Jambura Journal of Educational Chemistry
Volume 8 Issue 2, August 2026
p-ISSN: 2655-7606, e-ISSN: 2656-6427
Journal Homepage: http://ejurnal.ung.ac.id/index.php/jjec

Analysis the Flexibility of ChatGPT Use in Chemistry Learning Among 12th Grade Students at Senior High School in Samarinda

Frederich Pakaenoni[1], Usman Usman[1]*, Agung Rahmadani[1], Sudjanani Ulfa[2] , Kevin Tiurma Dame[3]

[1]*Universitas Mulawarman, Samarinda 75119, Indonesia*
[2]*SMA Negeri 5 Samarinda, Samarinda 75124, Indonesia*
[3]*SMA Kristen Sunodia Samarinda, Samarinda 75117, Indonesia*

Article Info

Article history:
Received: 24-03-2026
Revised: 25-04-2026
Accepted: 26-04-2026
Available online: 01-08-2026

Keywords:
Artificial Intelligence; ChatGPT; Chemistry Learning; Flexibility; Qualitative Study

***Corresponding author:**
sainusman@ymail.com

Abstract

The rapid development of artificial intelligence has influenced learning practices in chemistry, particularly through the use of ChatGPT as an adaptive learning tool. This study aims to explore how students interpret the flexibility of ChatGPT in supporting chemistry learning, focusing on flexibility of time, place, learning pace, interaction, and adaptation to individual needs. The study employed a qualitative research design with a phenomenological approach to capture students lived experiences in using ChatGPT during chemistry learning. Participants consisted of 122 twelfth grade students from SMAN 5 Samarinda and SMAK Sunodia Samarinda who actively used ChatGPT in their chemistry studies. Data were collected through open-ended questionnaires distributed via Google Forms. Data analysis followed the interactive qualitative analysis model of Miles, Huberman, and Saldaña, which includes data condensation, data display, and conclusion drawing or verification. The findings reveal that students perceive ChatGPT as a flexible learning facilitator that allows learning anytime and anywhere, supports self paced learning, enables repeated explanation without pressure, and provides dialogic and responsive interaction tailored to individual understanding levels. ChatGPT also helps students regulate their learning, maintain learning continuity, and create a psychologically safe learning environment. Overall, ChatGPT is interpreted not as a replacement for teachers, but as a complementary learning support that enhances student independence, self-regulated, and conceptual understanding in chemistry. These results highlight the potential role of ChatGPT in supporting adaptive, personalized, and student centered chemistry learning.

How to Cite: Pakaenoni, F., Usman, U., Rahmadani, A., Ulfa, S., & Dame, K. T. (2026). Analysis the Flexibility of ChatGPT Use in Chemistry Learning Among 12th Grade Students at Senior High School in Samarinda. *Jambura J. Educ. Chem., 8*(2), 151-163. https://doi.org/10.37905/jjec.v8i2.37894

1. INTRODUCTION

The current development of artificial intelligence has transformed interaction patterns in the teaching and learning process, including in chemistry education. One rapidly advancing technology is ChatGPT, an AI-based language model capable of providing interactive and adaptive responses. In the context of chemistry learning, which is often perceived as difficult due to its abstract nature and the need for deep conceptual understanding, the presence of ChatGPT creates new opportunities to support a more flexible and personalized learning process. Empirical findings show that the use of ChatGPT helps students understand complex concepts through varied explanations and increases independent learning engagement (Taruklimbong & Sihotang, 2023).

Several studies also indicate that AI functions as an effective learning tool. This technology provides rapid feedback, simplifies concepts through multiple explanatory approaches, and supports intensive question-and-answer interactions. Studies by Mahmudah (2023) and Prastika et al. (2024) show that the use of AI improves students understanding of topics that require higher order thinking skills, such as thermochemistry and chemical reactions. In addition, students demonstrate increased learning autonomy because they can access assistance anytime without relying entirely on teachers.

