



Analysis of Comprehension Difficulties in Chemistry and Their Impact on Student Interest in Learning

Febriani^{1*}, Hayyun¹, Ratna Nilawati¹, Abdullah²

¹Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

²Conservation Research Center Universitas Syiah Kuala, Banda Aceh 23111, Indonesia

Article Info

Article history:

Received: 02-06-2024

Revised: 21-08-2024

Accepted: 31-08-2024

Available online: 31-08-2024

Keyword:

Chemistry; Interest in learning;
Difficulty understanding the
material

*Corresponding author:

febrianisbo@gmail.com

Abstract

Chemistry is often considered a difficult subject for learners due to its abstract concepts and complex terminology. This can lead to difficulties in understanding the material and a decrease in students' interest in studying chemistry. The aim of this research is to describe and explain the factors of difficulty understanding in solving chemistry material experienced by students. The research method used is descriptive qualitative. The results show that 62.3% of students experience slight difficulty and 37.7% experience moderate difficulty in understanding chemistry material. The interest in learning chemistry of class XII MIA students is categorized as sufficient with a percentage of 46.68%. Factors causing difficulties in understanding chemistry material include a lack of understanding of mathematical concepts, the predominance of lecture methods, limited learning media, and the suboptimal use of chemistry laboratories. The conclusion of this research provides an overview that the factors causing difficulties in understanding chemistry material affect students' interest in learning. Therefore, these findings can be used as evaluation material to improve the quality of chemistry education in schools.

How to Cite: Febriani., Hayyun., Nilawati, R., & Abdullah. (2024). Analysis of Comprehension Difficulties in Chemistry and Their Impact on Student Interest in Learning. *Jambura Journal of Educational Chemistry*, 6(2), 103-112. <https://doi.org/10.37905/ijec.v6i2.25748>

1. INTRODUCTION

Education stands as a cornerstone of human progress, empowering individuals to elevate their lives and shape a brighter future. Through the transformative power of education, individuals can refine their character, expand their knowledge, and unlock their full potential (Ramadhona & Izzati, 2018). Education plays a pivotal role in shaping the quality of human resources, laying the foundation for societal advancement. The Undang-Undang Sistem Pendidikan Nasional (Sisdiknas), or the National System of Education Law, underscores the strategic significance of education in fostering a skilled and competent workforce (Hilda, 2020).

Education is a transformative process that fosters the transfer of knowledge and skills from educators to learners, aiming to cultivate the full potential within each student. Through this enriching journey, students embark on a path of intellectual and creative

growth, reshaping their mindsets and unlocking their innate abilities (Guo & Wang, 2021; Maemanah et al., 2019). On a national scale, education serves as a cornerstone for societal progress, nurturing the capabilities and shaping the character of a dignified nation. It empowers individuals to become steadfast believers in God, uphold noble morals, embrace physical well-being, cultivate knowledge, demonstrate competence, foster creativity, embody self-reliance, and emerge as responsible democratic citizens (Sariati et al., 2020).

Learning is a scientific process capable of enhancing cognitive (thinking ability), affective (behavior), and psychomotor (skills of learners) abilities, which are developed in conjunction with the acquisition of learning experiences (Lumban Gaol et al., 2022). Teachers are educators who play a very important role in the learning process (Aldalur & Perez, 2023). According to Yestiani &

Zahwa, (2020), teachers have primary functions in the learning process, namely, as educators, instructors, sources of learning, facilitators, guides, demonstrators, managers, advisors, innovators, motivators, trainers, evaluators, planners, organizers, and evaluators. Chemistry subject teachers provide learning in the form of theory and practicum (Huang, 2020). The aim is to enhance learners' understanding of the subject matter. Therefore, good lesson planning is required for both theory and practice. Additionally, in preparing theory and practice, the development of students' problem-solving skills is also necessary, as it aligns with the demands of 21st-century learning (Anggraini et al., 2021; Stroumpouli & Tsapalis, 2022).

Chemistry is one of the branches of science education that aims to enable students to master chemical concepts and apply scientific attitudes to solve problems in everyday life (Zephrinus et al., 2015). Chemistry is often perceived as a difficult and abstract subject in achieving learning objectives (Hu et al., 2024; Timilsena et al., 2022; D. K. Sari et al., 2020). This can lead to difficulties in understanding and a decline in students' interest in studying chemistry subject.

