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High School Student Chemistry Learning Skills: An Empirical Study on Lombok Island

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Abstract: To achieve maximum learning, the study of learning skills is still needed, especially for teachers in implementing the teaching process. This study aims to assess the chemistry learning skills of high school students on the island of Lombok. It evaluated gender, grade level, learning style, learning interest, school location, and school status in students' chemistry learning skills with the researcher's instrument. This descriptive study involved 467 students from four districts/cities on Lombok Island. The questionnaire has 30 statements in five dimensions: responsibility, organization, independent work, collaboration in group work, and initiative. The research instrument was adapted from previous studies, tested, and validated to ensure its feasibility as a reliable measuring tool. Empirical data were analyzed using ANOVA, LSD, and Scheffe's test. The results showed that gender, grade level, learning style, interest in learning, and school status significantly affected students' chemistry learning skills. However, the school location showed little difference in all the skill dimensions measured.

Keywords: collaboration, initiative, interest, learning chemistry, responsibility

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INTRODUCTION

The current research report focuses more on the condition of education after the COVID-19 pandemic. For most students and teachers, two years of online learning has provided significant change, flexibility, and learning goals (Echeverría et al., 2022). The positive and negative impacts of online learning are an essential concern for dealing with the learning process after the pandemic (Jones, 2023).

The impact of the pandemic on students and teachers has become a concern of current education experts. The application of online learning causes changes in study habits that have an impact on student learning outcomes and emotional conditions (Bond et al., 2021; Chakraborty et al., 2020; Cranfield et al., 2021). As a result, many students experience a loss of learning skills (Donnelly & Patrinos, 2022; Händel et al., 2022).

Current learning still focuses on mastering 21st-century skills. The connection between 21st-century education and post-pandemic learning is improving skills in technology and creating a broader learning environment (Bozgun et al., 2022). As is well known, 21st-century education is centered on achieving (1) learning and innovation skills; (2) life and career skills; and (3) skills related to information processing, media, and technology (Wetchasit et al., 2020). However, this achievement will take more work to achieve after the pandemic. The critical learning point is returning to the face-to-face learning process or using blended learning (Erkut, 2020; Lin, 2021; Özalkan, 2021).

As with other science subjects, chemistry also faces problems in achieving learning objectives. The characteristics of chemistry content that integrates literacy and numeracy skills are quite a complex problem before and after the pandemic (Timilsena et al., 2022). Until now, reports on students'

conditions in chemistry after the pandemic are minimal. Even though students' perceptions of learning experiences are essential to collect (Yang et al., 2011), the resulting data can be used as a consideration for programming that can help improve the quality of learning in the future (Heflin & Macaluso, 2021; Yarbrough, 2018).

In Indonesia, there has been a change in the curriculum after the start of face-to-face learning. Thus, chemistry learning connected to students is very close to the chemistry teacher's interaction with the curriculum. According to Remillard (2005), this interaction consists of several aspects. First, chemistry teachers are oriented toward using active and participatory curriculum materials through interpretation, evaluation, and adaptation of curriculum materials. Second, chemistry teachers are involved in curriculum design to promote reform-oriented practices in the classroom. Third, teachers have an orientation toward their capacity for direct learning through curriculum implementation, including pedagogy, content, and knowledge. The first aspect consists of one dimension, which includes routine use. The second aspect comprises two dimensions: scientific inquiry and science; technology, society, and the environment. Finally, the third aspect includes the teacher learning dimension and is more dominantly related to teacher interaction to train students' chemistry learning skills (Chen et al., 2019).

Student learning skills are used to acquire new knowledge in classroom settings (Sam, 2013) . The term learning skills is comprehensive to describe the skills required to acquire new skills and knowledge, particularly in formal learning settings. The term learning skills is divided into several sub-categories, including information and communication skills, often associated with literacy; thinking skills and problem-solving; and interpersonal skills and self-regulation (Higgins et al., 2007). Chemistry and other science learning skills must be distinct from the abovementioned sub-categories.