However, the implementation of ChatGPT in learning is not without challenges. Unequal access to technological devices, the potential misuse such as plagiarism, and differences in users readiness to utilize AI effectively are critical issues that need attention. These conditions highlight the need for deeper investigation into how this technology is actually interpreted and used by students in real learning contexts.

Despite the growing body of research on ChatGPT in education, a clear gap remains in the literature. Most studies focus on general applications of ChatGPT or on other disciplines such as physics (Qudratuddarsi et al., 2025) and scientific writing (Nursafitri & Munajat, 2025). Studies that specifically examine how students interpret the flexibility of ChatGPT use in chemistry learning are still very limited. Furthermore, phenomenological perspectives that explore students lived experiences, particularly at the high school level, remain underexplored. This gap becomes more critical considering that chemistry learning requires strong critical thinking, analytical skills, and problem solving abilities. Without a deep understanding of how students interact with and interpret the use of ChatGPT, the potential of this technology will not be fully utilized. Therefore, this study aims to explore how students interpret the flexibility of ChatGPT use in understanding chemistry concepts. This research is important to provide empirical insights into the role of AI in supporting scientific thinking processes and improving the quality of chemistry learning in context.

2. METHOD

This study employs a qualitative research design with a phenomenological approach to understand students' experiences in using ChatGPT in chemistry learning. Qualitative research focuses on an in-depth understanding of social phenomena from the participants' perspectives by emphasizing meaning, experience, and processes within specific contexts, rather than statistical generalization. This approach allows researchers to systematically and factually describe how students experience, interpret, and evaluate the flexibility and capability of ChatGPT in adapting to their learning needs. Phenomenology is a research approach that seeks to explore and describe how individuals consciously experience a particular phenomenon, focusing on the essence of those experiences as perceived by the participants. It emphasizes the study of lived experiences (lived experience) and how meaning is constructed through awareness and reflection. The phenomenological approach is selected because it aims to explore individuals' lived experiences of a phenomenon and to understand how meaning is consciously constructed through those experiences. This study specifically adopts a Husserlian (descriptive) phenomenological approach, which focuses on describing the essence of participants' experiences while setting aside the researcher's assumptions through a process known as epoché or bracketing. In education, particularly in the use of technologies such as ChatGPT, this approach is useful for understanding the meaning of AI's presence in the learning process in ways that align with students' learning styles and needs (Creswell & Poth, 2016).

The target of this study was 12th grade students at SMAN 5 Samarinda and SMAK Sunodia Samarinda. This study involved 122 respondents, consisting of 94 students from SMAN 5 Samarinda and 28 students from SMAK Sunodia Samarinda. The participants were selected using purposive sampling, with the main consideration that they had direct experience in using ChatGPT as part of their chemistry learning process. The inclusion criteria for this study were students who actively use ChatGPT to support their understanding of chemistry material, have engaged in independent learning using AI, and are able to reflect on their learning experiences. The focus on 12th grade students was intentional, as they have studied most chemistry topics at the senior high school level. This condition allows them to provide more comprehensive and reflective insights based on their accumulated learning experiences. Data saturation in this study varied across aspects (combined from both schools). It was achieved at the 7th respondent for flexibility of time , the 6th respondent for flexibility of place, the 6th respondent for flexibility of learning pace, and the 4th respondent for both flexibility of interaction and flexibility in adapting to individual needs. At this point, no new themes or significant variations in responses emerged. The remaining responses served to confirm and strengthen the consistency of the identified patterns. Therefore, the analysis in this study emphasizes depth of meaning rather than the quantity of responses, which is consistent with the principles of qualitative research.