Some previous studies have also explained that students' difficulties in learning chemistry are influenced by several factors, including internal factors such as students' interest and motivation, and external factors including family, facilities, society (Siti Hadewia, 2022), peers (Barth & Grütter, 2024) and academic involvement (Zhang et al., 2024; Wu et al., 2021). Indicates that the forms of difficulties students face in learning chemistry include topics such as salt hydrolysis (Ristanti & Sumarti, 2024), students' understanding of acid-base concepts, writing and determining formulas to calculate the pH of buffer solutions (NLI et al., 2018), students' ability to write chemical equations, students' calculation skills in chemistry (stoichiometry) (Susanty, 2022), Chemical Thermodynamics (Sokrat et al., 2014) and students' accuracy in problems solving.

Other research also mentions that understanding chemical concepts requires a strong basic ability in mathematics. Both chemistry and mathematics skills are highly necessary for students who are majoring in science at high schools or Madrasah Aliyah. In fact, mathematics itself is often linked to having a significant influence on one's success in learning chemistry (Rosmalinda, 2020; Zhou et al., 2022). Besides

mathematical ability, students' interest in learning is also an important factor that affects chemistry learning achievement. High student interest will impact their learning methods and improve learning outcomes, as evidenced by the improvement in learning results (Alexander et al., 2020).

Based on the results of several studies, it can be said that there are still many factors that can influence students' interest in learning chemistry. Therefore, this study focuses on analyzing the problems in chemistry for Class XII students with the aim of describing and explaining the factors that contribute to the difficulties in understanding and solving chemistry material experienced by class XII MIA students at SMA Negeri 1 Baitussalam, Aceh Besar.

2. METHOD

Type of Research

This study is a descriptive research with a qualitative approach, aimed at describing the factors that influence the learning process.

Time and Place of Research

This research was conducted over a period of three months from February to May 2024 at SMA Negeri 1 Baitussalam, Aceh Besar.

Research Subjects

The subjects of this study are students of class XII MIA.

Data, Instruments, and Data Collection Techniques

Data collection was carried out using a questionnaire instrument aimed at the students, an interview instrument conducted with the chemistry subject teacher of class XII, an observation instrument for teaching activities of the chemistry subject teacher of class XII, and documentation as evidence of having conducted case study observations. The questionnaire used is a closed-ended questionnaire with "Yes" or "No" answer choices consisting of 15 statement items. To facilitate data processing, the data from the questionnaires were entered into a table with columns created for each section of the questionnaire. Then the researcher summed up the "Yes" or "No" answers given by the respondents to each question. The responses of the students were then presented as percentages and displayed in the form of graphs (Munandar & Jofrisha, 2017).

Data Analysis Techniques

The students' questionnaire answer sheets were counted and analyzed using the following formula:

$$P = \frac{F}{N} \times 100\% \quad (1)$$

Information :

P = Percentage number

F = Frequency (Number of respondents' answers)

N = Number of individuals/students

then the average percentage is found using the formula below:

$$\bar{x} = \frac{\sum xi}{n} \quad (2)$$

Information:

\bar{x} = Average

$\sum xi$ = Total percentage of student responses

n = Number of questions

From the results of calculating the scores obtained, the percentages can be categorized in the following table:

Table 1. Category percentage of student response questionnaire scores

Intervals	Category
81% - 100%	Very good
61% - 80%	Good
41% - 60%	Enough
21% - 40%	Low
1% - 20%	Very low

(Buchori, 2019)

3. RESULT AND DISCUSSION

3.1. Result

Student Learning Difficulties

The analysis in this research was conducted to determine the level of learning difficulties experienced by students. The analysis of students' learning difficulties was carried out by conducting a document study on the final semester exam scores of students XII MIA in understanding the XI grade chemistry material from the second semester at SMA Negeri 1 Baitussalam, Aceh Besar, who are now in the XII grade. The scores obtained by the students were then converted into a scale of 0-100. The final semester exam scores of XI MIA grade students for the second semester of the 2022/2023 academic year were then converted into percentages of learning difficulty

categories to determine the level of learning difficulties experienced by the students.

Table 2. Percentage of Students in the Learning Difficulties Category Based on Learning Outcomes.

Score Range	Learning Difficulty Criteria	Number of Students	Percentage (%)
81-100	Not Difficult	0	0
61-80	Slightly Difficult	33	62,3
41-60	Quite Difficult	20	37,7
21-40	Difficult	0	0
0-20	Very Difficult	0	0
	Total	53	100

Based on Table 2, the data shows that all students experience learning difficulties. The number of students experiencing these difficulties ranges across categories from slightly difficult to moderately difficult. Students who experience a slight difficulty in understanding the completion of chemistry material amount to 62.3%, while in the category of quite difficult to understand the completion of chemistry material, it amounts to 37.7%.