Measurement of learning skills can be done through tests, observations, or self-assessment with a questionnaire (Higgins et al., 2007). To obtain learning skills data on a large scale, we can use self-assessment with a questionnaire that can be an option to provide information on how students learn, think, and act (Escolà-Gascón & Gallifa, 2022).

Self-evaluation of learning skills in high school students consists of five dimensions: responsibility, organization, independent work, collaboration in group work, and initiative. The five dimensions adopt 21st-century education skills to deal with fast, volatile, and unpredictable changes (Dishon & Gilead, 2021). Therefore, the five dimensions of learning skills described above have relevance to the level of thinking of high school-aged students.

There needs to be more study on analyzing students' learning skills, especially skills in learning chemistry. The assessment focuses more on achieving learning goals and implementing an independent school curriculum, even though the analysis of learning skills is needed to prepare programs that lead to the achievement of learning objectives.

This study aims to reveal the chemistry learning skills of high school students with the demographic conditions of the students.

METHOD

Types of research

Descriptive research is the type of research used in this study. Descriptive research aims to define the conditions and characteristics of the subjects studied.

Research Sample

The research data were obtained from 467 high school students on Lombok Island (n = 209 males, n = 258 females). The demographics of the research sample include gender, class, learning style, interests, school location, and school status (Table 1).

Table 1. Research Sample Demographics (N = 467)

		N	Frequency (%)
Gender	Male	209	44.75
	Female	258	55.25
Grade	Grade X	116	24.80
Level	Grade XI	184	39.40

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		N	Frequency (%)
	Grade XII	167	35.80
Learning	Kinesthetic	108	23.10
Style	Audio Visual	116	24.80
	Kinesthetic and Audiovisual	243	52.10
Motivation	Low	123	26.30
	Moderate	238	51.00
	High	106	22.70
School	Mataram City	117	25.05
Location	Central Lombok District	117	25.05
	East Lombok District	117	25.05
	West Lombok District	116	24.85
School	Public High School	154	32.98
Status	Public Madrasah School	151	32.33
	Individual High School	78	16.70
	Individual Madrasah School	84	17.99

Research Instruments

Based on literature studies, this study uses a questionnaire that measures chemistry learning skills with five dimensions, namely responsibility, organization, independent work, collaboration in group work, and initiative. A total of 35 statements were developed, consisting of positive and negative statements. The statements are on a ten-point Likert scale, ranging from strongly disagree to strongly agree.

The research questionnaire was first validated by five experts in the field of chemistry education. All statements were assessed based on their relevance to the measured dimensions. Revisions were made based on expert advice, and as a result, five statements were excluded because they were considered less relevant. So, the questionnaire used consisted of 30 statements (19 positive statements and 11 negative statements).

After analysis, 30 statements (Table 2) were formed with a loading factor below 0.3. All statements had a Pearson correlation between 0.269 and 0.776. The scale consistency interval was found to be 0.88 using Cronbach Alpha. Each dimension had reliability: responsibility (five statements, α = 0.743), organization (seven statements, α = 0.853), independent work (five statements, α = 0.743), collaboration in group work (seven statements, α = 0.833), and initiative (six statements, α = 0.748).

Table 2. Questionnaire of CLS

No	Indicator	Statement	Category
1	Responsibility	1. I am responsible for assignments in chemistry subjects.	Positive
		2. I am not committed to understanding the material in chemistry lessons.	Negative
		3. I do the assignment given by the chemistry teacher	Positive
		4. I must be on time to submit the assignments the chemistry teacher gave according to the agreed time.	Positive
		5. I receive a penalty if I do my chemistry assignment better.	Positive
2	Organization	1. I make a plan so that chemistry assignments are correctly completed.	Positive
		2. I was doing my chemistry homework while another lesson was going on.	Negative
		3. I obey the instructions given by the chemistry teacher when completing assignments.	Positive
		4. I do not set priorities in solving chemistry assignments.	Negative
		5. I manage my time as best as possible so that all chemistry assignments are correctly completed.	Positive
		6. I identify what is needed to complete a chemistry assignment.	Positive
		7. I used information from friends when learning chemistry.	Negative
3	Independent Work	1. I judge my ability to learn chemistry.	Positive
		2. I try a good way of studying to get better grades in chemistry.	Positive
		3. I ignore the chemistry teacher's suggestions for the assignments given to me.	Negative

