching 60%. Although the mastery at C3 and C4 levels has not met the target, classroom observations indicated that students who had not yet achieved mastery still demonstrated motivation and engagement by making efforts to understand the material and occasionally asking questions to the teacher or peers. Despite the suboptimal scores, the learning process itself reflected positive outcomes.
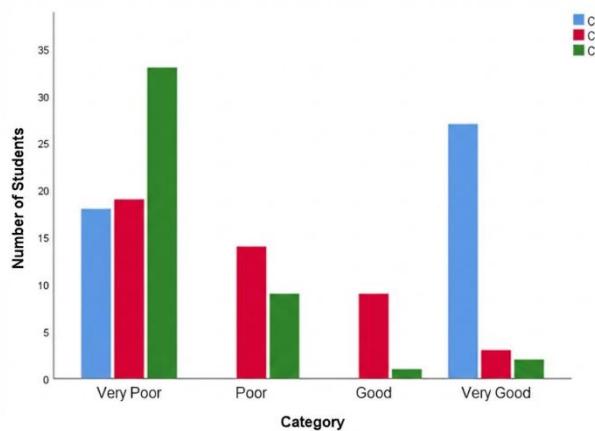
Figure 2. Distribution of Student Learning Outcomes by Bloom's Taxonomy Levels

Descriptive Analysis of Chemistry Basic Laws Learning Outcomes – Affective Dimension
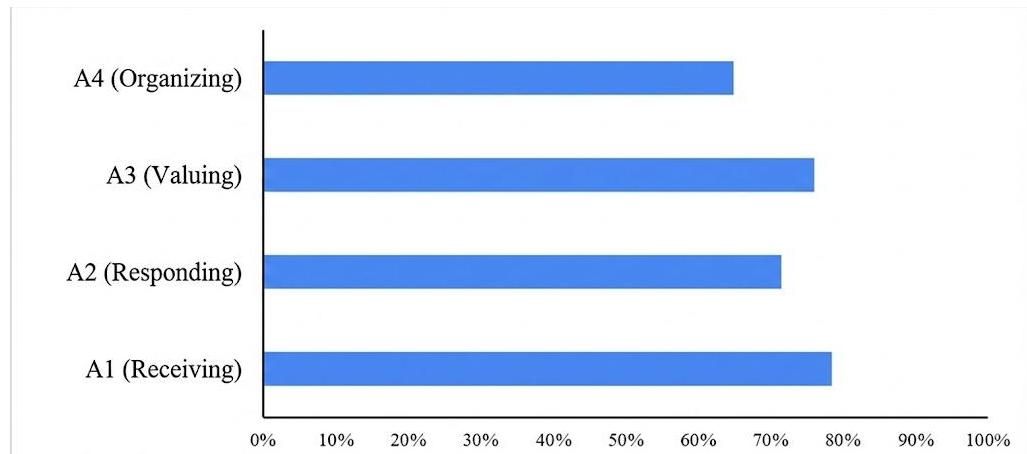

Figure 3. Average Student Attitude Scores Across Affective Levels

The affective learning outcomes were obtained from a learning interest questionnaire administered at the end of the lesson. Each questionnaire item was aligned with the affective levels of Bloom's taxonomy. The average scores for each affective level are presented in Figure 3. The figure shows that students generally demonstrate positive attitudes in terms of acceptance and appreciation. This is reflected in their efforts to participate in the learning process, such as paying attention during discussions and actively asking questions to peers or the teacher. Such active engagement is also considered one of the advantages of implementing the guided discovery learning model (Eggen & Kauchak, 2016).