Observation of Student Interests

The observation of students is conducted to assess the extent of students' learning interest in chemistry education. The instrument used for data collection is an observation sheet in the form of a questionnaire. Data collection is carried out using questionnaire sheets aimed at students.

Table 3. Student interest response questionnaire

Indicator	Statement	Student Response	
		Yes	No
Interest	I am happy with the subject of chemistry	23	30
	I always try to read chemistry books in addition to the school textbooks	14	39
	I read chemistry books in the library every day	7	46
Involvement	If there is subject material that is difficult to understand, I suggest to the teacher to repeat the discussion	53	0

Indicator	Statement	Student Response	
		Yes	No
Motivation	I feel happy when the teacher assigns tasks in groups	48	5
	I am pleased with the way the teacher uses the question-and-answer method in teaching	11	42
	I always complete the chemistry assignments given by the teacher	53	0
	I always submit my chemistry assignments on time	34	19
	I always finish my chemistry assignments even though I don't understand them well	27	26
	I always complete my chemistry assignments independently	21	32
	I complete my chemistry assignments as quickly as possible without procrastinating	17	36
	I participate in class with great enthusiasm	17	36
	In my opinion, chemistry is useful for everyday life	23	30
	Learning Preferences	I am able to learn chemistry even though I am not always accompanied by a teacher	16
Besides books, teachers also use electronic media in their teaching		23	30

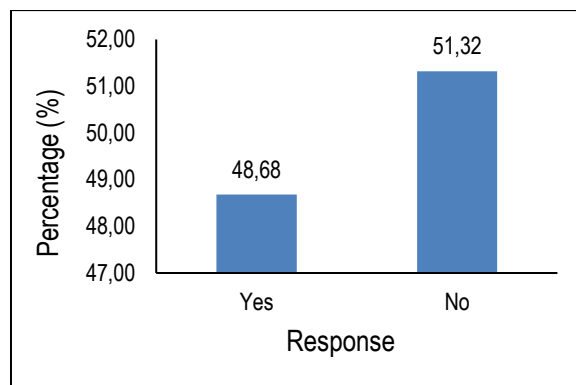


Figure 1. Student Interest Graph

Figure 1 shows students' interest in chemistry subjects at SMA Negeri 1 Baitussalam showing that out of 53 students in class XII MIA, 48.68% are interested in chemistry subjects and 51.32% are not interested. This shows that the interest in learning chemistry of class XII MIA students is included in the category of enough.

Observation of the Learning Process in Class

Table 4. Teacher interview results

No.	Question	Teacher's answer
1.	Do you always prepare a Learning Implementation Plan (RPP) before teaching?	yes
2.	Do you always provide evaluation questions for students at the end of each learning activity?	Not always, sometimes providing practice questions in the book for students
3.	Do you always use media in the learning process?	The media provided at school are projectors and whiteboards. Because the available media is limited, so more often use the whiteboard.
4.	Do you always use teaching aids in the learning process?	Yes, during the practicum I used teaching aids. Such as colligative properties of solutions and osmosis.
5.	What learning resources do you use in teaching?	Books, internet and Youtube
6.	How do you organize learning activities to make students active?	Usually discussions are made in group form. If there is someone who does not understand, they are guided directly.

No.	Question	Teacher's answer
7.	What difficulties do students experience during learning?	The most common difficulty experienced by students is when there is a chemical concept related to calculations.
8.	What factors caused the difficulty to occur?	Mathematical concepts, Even many who can not basic mathematical concepts. Unable to determine units in chemical calculations
9.	If there are students who do not understand the material that you are presenting, what do you do?	Always repeat the lessons that are not understood. At least there is one student who understands
10.	Do students like Chemistry?	There are those who like it and there are those who don't like it
11.	What methods do you use when teaching?	The most frequently used is the lecture method. But sometimes using the discussion and question and answer method
12.	What learning method is most preferred by students?	Students prefer direct guidance, so they use the lecture method more often.
13.	When the test took place, were the students' grades good?	Student grades are often below the minimum completion criteria. And usually I make remedial
14.	What material is difficult for students?	During my teaching, the material that is difficult for students is related to chemical calculations. Such as stoichiometry, redox, reaction rates, Mole Concept, Kinetics, Thermodynamics, Acid-Base and pH.
15.	Do you often use the laboratory when teaching?	No, because the tools and materials do not support it. If there are practical activities, they usually use simple natural materials.
16.	Who makes the lab guides?	Make it yourself
17.	Where do the tools and materials used by students	bring your own tools and materials

No.	Question	Teacher's answer
	during the practicum from?	come from?