This research employed an open-ended questionnaire distributed through Google Form as the

https://doi.org/10.37905/jjec.v8i2.37894

primary research instrument. The use of open-ended questions enabled respondents to express their experiences freely and provided rich qualitative data for in-depth analysis of how students interpret the use of ChatGPT in chemistry learning. The data analysis technique used in this study refers to the qualitative data analysis model developed by Miles, Huberman, and Saldaña. This model emphasizes that data analysis is conducted in an interactive and continuous manner, beginning from the data collection process until data saturation is achieved. The analysis process consists of three main components: data condensation, data display, and conclusion drawing and verification (Miles et al., 2014). Data condensation refers to the process of selecting, focusing, simplifying, and transforming raw data into information that is relevant to the research focus. Data collected from questionnaires and documents were analyzed through coding, categorizing, and summarizing. This process was carried out continuously during and after data collection until the final report writing stage, with the aim of clarifying relevant information and supporting the interpretation of the phenomenon under study. The next step is data display in a systematic and easily understandable form through descriptive narratives. A well-structured data presentation helps the researcher review the findings, understand patterns or relationships among data elements, and plan further analytical steps based on the insights developed. The final stage is conclusion drawing, which is conducted based on the analyzed findings. The conclusions drawn are not immediately considered final but are continuously verified throughout the analysis process. Verification is carried out by comparing new and previous data, checking consistency, and seeking supporting evidence to strengthen the validity of the research results. This process ensures that the conclusions accurately and credibly reflect the phenomenon being studied.

3. RESULT AND DISCUSSION

ChatGPT acts as a flexible learning support tool,to examine the extent of this flexibility in assisting the learning process, five aspects were identified after analyzing students experiences in interpreting the flexibility of ChatGPT use in chemistry learning. These aspects include flexibility of time, flexibility of place, flexibility of learning pace, flexibility of interaction, and flexibility in adapting to individual needs.

3.1. FLEXIBILITY OF TIME

The analysis of students' experiences identified several categories that represent how flexibility of time is interpreted in the use of ChatGPT. These categories are summarized in Table 1.

Table 1. Summary of themes in flexibility of time

Category	Description	Sample Evidence
Alternative learning time	Students use ChatGPT outside formal school hours such as at night or weekends	"I have used ChatGPT outside of school hours, usually at night or during holidays" (R1)
Self-regulated learning	Students independently manage their study time and learning activities	" After using ChatGPT, I have become more independent…" (R6)
Alternative to classroom learning	ChatGPT is used when students cannot attend class or miss lessons	"Catching up on chemical bonding and stoichiometry." (R4)
Accessibility	ChatGPT can be accessed anytime without time limitations	"Having access at any time is very important…" (R1)
Real-life experience	Learning is connected to students' daily activities and situations	"One of my experiences was when learning about Gay-Lussac's Law…" (R8)

Table 1 shows that flexibility of time in the use of ChatGPT is interpreted by students through several interconnected categories that reflect diverse learning experiences. This finding indicates that time flexibility does not stand as a single aspect, but is formed through a combination of alternative learning time, self-regulated learning, the role as a substitute for classroom learning, accessibility, and students concrete learning experiences.The research findings show that students interpret ChatGPT as a flexible learning tool that supports the chemistry learning process according to individual needs. This flexibility is mainly evident in learning time, management of learning pace, and adjustment to students academic conditions. The use of ChatGPT allows students to learn at any time without fully depending on formal school schedules. Students use ChatGPT at night, on weekends, and during holidays to understand materials, complete assignments, and

prepare for examinations. This condition indicates that the chemistry learning process is no longer limited to face to face classroom time. This finding is in line with research conducted by (Adiguzel et al., 2023), which states that AI guided learning systems are able to provide more flexible and student centered learning experiences, especially for students who study outside formal hours.

Time flexibility gives students space to regulate the duration and intensity of learning according to the level of difficulty of the material they face. When students experience difficulties in understanding abstract chemistry concepts, they can repeat explanations, request simpler descriptions, or study the material gradually. This pattern helps students build deeper conceptual understanding and reduces learning pressure that often arises in time limited learning environments. This flexibility does not encourage unfocused learning, but instead forms learning patterns that are more planned and reflective. Research on self-regulated learning in digital learning contexts by (Faza & Lestari, 2025), states that independent time management and learning strategies are important components of self-regulated skills required in flexible learning environments. Thus, the use of ChatGPT does not only function as an academic support tool, but also as a medium that strengthens students capacity to manage learning pace, build discipline, and foster personal responsibility for their learning process.