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No	Indicator	Statement	Category
		4. I use my spare time to understand chemistry better.	
		5. I ignore the teacher's explanation during chemistry class.	Positive Negative
4	Collaboration in group work	1. I accept the assignment given to me by the group during chemistry class.	Positive
		2. I determine for myself the tasks I want to do during chemistry lessons.	Negative
		3. I appreciate the opinions conveyed by group mates during chemistry lessons.	Positive
		4. I do all the group assignments myself during chemistry lessons.	Negative
		5. I convey the idea of completing a chemistry assignment with my group mates.	Positive
		6. I work together with all group friends when completing chemistry assignments.	Positive
		7. I accept all the decisions given by group members when completing chemistry assignments.	Negative
5	Initiative	1. I find out if I need help understanding the chemistry concepts taught by the chemistry teacher.	Positive
		2. I keep quiet if I can't do chemistry problems.	Negative
		3. I take additional tutoring to understand chemistry concepts.	Positive
		4. I always volunteer to work on chemistry problems in front of the class.	Positive
		5. I need help solving the questions given by the chemistry teacher.	
		6. I keep quiet when my friends have difficulty understanding chemistry.	Negative
			Negative

Data Analysis Technique

Student scores on each dimension were tabulated, and the average was calculated. The analysis used one-way ANOVA, Scheffe test, and LSD with the help of the SPSS program (IBM SPSS 21).

RESULT AND DISCUSSION

There were significant differences between male and female students for all dimensions of chemistry learning skills. Female students showed higher average chemistry learning skills (CLS) in all dimensions than male students. The summary of the descriptive statistics for gender on the five CLS dimensions is shown in Table 3.

Table 3. Mean and Standard Deviation of the Five Dimensions of the CLS Questionnaire for gender

Dimension of questionnaires	Gender	Mean	SD	P
Responsibility	Male	6.845	2.0166	0.000
	Female	7.636	1.7993	
Organization	Male	7.052	2.1167	0.000
	Female	8.029	1.7513	
Independent work	Male	6.658	1.9616	0.000
	Female	7.308	1.7020	
Collaboration in group work	Male	7.256	1.9752	0.000
	Female	8.009	1.6742	
Initiative	Male	6.165	1.9187	0.001
	Female	6.724	1.8053	

$p < 0.05$

The one-way analysis showed that class differences had a significant effect on CLS for class XII students showing the highest average score compared to class X and class XI for all CLS dimensions (Table 4). The Scheffe and LSD tests showed that the average scores on the dimensions of responsibility, organization, independent work, and collaboration in group work for class XII were significantly

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different from class X but not significantly different from class XI. The initiative dimension showed that the three classes were not significantly different.

Table 4. Mean and Standard Deviation of the Five Dimensions of the CLS Questionnaire for grade-level

Dimension of questionnaires	Class	Mean	SD	P
Responsibility	X	7.193	2.0216	0.014
	XI	7.564	1.8851	
	XII	8.950	1.9673	
Organization	X	7.263	2.0280	0.000
	XI	7.391	2.0790	
	XII	8.081	1.7830	
	X	6.647	1.9250	0.001
Independent Work	XI	6.976	1.8780	
	XII	7.386	1.6750	
Collaboration in group work	X	7.324	1.8390	0.000
	XI	7.546	2.0020	
	XII	8.111	1.7130	
Initiative	X	6.467	1.9250	0.130
	XI	6.463	1.8760	
	XII	6.741	1.7730	

$p < 0.05$

Significant differences are found in the three learning styles: responsibility, group work collaboration, and initiative. However, CLS is the same for the dimensions of the organization and independent work. In addition, the highest average CLS score is shown in the audiovisual and kinesthetic learning styles, while the lowest is in the kinesthetic learning style (Table 5).