The external factors influencing students' learning interest are the less-than-optimal learning methods applied by teachers and the lack of learning media. The inadequacy of teachers' skills in employing appropriate teaching methods will certainly affect the level of students' understanding (Sudrajat, 2020).

Based on the observation results, the learning process in the classroom is only one-way, and there are still many students who are very passive because only the teacher dominates the learning process. The teaching methods used by the chemistry subject teacher include lectures, discussions, and question-answer sessions, but the most frequently used method is lecturing.

Laboratory Observation

The chemistry laboratory is one way to support the implementation of chemistry learning activities through practical work in schools (Cho et al., 2022). This practical work requires various forms of support in terms of facilities, infrastructure, and teacher skills to implement the theories that will be taught to students (Emda, 2017).



Figure 2. Conditions of the Science Laboratory; (a) Material Cupboard, (b) Fume Cupboard, (c) Tool Cupboard, (d) Practical Table

Based on the results of the science laboratory observation at SMA Negeri 1 Baitussalam, the researcher found that this science laboratory combines both chemistry and biology subjects, while the physics laboratory is in a different location. The equipment and materials available in the science laboratory are complete; however, the laboratory has never been used due to the absence of a lab assistant, and many of the available chemicals have expired.

3.2. Discussion

Learning is an essential aspect of education to achieve educational goals. According to several factors influence the success of the learning process in elementary schools, including teacher factors, student factors, environment, facilities, and infrastructure. The success of learning is marked by changes in individual behavior for the better. These changes are manifested in abilities, skills, understanding, attitudes, interests, adaptation, self-esteem, and character. Learning in schools is a planned and organized process of activities, including teaching and learning activities. These activities aim to develop students' intellectual abilities. Teachers are required to convey various understandings and knowledge to students. Therefore, it is essential to understand the learning difficulties and interests of students in the subjects taught by the teacher, so that the teacher can easily impart knowledge to the students.

Student Learning Difficulties

The study by Ofem et al., (2024) explains that learning outcomes are focused on the cognitive domain of students. Student assessments in schools are highly dependent on the scores obtained in specific subjects. The difficulties that arise in the implementation of chemistry education cannot be separated from the characteristics of chemistry learning, which tend to present material that is abstract and complex (Fena Prayunisa, 2022; M. P. Sari et al., 2020). Another factor contributing to these difficulties is the understanding of the material. If students are unable to comprehend the material well, it can be considered that the learning process has not been successful (Oktawirawan, 2020). This is reinforced by the results of interviews with chemistry subject teachers, who stated that most students experience difficulties in understanding chemistry calculations, Such as stoichiometry, redox,

reaction rates, mole concept, Kinetics, Thermodynamics, Acid-Base and pH.

Observation of Student Interests

Vries et al., (2024) research reveals that interest is a positive predictor of academic achievement, persistence in subjects, and satisfaction with study outcomes. The interest in learning also affects the difficulties students face in mastering chemistry material. As has been explained, interest in learning is a tendency of feeling enjoyment towards something; if a student diligently studies, their grades will be satisfactory. The same applies to students' interest in chemistry. If students have an interest in learning chemistry, they will diligently study the subject, which will result in satisfactory achievements.

In Figure. 1, when viewed from the percentage of learning interest, the interest of students in class XII MIA falls into the enough category. This is also supported by the results of interviews with chemistry teachers who stated that the learning interest of class XII MIA students was quite low.

The lack of students' interest in learning is influenced by two factors, namely internal and external factors. Based on observations conducted by researchers at SMA Negeri 1 Baitussalam, researchers obtained information about classroom conditions during the learning process. During the lessons, it was observed that the chemistry learning process was still teacher-centered. In addition, teachers were still using the lecture method, which caused students to be passive, leading to a lack of student motivation in chemistry learning activities. The teaching methods of the teacher were reported to influence students' attitudes towards the subject (Musengimana et al., 2022; Lee & Boo, 2022). Furthermore, in the chemistry learning process, students experienced difficulties with calculations. This was reinforced by the results of interviews with the chemistry subject teacher of grade XII MIA. The teacher stated that the factor causing difficulties in understanding and solving chemistry material encountered by students during chemistry lessons was the calculation part or the lack of understanding of mathematical concepts within the students.

The research by Krawitz et al., (2024) explains that students with a high level of mathematical competence are more likely to find complex problems interesting because they are more confident in their ability

to solve them compared to students with lower levels of competence. Research results conducted by (Susanty, 2022; and (Priliyanti et al., 2021) explain that students' difficulties in learning chemistry are caused by internal factors, including low interest in learning chemistry, low motivation to learn chemistry, poor understanding of chemistry concepts, and weak student abilities in calculation aspects, as well as external factors, including poor adjustment of student abilities in the application of teaching methods by teachers in class, how teachers manage chemistry learning, peer influence, and ineffective chemistry learning time.