The meaning of ChatGPT flexibility is also related to increased student independence and learning responsibility. Students no longer fully wait for teacher explanations, but actively seek understanding when they encounter difficulties. More independent management of learning time encourages the formation of learning discipline and awareness of personal academic needs. Students learn to determine when to study, which materials should be prioritized, and which learning strategies best suit their abilities (Hastuti et al., 2025). In addition, time flexibility plays an important role in helping students catch up on missed material when they are unable to attend classroom learning. In such conditions, ChatGPT is used as an alternative source to obtain material summaries and concept explanations. This function maintains the continuity of the learning process and prevents disruption of students understanding of chemistry content. This flexibility also provides opportunities for students to deepen certain materials according to their needs, especially topics that are considered difficult and require repeated explanations. Overall, the flexibility of ChatGPT in chemistry learning is interpreted by students as learning convenience that allows personal regulated of time, pace, and depth of learning. This flexibility supports more adaptive, student centered learning that aligns with individual needs. Thus, ChatGPT not only serves as an academic support tool, but also as a facilitator that strengthens student independence, self-regulated, and learning continuity in chemistry education (Turan et al., 2022).

3.2. FLEXIBILITY OF PLACE

The analysis of students' experiences identified several categories that represent how flexibility of place is interpreted in the use of ChatGPT. These categories are summarized in Table 2.

Table 2. Summary of themes in flexibility of place

Category	Description	Sample Evidence
Preferred learning places	ChatGPT is effectively used in the classroom to help when facing difficulties in solving chemistry problems.	"I usually use ChatGPT to study chemistry in my room… sometimes in the living room… or at school during free periods… but the most comfortable place is still my room." (R4)
Learning outside school	Studying at home at night to review chemistry; studying in the library is more focused and conducive.	"Yes, I have used ChatGPT to study chemistry outside of school, like at home and while hanging out in the library. At home, I usually use it at night to review materials… in the library, it is more quiet, so I can focus better…" (R1)
Influence of place on learning effectiveness	Home/bedroom provides a relaxed environment for studying, the library is more conducive and focused, while public places can be distracting.	"Yes, the place of study really matters. In my room or in the library, I am more focused, so using ChatGPT becomes more effective for

Category	Description	Sample Evidence
		understanding chemistry." (R5)
Place accessibility	Flexible access at home, in the library, or outside allows for more independent and flexible learning.	"It is easily accessible anywhere and anytime." (R3)
Alternative to classroom learning	When sick and unable to attend school, students can still understand the material (electrolyte solutions) through ChatGPT from home.	"Yes, when I was sick… I studied redox reaction material independently at home… I felt relieved because I could still catch up with the lessons." (R2)
Learning motivation	Students become more motivated and consistent in learning because they can study anywhere, and a changing environment reduces boredom.	"Easy access increases learning motivation." (R3)
Real the role of ChatGPT as a substitute learning companion	ChatGPT acts as a substitute for a teacher, helping students understand material when the teacher is absent or during long holidays.	"ChatGPT acts as a companion for independent learning… I can still get explanations, practice questions, and application examples… even without face-to-face interaction with the teacher." (R6)

Table 2 shows that flexibility of place in the use of ChatGPT is interpreted by students through several interconnected categories that reflect diverse learning experiences.. This finding indicates that place flexibility is not only understood as freedom in learning location, but also includes aspects of learning effectiveness, accessibility, motivation, and the role of ChatGPT as a learning companion when teachers or classroom instruction are unavailable. The research findings show that place flexibility becomes an important meaning in the use of ChatGPT to support chemistry learning according to students individual needs. Flexibility of place is interpreted as students freedom to determine learning locations that best support comfort, focus, and learning effectiveness. With ChatGPT, the chemistry learning process is no longer limited to formal classroom spaces, but can take place in various locations such as home, bedrooms, libraries, or other places considered conducive by students. These findings are in line with research by (Kasneci et al., 2023), which emphasizes that ChatGPT has great potential in supporting flexible and personalized context based learning, because it allows students to learn in environments they choose without spatial and temporal limitations. In other words, ChatGPT is not only a digital learning support tool, but also a mediator that strengthens student learning independence through adaptive, responsive, and student centered learning.