Table 5. Mean and Standard Deviation of the Five Dimensions of the CLS Questionnaire for learning styles

Dimension of questionnaires	Learning Style	Mean	SD	P
Responsibility	Kinesthetic (K)	6.970	2.1434	0.043
	Audio Visual (A)	7.295	2.0817	
	K + A	7.638	1.5958	
Organization	Kinesthetic (K)	7.116	1.9360	0.372
	Audio Visual (A)	7.292	1.9170	
	K + A	7.448	2.1940	
	Kinesthetic (K)	6.913	1.8370	0.225
Independent Work	Audio Visual (A)	7.214	1.9999	
	K + A	7.343	1.8175	
Collaboration in group work	Kinesthetic (K)	7.037	1.7460	0.001
	Audio Visual (A)	7.569	1.6518	
	K + A	7.721	1.8237	
Initiative	Kinesthetic (K)	6.554	2.0190	0.000
	Audio Visual (A)	7.101	1.9260	
	K + A	7.818	1.7220	

$p < 0.05$

The results of the Scheefe and LSD tests on the dimensions of responsibility, collaboration in group work, and initiative show that audio-visual learning styles integrated with kinesthetics provide a significant difference between audio-visual and kinesthetic learning styles. However, the audio-visual learning style is similar to the kinesthetic learning style.

Statistical analysis shows that interest in learning chemistry significantly affects CLS. Students with high learning interests get the highest average score for all CLS dimensions (Table 6). The Scheefe and LSD tests show that each CLS dimension's average score significantly differs for the three interest categories except for the organization dimension. Students in the medium interest category have average CLS, similar to students with low interest in learning chemistry.

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Table 6. Mean and Standard Deviation of the Five Dimensions of the CLS Questionnaire for Interest in Learning

Dimension of questionnaires	**Interest in Learning**	**Mean**	**SD**	**P**
Responsibility	Low	6.936	1.9618	0.009
	Moderate	7.221	2.0577	
	High	7.415	1.9025	
Organization	Low	7.127	2.080	0.002
	Moderate	7.471	2.0640	
	High	7.910	1.8440	
Independent work	Low	6.525	1.9798	0.004
	Moderate	7.031	1.8480	
	High	7.235	1.7391	
Collaboration in group work	Low	7.268	1.8493	0.005
	Moderate	7.593	1.9776	
	High	7.950	1.7779	
Initiative	Low	5.978	1.8736	0.007
	Moderate	6.504	1.9505	
	High	6.658	1.7799	

$p < 0.05$

Unlike the other variables, school location does not significantly affect the CLS score. Although students in the city of Mataram get the highest scores compared to those in other districts/cities, the scores are similar. The results of the descriptive statistics with the school location variable are shown in Table 7.

Table 7. Mean and Standard Deviation of the Five Dimensions of the CLS Questionnaire for the Location of the School

Dimension of questionnaires	Location of the school	Mean	SD	P
Responsibility	Mataram City	7.219	1.9009	0.120
	Central Lombok	7.212	1.9126	
	East Lombok	7.075	1.9976	
	West Lombok	7.079	1.9957	
Organization	Mataram City	7.658	1.7391	0.405
	Central Lombok	7.383	1.8365	
	East Lombok	7.314	1.8094	
	West Lombok	7.281	1.8746	
	Mataram City	6.905	1.707	0.180
Independent work	Central Lombok	6.879	1.638	
	East Lombok	6.820	1.739	
	West Lombok	6.912	1.718	
Collaboration in group work	Mataram City	7.543	1.781	0.260
	Central Lombok	7.453	1.776	
	East Lombok	7.583	1.739	
	West Lombok	7.383	1.707	
Initiative	Mataram City	6.540	1.8675	0.358
	Central Lombok	6.312	1.8079	
	East Lombok	6.560	1.8442	
	West Lombok	6.400	1.8746	