Descriptive Analysis of Basic Chemistry Learning Outcomes: Skills Dimension

The skills dimension of learning outcomes was obtained from the basic chemistry achievement test. The skills measured focused on critical thinking, using indicators from Ennis (2018). The test items, originally based solely on Bloom's cognitive levels, were adjusted according to Ennis's critical thinking indicators, and the scores from these items were used as the basis for measuring the skills dimension of critical thinking. Two critical thinking skill indicators were assessed: **Basic Clarification** (analyzing arguments: identifying reasons or premises) measured in items 8 and 13, and **Inference** (deduction and evaluating deductions: conditional logic) measured in items 10, 11, 14, and 15. The distribution of students' critical thinking skills is presented in Figure 4.
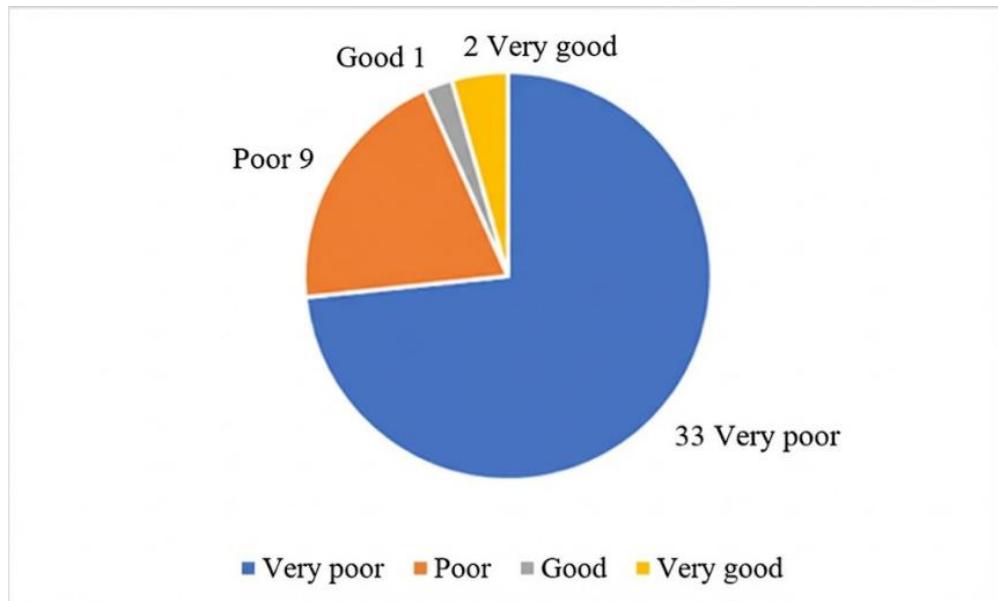
Figure 4. Distribution of Critical Thinking Skills

The results show that the majority of students (73%) fall into the "Very Low" category for critical thinking skills. Only a small portion of students (7%) reach at least the "Sufficient" category. This indicates that most students' abilities in **basic clarification**, including argument analysis, and **inference**, including deduction and evaluation of deductions, remain very low. Unfortunately, this shows that the implemented **guided discovery learning** model has not yet been able to develop students' critical thinking skills as expected (Rahmawati et al., 2022).

Descriptive Analysis of Students' Interest in Chemistry

Table 2. Descriptive Analysis of Chemistry Learning Interest in Class XI Fearless

Mean	Std. Deviation	Minimum	Maximum	Skewness	Kurtosis
96,13	14,204	71	131	0,138	-0,461

The descriptive analysis of students' interest in chemistry is presented in Table 2. The average score of students' interest in chemistry was 96.13 (SD = 14.204). When converted into a percentage, the average interest reached 73%, which falls into the "High" category. Students with the lowest interest were in the "Moderate" category, while students with the highest interest were in the "Very High" category. Classroom observations reflected these scores: students with low interest often appeared inattentive or engaged in activities unrelated to learning, whereas highly interested students actively asked questions, participated in discussions, and frequently assisted peers. The moderate standard deviation indicates a fairly uniform distribution of interest levels, while the positive skewness (0.138) suggests that several students had higher-than-average interest, pulling the distribution slightly to the right. The highest interest was observed in the indicator "Students' attitude toward assigned tasks" (81%), closely followed by "Communication between teacher and students" (80%). Most students demonstrated high engagement by completing tasks diligently and interacting actively with the teacher. For instance, students xi_f_9 and xi_g_2 consistently asked questions to confirm their findings. The indicator "Students' activeness during chemistry lessons" averaged 78%, showing that most students responded actively to questions and participated in discussions. Even some students who were generally less active, such as xi_f_2, xi_f_13, and xi_g_6, became more engaged during the guided discovery learning sessions on basic chemistry laws. Overall, the descriptive analysis indicates that guided discovery learning effectively promotes high student motivation and engagement, which aligns with previous research showing that active participation positively correlates with learning outcomes (Janssen et al., 2014; Schnitzler et al., 2021; Rahmawati et al., 2022).