ChatGPT's accessibility through personal devices allows students to adjust their learning environment according to individual preferences. Students tend to choose quiet and comfortable places so they can focus more effectively on understanding abstract and complex chemistry concepts. Self selected learning environments help students reduce distractions, increase concentration, and improve the quality of material comprehension. This shows that place flexibility directly contributes to students cognitive readiness in learning chemistry. Place flexibility also plays an important role when students are unable to attend learning activities at school. In conditions of limited attendance or restrictions on device use within the school environment, students use ChatGPT outside of school as an alternative learning option. ChatGPT functions as a learning companion that allows students to continue accessing materials, obtaining explanations, and catching up on missed learning. Thus, place flexibility maintains the continuity of the learning process and prevents disruption of chemistry concept understanding due to physical space constraints. This type of place flexibility is consistent with the findings of (Bond et al., 2021), which state that variation in learning locations contributes to increased student engagement and learning effectiveness. These findings are also aligned with research results showing that technology based learning can reduce the impact of physical absence on the continuity of student learning (Martin & Borup, 2022). Place flexibility allows students to continue learning even when they are not at school. Learning activities can take place from home or other supportive

https://doi.org/10.37905/jjec.v8i2.37894

locations. Learning continuity remains maintained without physical space barriers.

Beyond practical aspects, place flexibility also affects students affective dimensions. Freedom to choose learning locations provides a sense of control over the learning process, which ultimately increases motivation and learning consistency. Students feel more comfortable and confident when learning in environments that suit their needs. This condition encourages more stable and sustainable learning engagement and strengthens student learning independence. Overall, flexibility of place in the use of ChatGPT is interpreted as a form of adaptive and student centered learning support. This flexibility allows students to learn chemistry in various locations according to personal conditions and preferences, maintains learning continuity, and enhances learning comfort and motivation. Thus, ChatGPT acts as a learning facilitator that expands students learning spaces and supports the fulfillment of individual needs in chemistry learning (Bond et al., 2021; Crompton & Burke, 2020).

3.3. FLEXIBILITY OF LEARNING PACE

The analysis of students' experiences identified several categories that represent how flexibility of learing pace is interpreted in the use of ChatGPT. These categories are summarized in Table 3.

Table 3. Summary of themes in flexibility of learing pace

Category	Description	Sample Evidence
Adjustment of learning pace	Students actively control and adjust their learning speed based on their comprehension level and learning needs.	"ChatGPT helps me because I can learn at my own pace. If there is difficult material, I can pause for a while, reread the explanation, then continue again without feeling left behind by my classmates." (R8)
Repetition strategies	Students repeat questions or request explanations multiple times to improve clarity and ensure understanding.	"I often repeat questions or ask ChatGPT to explain in a different way… after it is re-explained using simpler language or other examples, I understand better." (R6))
In-depth understanding of chemistry content	Flexible pacing enables students to explore concepts more deeply through examples, analogies, and step-by-step explanations.	"I usually ask ChatGPT to explain with more detailed steps or provide example problems… so my understanding of chemistry becomes deeper." (R7)
Pressure-free learning environment	Students experience a relaxed learning atmosphere without time constraints, allowing better focus and comprehension.	"I feel calmer. In class, I often have to follow the teacher quickly, but with ChatGPT I can learn anytime without feeling rushed." (R4)
Impact on learning speed	Flexibility allows students to accelerate or slow down learning depending on topic complexity and individual readiness.	"In my opinion, ChatGPT actually speeds up my understanding… because it provides explanations with clear calculation examples." (R1)
Use of question and answer features	Students utilize iterative questioning to guide, refine, and control their learning process.	"I often use it by asking repeatedly but from different perspectives." (R3)
Repeated learning without barriers	Students can revisit and relearn material anytime without social pressure or classroom limitations.	"I can review the topic repeatedly until I truly understand it, without feeling embarrassed or afraid of falling behind." (R2)
Personal pace preferences	Students prefer self-paced learning because it aligns with their individual learning styles and comfort levels.	"I prefer learning at my own rhythm… I can repeat until I really understand." (R5)
Support for classroom understanding	ChatGPT functions as a supplementary tool that helps students catch up with or reinforce classroom instruction.	"When the teacher has moved on to the next chapter, I can still study the previous one with the help of ChatGPT, so I do