Observation of the Learning Process in Class

The learning process in the classroom can affect students' learning difficulties in terms of teaching methods, media, and student involvement in the class. (Fauzannur, 2018) also explains that using the lecture method can cause students to quickly become bored, tired, lazy, and sleepy when the teacher explains the lesson material, resulting in very low learning motivation. The learning media used are blackboards and projectors. However, chemistry teachers most often use the blackboard. This is also supported by the results of interviews with chemistry teachers. They said that the learning media are very limited, so the use of the projector is rotated among other teachers. Research Harmawati et al. (2024) also explains that learning media are one of the important elements in the teaching and learning process. The use of media in every learning process has become a necessity, even a requirement, for every teacher (Demir, 2024). The importance of using media in the learning process is to make the learning atmosphere more interesting and less monotonous.

Laboratory Observation

The presence of laboratories in learning within the fields of science, particularly chemistry, is extremely important. Laboratories serve as a means to prove something through experimentation. Students can conduct experiments to verify the scientific theories they have learned during their lessons. This highlights the crucial role of laboratory activities in achieving educational goals. Activities in the laboratory make it easier for students to understand and explore what they are learning (Nelson et al., 2022).

The lack of activity in the laboratory is also due to the raw materials being available in a concentrated form, requiring lab assistants to prepare the equipment

and materials. Until now, practical sessions have been conducted using natural materials. This is supported by the results of an interview with the chemistry subject teacher, who stated that practical sessions are conducted outside the laboratory and use natural materials, such as measuring pH using hibiscus flower indicators.

In the research conducted by (Zakiyah et al., 2022), it is explained that students are naturally capable of applying the learning theories conveyed by teachers using the tools and materials available in the laboratory. This enables students to become more skilled in laboratory practices. As a result, students will feel interested in participating in activities within the laboratory. In research by (Trisusilosakti & Aisyah, 2020) explains that laboratory activities influence learning outcomes and student interests. Apart from that, laboratory activities also influence student motivation (Kirchhoff et al., 2024)

4. CONCLUSION

The results of this study indicate that 62.3% of students find it somewhat difficult to understand chemistry lessons, while 37.7% find it fairly difficult. Meanwhile, students' interest falls into the moderate category, with a percentage of 48.68%. Based on the results of observations and interviews several factors influence the difficulty in understanding and solving chemistry material, which in turn affects students' interest in learning. These factors include difficulties in understanding chemistry when solving calculation problems due to a lack of mathematical concepts among students, the continued use of lecture methods in teaching, and limited learning media. Additionally, supporting facilities such as laboratories are not being utilized optimally. Therefore, these findings can be used as a basis for evaluating and improving the quality of chemistry education in schools.

5. ACKNOWLEDGEMENTS

Alhamdulillah, with all due respect, the writer extends the utmost gratitude primarily to Ms. Khairani, S.Pd and the staff at SMA Negeri 1 Baitussalam for granting permission to conduct the observation. Thanks also go to Ms. Rosmalawati, S.T., Gr., the chemistry teacher, for her willingness to guide and provide the opportunity to carry out this research.