Correlation Analysis between Students' Knowledge Dimension in Basic Chemistry Learning Outcomes and Interest in Chemistry

Table 3. Pearson Correlation between Learning Outcome Scores and Interest in Chemistry

	Chemistry Interest Questionnaire Score
	Pearson Correlation: 0.031
Basic Chemistry Test Score	Sig. (2-tailed): 0.838
	N: 45

A correlation analysis was conducted between students' test scores on basic chemistry learning outcomes and their interest in chemistry to examine the trend of their relationship. The Pearson correlation results are presented in Table 3. The analysis indicates a very weak positive correlation between students' basic chemistry test scores and their interest in chemistry, which is not statistically significant, $r(45) = 0.031$, $p > 0.05$. This suggests that increases in test scores tend to coincide with slight increases in interest scores, and vice versa, but the strength of this relationship is negligible. Therefore, it cannot be concluded that there is a significant relationship between students' knowledge dimension in basic chemistry learning outcomes and their interest in chemistry.

Relationship between Basic Chemistry Learning Outcomes and Students' Interest in Chemistry

Table 4 presents students' basic chemistry test scores, the corresponding learning outcome categories, chemistry interest questionnaire scores in percentage, and the category of students' interest in chemistry. From Table 4, it is evident that several students' learning outcomes do not align with their level of interest in chemistry. Previous research has shown that higher learning interest generally correlates with higher learning achievement, indicating a positive relationship between students' interest and learning outcomes (Suryana et al., 2022). The analysis of students' chemistry interest and their basic chemistry learning outcomes shows an interesting pattern. Although most students reported high interest in chemistry, their test scores did not always reflect this enthusiasm. For example, several students with high interest scores, such as xi_f_1, xi_f_3, and xi_f_5, scored very low on the basic chemistry test, indicating "very low" learning outcomes despite their strong motivation. Conversely, a few students, such as xi_g_11 and xi_g_17, achieved very high test scores corresponding to "very good" learning outcomes, which aligned with their reported high interest. Some students with moderate interest levels, for instance xi_f_8 and xi_g_3, still obtained low test scores. Interviews with selected students revealed that factors such as engagement in extracurricular activities, preference for conventional learning methods, difficulty in understanding guided discovery learning phases, and time constraints influenced the discrepancy between interest and learning outcomes. Overall, while high interest in chemistry was observed among many students, it did not consistently translate into high test performance. This suggests that factors beyond interest, including learning strategies, teaching methods, and external commitments, play a significant role in determining students' achievement in basic chemistry.

To better understand these unexpected patterns, interviews were conducted with students whose test scores did not reflect their reported interest levels. Additionally, students whose interest and learning outcomes were consistent were interviewed for comparison. Based on the interview summary Table 5, it can be seen that although most students show a high interest in learning chemistry, not all of them are able to achieve optimal learning outcomes in the topic of basic chemical laws. The factors influencing this discrepancy vary, including extracurricular commitments, adaptation after semester breaks, and preferences for conventional learning methods over guided discovery learning. Some students with high interest still struggle to understand the material because the reinforcement phase in the learning process was not fully effective, while others face challenges in concentration or lack attention to detail during tests. These findings indicate that high learning interest does not always correspond directly to high academic achievement, as successful learning is also influenced by instructional strategies, time management skills, and student preparedness prior to testing. Therefore, although the guided discovery learning model can enhance student interest and engagement, additional support such as material reinforcement, method adaptation, and individualized guidance is needed to ensure that high learning interest translates into optimal learning outcomes.