Category	Description	Sample Evidence
		not fall too far behind." (R4)
Adjustment of learning pace	Students actively control and adjust their learning speed based on their comprehension level and learning needs.	"ChatGPT helps me because I can learn at my own pace. If there is difficult material, I can pause for a while, reread the explanation, then continue again without feeling left behind by my classmates." (R1)

Table 3 shows that flexibility of learing pace in the use of ChatGPT is interpreted by students through several interconnected categories that reflect diverse learning experiences. The research findings show that students interpret ChatGPT as a learning medium that provides flexibility of learning pace in chemistry education. This flexibility is reflected in students freedom to regulate their learning rhythm, opportunities to repeat material without limits, adjustment of explanations according to needs, and the creation of a calmer and more personal learning atmosphere. These findings strengthen the view that ChatGPT does not only function as a technical support tool, but as an adaptive learning companion that supports differences in individual students learning needs and abilities (Ocak et al., 2023).

Flexibility of learning pace is understood by students as the ability to learn according to their own rhythm without time pressure. Students can slow down the learning process when facing difficult chemistry concepts, such as chemical reactions, equilibrium, or titration, and speed up learning on materials they have already mastered. Control over learning tempo provides space for students to adjust the learning process to their cognitive conditions, so conceptual understanding becomes more optimal. These findings align with the concept of self paced learning, where learners have control over the speed and flow of their learning (Bond et al., 2021; Zawacki-Richter et al., 2019). Flexibility of learning pace gives students the opportunity to determine their learning rhythm according to their cognitive abilities. Students can slow down the process when encountering difficult concepts. This control over tempo increases a sense of responsibility toward the learning process.

The practice of repeating material becomes one of the main forms of flexibility of learning pace facilitated by ChatGPT. Students consistently use ChatGPT to ask repeated questions, request explanations in different ways, and deepen material until it is truly understood. ChatGPT's ability to respond to repeated questions without limits allows students to process information gradually and deeply. This supports the formation of stronger conceptual understanding, because students are not bound by time limitations or feelings of hesitation that are often experienced in classroom learning. In addition to repetition, flexibility of learning pace is also supported by the use of practice problems, solution steps, and material summaries. Students use these features to accelerate understanding without reducing learning quality. Abstract chemistry material becomes easier to understand when presented in the form of concrete examples and step by step explanations. Thus, students can allocate learning time more efficiently according to their level of material mastery (Mayer, 2024). Flexibility of learning pace allows students to break material into smaller parts. Each part is understood gradually without time pressure. This process helps form deeper conceptual understanding.