6. REFERENCES

- Aldalur, I., & Perez, A. (2023). Gamification and discovery learning: Motivating and involving students in the learning process. *Heliyon*, 9(1), e13135. <https://doi.org/10.1016/j.heliyon.2023.e13135>
- Alexander, C., Wyatt-Smith, C., & Du Plessis, A. (2020). The role of motivations and perceptions on the retention of inservice teachers. *Teaching and Teacher Education*, 96, 103186. <https://doi.org/10.1016/j.tate.2020.103186>
- Anggraini, U. T., Lestari, I. D., Rahman KN, A., Usman, U., & Rifqiawati, I. (2021). Studi Kasus SMA di Banten: Proses Pembelajaran Biologi SMA Melalui Pendekatan Saintifik dalam Mengembangkan Keterampilan Pemecahan Masalah Siswa. *Bioedusiana: Jurnal Pendidikan Biologi*, 6(1), 14–26. <https://doi.org/10.37058/bioed.v6i1.2465>
- Barth, C., & Grütter, J. (2024). Inclusive classroom norms and children's expectations of inclusion of peers with learning difficulties in their social world. *Journal of School Psychology*, 104(101312), 1–16. <https://doi.org/10.1016/j.jsp.2024.101312>
- Buchori, A. (2019). Pengembangan Multimedia Interaktif dengan Pendekatan Kontekstual untuk Meningkatkan Pemecahan Masalah Kemampuan Matematika. *Jurnal Inovasi Teknologi Pendidikan*, 6(1), 104–115. <https://doi.org/10.21831/jitp.v6.1.20094>
- Cho, W. J., Hafalir, I. E., & Lim, W. (2022). Tie-breaking and efficiency in the laboratory school choice. *Journal of Economic Theory*, 205. <https://doi.org/10.1016/j.jet.2022.105546>
- Demir, M. (2024). A taxonomy of social media for learning. *Computers and Education*, 218, 1–18. <https://doi.org/10.1016/j.compedu.2024.105091>
- Emda, A. (2017). Laboratorium Sebagai Sarana Pembelajaran Kimia Dalam Meningkatkan Pengetahuan Dan Keterampilan Kerja Ilmiah. *Lantanida Journal*, 5(1), 83. <https://doi.org/10.22373/lj.v5i1.2061>
- Fauzannur. (2018). Studi Kasus Proses Pembelajaran Mata Pelajaran Kimia Di Sman 7 Banda Aceh Tahun 2017 / 2018. *Prosiding Seminar Nasional MIPA IV*, 162–168.
- Fena Prayunisa. (2022). Analisa kesulitan siswa kelas xi dalam pembelajaran kimia di sman 1 masbagik. *Journal of Classroom Action Research*, 4(3), 147–150.
- Guo, L., & Wang, J. (2021). Relationships between teacher autonomy, collaboration, and critical thinking focused instruction: A cross-national study. *International Journal of Educational Research*, 106. <https://doi.org/10.1016/j.ijer.2020.101730>
- Harmawati, Y., Sapriya, Abdulkarim, A., Bestari, P., & Sari, B. I. (2024). Data of digital literacy level measurement of Indonesian students: Based on the components of ability to use media, advanced use of digital media, managing digital learning platforms, and ethics and safety in the use of digital media. *Data in Brief*, 54, 1–14. <https://doi.org/10.1016/j.dib.2024.110397>
- Hilda, L. (2020). Kemampuan Koneksi Matematika dalam Pembelajaran Kesetimbangan Kimia. *Logaritma : Jurnal Ilmu-Ilmu Pendidikan Dan Sains*, 8(01), 79–92. <https://doi.org/10.24952/logaritma.v8i01.2412>
- Hu, Y., Wouters, P., van der Schaaf, M., & Kester, L. (2024). The effects of achievement goal instructions in game-based learning on students' achievement goals, performance, and achievement emotions. *Learning and Instruction*, 93(101943 Contents), 1–11. <https://doi.org/10.1016/j.learninstruc.2024.101943>
- Huang, J. (2020). Successes and Challenges: Online Teaching and Learning of Chemistry in Higher Education in China in the Time of COVID-19. *Journal of Chemical Education*, 97(9), 2810–2814. <https://doi.org/10.1021/acs.jchemed.0c00671>
- Kirchhoff, T., Wilde, M., Randler, C., & Großmann, N. (2024). Are you learning or performing? A comparison of students' goal orientation during experimentation at an outreach science laboratory and at school using the CEAS model. *Learning and Instruction*, 93. <https://doi.org/10.1016/j.learninstruc.2024.101972>
- Krawitz, J., Hartmann, L., & Schukajlow, S. (2024). Do task variables of self-generated problems influence interest? Authenticity, openness, complexity, and students' interest in solving self-generated modelling problems. *Journal of Mathematical Behavior*, 73, 1–12. <https://doi.org/10.1016/j.jmathb.2024.101129>
- Lee, H., & Boo, E. (2022). The effects of teachers' instructional styles on students' interest in learning school subjects and academic achievement: Differences according to students' gender and prior interest. *Learning and Individual Differences*, 99, 1–11. <https://doi.org/10.1016/j.lindif.2022.102200>