$p < 0.05$

Significant differences in CLS scores for all dimensions were found in schools with different statuses. State senior secondary schools have the highest scores compared to state madrasahs and private schools (Table 8). The Scheefe and LSD tests show that the average CLS score significantly differs between public and private SMAs, and public *madrasah aliyah* and private *madrasah aliyah*. The average private SMA and MA CLS scores were similar.

Several studies have reported the effect of gender on academic achievement. Cognitive, psychomotor, and affective domains are registered to be affected by gender differences. A survey

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conducted by Lowrie and Jorgensen (2011) shows that gender differences make a difference in learning attitude, which correlates with learning achievement. In the learning process, female students' motivation is higher than that of male students, which also connects with learning skills (Chang & Chung, 2017; Schatt, 2011) . In contrast, Naz et al. (2020) research shows male students are more extrinsically motivated than female students.

Research related to the learning skills of female and male students, especially when learning chemistry, has yet to be widely reported. However, some learning skills, such as social and numerical skills, have been reported to be affected by gender. In line with our research, female students reported having higher study skills than male students (Räsänen et al., 2021). This difference is likely due to the preferences of female students, which are different from male students. Male students usually dominate creative thinking and social skills, while female students have an advantage in analytical and technical skills (Cheryan, 2011; Combet, 2023). Characteristics of learning chemistry that require more analytical skills and technical skills, such as in carrying out investigative processes or laboratory work. In addition, it is known that female students' interest in learning chemistry is higher than that of male students. Students with a high interest in learning tend to use their learning skills to make academic achievements (Karpudewan & Heng, 2015).

Grade level is another factor that affects students' chemistry learning skills. The higher the grade level is indicated, the higher the student's CLS. As we know, specific subjects are studied for the first time at the high school level. This condition means that class X students have only recently acquired specific chemistry concepts. The CLS scores for class XII were higher than those for class X and XI, presumably because they had prior knowledge that had been trained at the previous grade level. Prior knowledge affects learning goals and interest in learning chemistry (Simonsmeier et al., 2021; Thurn et al., 2022). Although it does not explicitly explain CLS, several dimensions, such as independent work and initiative, can be affected by students' prior knowledge (Dong et al., 2020). Grade level is also believed to be an intrinsic factor affecting the chemistry learning process. Grade level is often associated with feedback about how well students have mastered the chemistry concepts they have learned (Musengimana et al., 2021).

Learning initiative has been reported to be closely related to grade level on one of the CLS dimensions. The difference in an initiative for each grade is caused by several things (Knowles et al., 2014) as follows.

1. Students with higher grade levels understand better why they need to learn something.
2. Students with higher grade levels have a self-concept of being responsible for the learning they do.
3. The learning approach of students with higher grade levels prioritizes their experience.
4. Students with higher grade levels have preparation for learning continuous content.
5. Students with higher grade levels have a problem-centered learning orientation.
6. Students with higher grade levels are intrinsically motivated to continue learning.

Student learning styles are also known to affect student academic performance. In line with this research, students who integrate learning styles provide an average academic performance higher than those using other learning styles (İlçin et al., 2018). In contrast to this study, Al-Roomy (2023) shows that kinesthetic learning styles provide better learning goals than auditory and individual learning styles. It should be understood that although learning style can affect learning performance, it does not always affect student learning achievement (Al Shaikh, 2015). Students need to apply several learning styles depending on the situation students face (Himmele & Himmele, 2021). For example, the characteristics of chemistry subject as the core of science learning require a variety of learning styles to achieve maximum learning outcomes.