Another prominent aspect is the creation of a calmer learning atmosphere free from time pressure. Students feel more comfortable learning using ChatGPT because there is no demand to immediately understand the material or follow the learning speed of peers. This condition contributes to increased focus and psychological comfort, making the learning process more meaningful. A non pressuring learning environment also encourages students to be more active in asking questions and independently exploring material. Flexibility of learning pace through ChatGPT also helps students overcome learning gaps. Students who feel they have not understood material in class can independently catch up without feeling embarrassed or afraid of falling behind. Differences in learning speed among students are no longer a major barrier, because ChatGPT can adjust responses according to individual needs. This shows the role of ChatGPT in reducing learning gaps and supporting more inclusive learning principles, supported by findings from (Kassab et al., 2024), that a conducive and comfortable learning environment significantly relates to pressure free conditions that increase focus, psychological comfort, cognitive engagement, and

https://doi.org/10.37905/jjec.v8i2.37894

students psychological well being, where positive perceptions of the educational environment influence students cognitive and emotional engagement in the learning process and facilitate higher learning focus in academic contexts.

Overall, flexibility of learning pace mediated by ChatGPT is interpreted by students as freedom to regulate learning tempo integrated with material repetition, use of examples and summaries, learning without time pressure, and independent learning ability to catch up on missed content. Learning pace is not understood as acceleration alone, but as the ability to adjust learning rhythm until full understanding is achieved. Thus, flexibility of learning pace becomes an important part of the meaning of ChatGPT flexibility in supporting adaptive, personal, and student centered chemistry learning aligned with individual student needs.

3.4. FLEXIBILITY OF INTERACTION

The analysis of students' experiences identified several categories that represent how flexibility of learing pace is interpreted in the use of ChatGPT. These categories are summarized in Table 4.

Table 4. Summary of themes in flexibility of interaction

Category	Description	Sample Evidence
Dialogic learning experience	Learning interactions occur in a two-way manner. Students feel as if they are actively engaged in discussion rather than merely receiving information.	"It feels like having a discussion… I can keep asking questions and get immediate answers." (R1)
Response quality	Responses are quick, relevant, and context-appropriate. Explanations are easy to understand and are often accompanied by examples..	"Step-by-step explanations, complete with example problems." (R2)
Depth of conversation	Students are able to deepen their understanding of chemistry content through continuous conversation and gradual exploration.	"I keep continuing the conversation to explore the content more deeply." (R6)
Follow-up responses	Follow-up responses expand understanding, not only addressing the main point but also providing additional context and applications..	"It explains the factors affecting reaction rates, not just the calculations." (R8)
Increased learning activity	The interaction encourages students to actively ask questions, think critically, and explore the subject matter more deeply.	"It makes me think of follow-up questions instead of just staying quiet and reading." (R4)
Support for understanding difficult material	It helps students understand difficult concepts through repeated explanations, step-by-step guidance, and simple language.	"Breaking down difficult material into smaller, easier-to-understand parts." (R7)
Memorable learning experience	The interactive process creates meaningful learning experiences that are memorable and provide a sense of satisfaction.	"It makes the content easier to remember and more engaging." (R3)

Table 4 shows that flexibility of interaction in the use of ChatGPT is interpreted by students through several interconnected categories that reflect diverse learning experiences. The research findings show that flexibility of interaction is one of the important meanings in the use of ChatGPT in chemistry learning. This flexibility is interpreted by students as ChatGPT's ability to present two way interactions that are dialogic, responsive, and adaptable to individual learning needs. Through conversational interaction patterns, ChatGPT not only functions as a source of information, but also as a learning partner that enables students to be actively involved in the process of understanding chemistry concepts. This is in line with the findings of (Holmes, 2020), who explains that artificial intelligence based learning models such as ChatGPT create interactive learning environments that resemble two way discussions between teachers and students. Through open conversations, students can negotiate meaning, deepen concepts, and independently correct misconceptions.

Flexibility of interaction is evident from students experiences of perceiving the use of ChatGPT as similar to discussing or dialoguing. Students can ask questions,

follow up on answers, and deepen discussions according to their needs without limitations in number or time. This pattern creates an interactive and reflective learning process, in which students do not merely receive explanations, but gradually construct understanding through continuous question and answer interactions. Such interaction is highly relevant in chemistry learning, which demands conceptual understanding and reasoning. ChatGPT's fast and relevant responses further strengthen this flexibility of interaction. Students perceive that the answers provided generally match the context of the questions and can be immediately followed up with further inquiries. This responsiveness makes the learning process dynamic and uninterrupted, allowing students to maintain their train of thought and focus on the material being studied. ChatGPT's ability to provide contextual answers also helps students connect chemistry concepts with examples, analogies, or applications in everyday life (Yaseen et al., 2025).