- Lumban Gaol, B. K., Silaban, P. J., & Sitepu, A. (2022). Pengaruh Kemampuan Berpikir Kritis Terhadap Hasil Belajar Siswa Pada Tema Lingkungan Sahabat Kita Di Kelas V Sd. *JURNAL PAJAR (Pendidikan Dan Pengajaran)*, 6(3), 767. <https://doi.org/10.33578/pjr.v6i3.8538>
- Maemanah, S., Suryaningsih, S., & Yunita, L. (2019). Kemampuan Pemecahan Masalah Melalui Model Flipped Classroom Pada Pembelajaran Kimia Abad Ke 21 Orbital : Jurnal Pendidikan Kimia. *Orbital: Jurnal Pendidikan Kimia*, 3(2).
- Munandar, H., & Jofrisha, J. (2017). Analisis Pelaksanaan Pembelajaran Kimia Di Kelas Homogen (Studi Kasus Pembelajaran Kimia di SMA Negeri 11 Banda Aceh). *Lantanida Journal*, 4(2), 98. <https://doi.org/10.22373/lj.v4i2.1882>
- Musengimana, J., Kampire, E., & Ntawiha, P. (2022). Rwandan secondary school students' attitudes in learning chemistry: explored with task-based instruction. *Heliyon*, 8(9), 1–10. <https://doi.org/10.1016/j.heliyon.2022.e10509>
- Nelson, T. M., Ghosh, S., & Postler, T. S. (2022). L-RAPiT: A Cloud-Based Computing Pipeline for the Analysis of Long-Read RNA Sequencing Data. *International Journal of Molecular Sciences*, 23(24). <https://doi.org/10.3390/ijms232415851>
- NLI, S., IW, M., & IK, S. (2018). Analisis Kesulitan Belajar Kimia Pada Materi Larutan Penyangga Di Sma Negeri 2 Banjar. *Jurnal Pendidikan Kimia Undiksha*, 2(2), 75. <https://doi.org/10.23887/jjpk.v2i2.21170>
- Ofem, U. J., Idika, D., Otu, B., Victor Ovat, S., Arikpo, M. I., Anakwue, A. L., Akpo, C., Anake, P. M., Ayin, N. N., Edam-Agbor, I. B., Orim, F. S., Eunice Ngozi, A., Anyiopi, R. U., Nwinyinya, E., & Ekpenyong Effiong, I. (2024). Academic optimism, capital indicators as predictors of cognitive, affective, and psychomotor learning outcome among students in secondary school. Hierarchical regression approach (HRA). *Heliyon*, 10(9), 1–20. <https://doi.org/10.1016/j.heliyon.2024.e30773>
- Oktawirawan, D. H. (2020). Faktor Pemicu Kecemasan Siswa dalam Melakukan Pembelajaran Daring di Masa Pandemi Covid-19. *Jurnal Ilmiah Universitas Batanghari Jambi*, 20(2), 541. <https://doi.org/10.33087/jiubj.v20i2.932>
- Priyanti, A., Muderawan, I. W., & Maryam, S. (2021). Analisis Kesulitan Belajar Siswa Dalam Mempelajari Kimia Kelas Xi. *Jurnal Pendidikan Kimia Undiksha*, 5(1), 11. <https://doi.org/10.23887/jjpk.v5i1.32402>
- Ramadhona, R., & Izzati, N. (2018). Pengembangan Lembar Kerja Mahasiswa Berbasis Inkuiri Mata Kuliah Matematika Umum Untuk Mahasiswa Pendidikan Kimia. *Jurnal Kiprah*, 6(2), 21–24. <https://doi.org/10.31629/kiprah.v6i2.780>
- Ristanti, S. D., & Sumarti, S. S. (2024). Analisis Pemahaman Konsep dan Kesulitan Siswa Kelas XI pada Materi Hidrolisis Garam Menggunakan Tes TTMC dan TwTMC dengan Model Problem-Based Learning. *Jurnal Inovasi Pendidikan Kimia*, 18(1), 23–31. <https://doi.org/10.15294/jjpk.v18i1.46418>
- Rosmalinda, D. (2020). Kemampuan Kimia dan Matematika Siswa MAN 2 Kota Jambi: Relasi dalam Fakta. *Tarbawi: Jurnal Ilmu Pendidikan*, 16(1), 1–10. <https://doi.org/10.32939/tarbawi.v16i01.494>
- Sari, D. K., Suryaningsih, S., & Yunita, L. (2020). Implementasi Kecerdasan Emosional dan Minat Siswa pada Pembelajaran Kimia. *Jambura Journal of Educational Chemistry*, 2(1), 40–47. <https://doi.org/10.34312/jjec.v2i1.4170>
- Sari, M. P., Andromeda, A., & Hardinata, A. (2020). Studi Kesulitan Belajar Mahasiswa Jurusan Pendidikan IPA dalam Mempelajari Sifat Periodik Unsur. *Jurnal Eksakta Pendidikan (Jep)*, 4(1), 18. <https://doi.org/10.24036/jep/vol4-iss1/379>
- Sariati, Kadek, N., Suardana, Nyoman, I., Wiratini, & Made, N. (2020). Analisis Kesulitan Belajar Kimia Siswa Kelas Xi Pada Materi Larutan Penyangga. *Jurnal Ilmiah Pendidikan Dan Pembelajaran P-ISSN: 1858-4543 e-ISSN: 2615-6091*, 4(1), 86–97.
- Siti Hadewia. (2022). Analisis Kesulitan Belajar Siswa pada Mata Pelajaran Kimia Kelas XI di MAN 2 Kota Palu. *Jurnal Kolaboratif Sains*, 5(10), 701–705. <https://doi.org/10.56338/jks.v5i10.2834>
- Sokrat, H., Tamani, S., Moutaabbid, M., & Radid, M. (2014). Difficulties of Students from the Faculty of Science with Regard to Understanding the Concepts of Chemical Thermodynamics. *Procedia - Social and Behavioral Sciences*, 116, 368–372. <https://doi.org/10.1016/j.sbspro.2014.01.223>
- Stroumpouli, C., & Tsaparlis, G. (2022). Chemistry students' conceptual difficulties and problem solving behavior in chemical kinetics, as a component of an introductory physical chemistry