Integrating kinesthetic and audiovisual learning styles gives students more learning experiences and involvement. In principle, CLS can be connected to student learning experiences. Students are more likely to feel valued and motivated when involved in learning that provides much experience. Using kinesthetic combined with audiovisual shows, students use many learning skills to achieve better learning outcomes. In other words, student involvement in selecting learning styles is an important variable that supports the learning process (Cohen & Jackson-Haub, 2019; Kucuk & Richardson, 2019).

Interest in learning is a factor that also affects student CLS. Often, interest in learning is associated with motivation to learn chemistry. However, some researchers reveal that interest in learning is an intrinsic factor of motivation to learn chemistry (Hofstein & Mamlok-Naaman, 2011). In line with our research, Ferrell et al. (2016); Igboanugo (2023); Jannah and Sutrisno (2024); Menthe and

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Parchmann (2015); Ross et al. (2018); Vinko et al. (2020) found that interest affects success in using chemistry learning skills in learning chemistry. In addition, an interest in learning chemistry can affect learning achievement in the cognitive and psychomotor domains, for example, skills in conducting experiments and compiling scientific reports (Anwar et al., 2019; Touroutoglou et al., 2015).

School status significantly affects students' CLS, where students who attend public schools have the highest average scores for all CSL dimensions compared to students in private schools. The result of this study is in line with the research of Mangubat and Picardal (2023), who found that the type of school affects chemistry learning achievement. However, it differs from DeAngelis (2019) research which found that students' skills in private schools were higher than in public schools. This difference can be caused by several factors, for example, school facilities that support the learning process, the learning model used by the teacher, or other extrinsic factors (Hofstein & Mamlok-Naaman, 2011). Further research is needed to determine the factors that cause differences in CSL in public and private schools.

Some CLS dimensions still show a relatively low average in our study. For example, independent work and initiative dimensions provide an average score that is still relatively low for high school students' CSL. This phenomenon indicates that learning after the pandemic requires innovation to improve the CSL of middle school students. There are several reasons for learning problems after the pandemic, especially the problem of student learning skills. First, the change in the learning method from face-to-face to distance learning made students and teachers face many challenges in the learning process (Coe et al., 2020; Di Pietro et al., 2020). Second, the condition of online learning situations varies from one student to another, such as Internet access, IT knowledge and skills, and student family finances (Angrist et al., 2020; Bacher-Hicks et al., 2021; Frenette et al., 2020; García & Weiss, 2020; Haeck & Lefebvre, 2020). Third, learning time is reduced, causing students to lose understanding (Andrew et al., 2020; Di Pietro et al., 2020). Fourth, the lack of feedback that students receive during the learning process causes students to be unable to improve their performance in their learning process (Azubuike et al., 2021; Rouleau & Gosselin, 2021; Wisniewski et al., 2020). Fifth, the limitations of the learning process and the feedback that students get are minimal, causing disturbances to students' emotions and affecting their cognitive and psychomotor functions (Barrot et al., 2021; Yeh & Tsai, 2022). Finally, the return of the learning process from a distance to face-to-face causes students to experience a phase of adaptation that may affect changes in training student learning skills.

CONCLUSION

Our research found that the CLS of female students was significantly different from that of male students, with a higher average score of female students than male students on all dimensions. The higher the grade level, the higher the CLS score. The CLS score differed significantly from class X and XI. However, class XI had a CLS score that was not significantly different from class X. Grade level showed no statistically significant difference in the initiative dimension. The combination of kinesthetic and audiovisual learning styles gives the highest CSL score compared to kinesthetic and audiovisual learning styles. Significant differences were found in the three learning styles: responsibility, group work collaboration, and initiative. CLS is the same for the dimensions of the organization and independent work. Students interested in learning chemistry show the highest CSL scores on all CSL dimensions. Unlike the other variables, school location does not significantly affect the CLS score. However, school status showed significant differences, and the highest CSL scores were shown in public schools compared to private schools.

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