Table 4. Students' Chemistry Interest and Basic Chemistry Test Scores

Student Code	Questionnaire Score	Chemistry Learning Outcome Score	Interest Category	Learning Outcome Category
xi_f_1	103	38	High	Very Low
xi_f_2	94	46	High	Very Low
xi_f_3	119	8	Very High	Very Low
xi_f_4	101	62	High	Low
xi_f_5	117	54	Very High	Very Low
xi_f_6	98	38	High	Very Low
xi_f_7	105	31	High	Very Low
xi_f_8	76	46	Medium	Very Low
xi_f_9	112	54	Very High	Very Low
xi_f_10	95	77	High	Fair
xi_f_11	118	15	Very High	Very Low
xi_f_12	85	69	High	Low
xi_f_13	79	31	Medium	Very Low
xi_f_14	107	46	Very High	Very Low
xi_f_15	97	62	High	Low
xi_f_16	88	38	High	Very Low
xi_g_1	131	69	Very High	Low
xi_g_2	116	69	Very High	Low
xi_g_3	71	31	Medium	Very Low
xi_g_4	81	54	High	Very Low
xi_g_5	100	69	High	Low
xi_g_6	110	54	Very High	Very Low
xi_g_7	88	62	High	Low
xi_g_8	79	54	Medium	Very Low
xi_g_9	82	62	High	Low
xi_g_10	106	69	Very High	Low
xi_g_11	94	92	High	Very Good
xi_g_12	108	46	Very High	Very Low
xi_g_13	107	69	Very High	Low
xi_g_14	97	31	High	Very Low
xi_g_15	106	46	Very High	Very Low
xi_g_16	84	46	High	Very Low
xi_g_17	108	100	Very High	Very Good
xi_g_18	110	77	Very High	Fair
xi_g_19	71	38	Medium	Very Low
xi_g_20	73	69	Medium	Low
xi_g_21	93	54	High	Very Low
xi_g_22	92	69	High	Low
xi_g_23	86	62	High	Low
xi_g_24	95	69	High	Low
xi_g_25	95	38	High	Very Low
xi_g_26	97	69	High	Low
xi_g_27	90	77	High	Fair
xi_g_28	86	46	High	Very Low
xi_g_29	76	54	Medium	Very Low

Table 5. Summary of Student Interviews

Student Code	Summary of Interview Results
xi_f_1	• Has a personal interest in science, especially physics and chemistry. • Teacher also influences learning interest. • Sometimes bored or lazy but tries to overcome it. • Prior to the test, focused on a competition, so test preparation was suboptimal.
xi_f_11	• Finds the material interesting. • Likes concept application (calculations). • Just returned from semester break, so study for the test was not optimal.
xi_f_14	• Prefers concept application over theory. • Teacher influences learning interest. • Lazy and spends too much time on games, so study was not optimal.
xi_f_12	• Enjoys physics, chemistry, and math that involve calculations. • Strives for good chemistry grades for scholarship purposes. • Teacher does not influence learning interest.
xi_g_4	• Has high interest in chemistry. • Interest slightly decreased due to difficulty understanding basic chemistry laws with guided discovery learning → reinforcement phase not optimal → test score suboptimal.
xi_g_16	• Interest in chemistry mainly influenced by teacher. • Prefers physics and math that involve calculations. • Extracurricular activities (2x/week) and math tutoring (2x/week) limited study time for chemistry test.
xi_g_25	• High interest in chemistry. • Interest decreased due to difficulty with guided discovery learning → prefers conventional learning. • Test scores suboptimal due to incomplete understanding of material.
xi_g_28	• High interest in science, especially physics and chemistry. • Prefers conventional learning. • Struggled with guided discovery learning, so material not fully understood despite reinforcement → test score suboptimal.
xi_g_1	• High interest in science, especially chemistry. • Enjoys calculation-based material in math, physics, and chemistry. • Sometimes careless during tests, so scores below maximum despite meeting minimum competency.
xi_g_18	• High interest in chemistry. • Aspires to study Chemical Engineering, so studies physics and chemistry diligently. • High curiosity aligns well with guided discovery learning.

CONCLUSION

Based on the results of this study, it can be concluded that students' interest in learning chemistry is generally high, with an average score of 96.13 (75%), particularly in the indicator "students' attitude toward assigned tasks" (81%). However, this high interest does not consistently translate into high learning outcomes. The average score for the knowledge dimension was 54.67, with only 5 out of 45 students achieving scores above the Minimum Mastery Criteria (KKTP), while the majority remained below the expected threshold. The affective dimension showed relatively better results, with the highest achievement in level A1 (receiving) at 78% and level A3 (valuing) at 76%, reflecting students' positive attitudes and engagement during learning activities. In contrast, the skills dimension, particularly critical thinking skills, indicated that 33 out of 45 students were still in the "very low" category, suggesting that most students have not yet developed the ability to analyze and infer effectively. Interviews with selected students revealed several factors contributing to the gap between high interest and low learning outcomes, including difficulties in understanding the material, preference for conventional learning methods over guided discovery learning, limited time, and varying levels of concentration or focus. These findings indicate that while student interest is a crucial motivator, it must be accompanied by effective instructional strategies, targeted reinforcement, and individualized guidance to ensure that high interest is successfully converted into optimal learning achievement.

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