- course. *Chemistry Teacher International*, 4(3), 279–296. <https://doi.org/10.1515/cti-2022-0005>
- Sudrajat, J. (2020). Kompetensi Guru Di Masa Pandemi Covid-19. *Jurnal Riset Ekonomi Dan Bisnis*, 13(2), 100. <https://doi.org/10.26623/jreb.v13i2.2434>
- Susanty, H. (2022). Problematika Pembelajaran Kimia Peserta Didik Pada Pemahaman Konsep Dan Penyelesaian Soal Soal Hitungan. *Al Qalam: Jurnal Ilmiah Keagamaan Dan Kemasyarakatan*, 16(6), 1929. <https://doi.org/10.35931/aq.v16i6.1278>
- Timilsena, N. P., Krishna, Maharjan, B., & Devkota, M. (2022). Teachers' And Students' Experiences In Chemistry Learning Difficulties. *Journal of Positive School Psychology*, 6(10), 2856–2867.
- Trisusilosakti, A., & Aisyah, R. S. S. (2020). Kegiatan Laboratorium Kimia Berbasis Mini-Project Terhadap Hasil Belajar dan Aktivitas Siswa pada Praktikum Uji Aldehyd. *Jambura Journal of Educational Chemistry*, 2(1), 1–9. <https://doi.org/10.34312/jjec.v2i1.2681>
- Vries, de N., Meeter, M., & Huizinga, M. (2024). Does interest fit between student and study program lead to better outcomes? A meta-analysis of vocational interest congruence as predictor for academic success. *Educational Research Review*, 44, 1–20. <https://doi.org/10.1016/j.edurev.2024.100619>
- Wu, C., Gong, X., Luo, L., Zhao, Q., Hu, S., Mou, Y., & Jing, B. (2021). Applying Control-Value Theory and Unified Theory of Acceptance and Use of Technology to Explore Pre-service Teachers' Academic Emotions and Learning Satisfaction. *Frontiers in Psychology*, 12, 1–13. <https://doi.org/10.3389/fpsyg.2021.738959>
- Yestiani, D. K., & Zahwa, N. (2020). Peran Guru dalam Pembelajaran pada Siswa Sekolah Dasar. *Fondatia*, 4(1), 41–47. <https://doi.org/10.36088/fondatia.v4i1.515>
- Zakiah, A., Kurniawati, I., Firdaus, Nurul, A., & Mahardika, Ketut. I. (2022). Pengaruh Sarana Prasarana Laboratorium IPA Terhadap Motivasi Belajar Siswa di SMP Negeri 10 Jember Kelas 7. *Jurnal Ilmiah Wahana Pendidikan*, 8(24), 417–423.
- Zephrinus, C., Njoku, Phoebe, Mrs. I., & Eze-odurukwe. (2015). Resolving Nigerian Secondary School Students' Learning Difficulties in Nuclear Chemistry Using Computer Animation Solutions. *Procedia - Social and Behavioral Sciences*, 176, 1034–1040. <https://doi.org/10.1016/j.sbspro.2015.01.575>
- Zhang, Y., Zhang, X., & Meng, Z. (2024). Effect of interactive immediacy on online learning satisfaction of international students in Chinese universities: The chain mediating role of learning interest and academic engagement. *Acta Psychologica*, 244(97), 1–8. <https://doi.org/10.1016/j.actpsy.2024.104202>
- Zhou, D., Liu, J., Wang, T., Liu, J., & Li, G. (2022). Relationships among problematic smartphone use, mathematics anxiety, learning interest, and achievement: A multiple mediation model. *Computers in Human Behavior*, 129, 1–10. <https://doi.org/10.1016/j.chb.2021.107171>