Flexibility of interaction is also reflected in students freedom to regulate the direction and depth of conversations. Students can choose to expand material, request additional explanations, or clarify parts that are not yet understood. Through this process, students build understanding gradually according to their individual abilities. This continuous interaction supports cognitive engagement and helps students develop deeper understanding of complex chemistry concepts. These findings indicate that students use flexibility of interaction to construct understanding in a gradual and reflective manner, as facilitated by adaptive and interactive learning technologies that enhance cognitive engagement in dialog and feedback processes (Yaseen et al., 2025).

Flexibility of interaction contributes significantly to increased student activeness in chemistry learning. Through two way dialogue patterns, students not only receive information, but are encouraged to think, respond, and reflect on every explanation provided. Continuous interaction allows students to ask follow up questions, test their understanding, and correct errors directly. This process makes learning more meaningful because students actively participate in knowledge construction, rather than merely memorizing concepts or formulas. Thus, ChatGPT supports chemistry learning that is active, reflective, and student centered. This activeness is strengthened by a sense of psychological safety that emerges from flexibility of interaction. Students feel more free to ask questions, repeat inquiries, and explore material without fear of making mistakes or being judged. This pressure free learning environment creates more open interaction and supports students courage to independently attempt to understand chemistry concepts. This sense of psychological safety is important because it helps students remain engaged in the learning process, especially when facing difficult or abstract material. With flexibility of interaction, learning engagement can be consistently maintained, thereby supporting the continuity of the chemistry learning process according to individual student needs (Yaseen et al., 2025).

Overall, flexibility of interaction in the use of ChatGPT is interpreted by students as a dialogic, responsive, safe, and adaptive learning experience. This flexibility allows students to regulate interaction flow, deepen understanding, and adjust the learning process to their individual needs. Therefore, flexibility of interaction becomes an important part of the meaning of ChatGPT flexibility in supporting personal, inclusive, and student oriented chemistry learning.

3.5. FLEXIBILITY IN ADAPTING TO INDIVIDUAL NEEDS

The analysis of students' experiences identified several categories that represent how flexibility of learing pace is interpreted in the use of ChatGPT. These categories are summarized in Table 5.

Table 5. Summary of themes in flexibility of adapting to individual needs

Category	Description	Sample Evidence
Variation in explanation formats	ChatGPT provides multiple explanation formats such as simple language, analogies, and step by step problem solving to match different learner preferences.	"I ask ChatGPT to explain chemistry material in a simple way and give example problems… so it's easier to understand because it's explained step by step." (R1)
Strategies for adjusting questions	Students actively modify how they ask questions to control the type, depth, and format of responses they receive.	"If I want a short answer, I write 'please summarize'… if I need practice, I ask for example questions." (R4)
Adjustment of difficulty level	ChatGPT adapts the complexity of	"If I say I'm still confused…

Category	Description	Sample Evidence
	explanations based on user requests, from basic to more advanced levels.	ChatGPT will give a more basic explanation." (R2)
Alignment with learning needs	Responses are perceived as relevant because they directly match the learner's specific academic needs and goals.	"ChatGPT's answers really match my learning style… because I can directly see the process." (R1)
Comparison of explanation styles	Learners evaluate different explanation styles and identify which format best supports their understanding.	"I try to compare explanations… the most suitable one is example problems with solutions." (R3)
Alternative to teacher explanations	ChatGPT serves as a complementary source that offers different or clearer explanations than classroom teaching.	"ChatGPT helps me… I ask for everyday examples so I can better visualize it." (R6)
Guided answers	Learners guide responses by giving explicit instructions, resulting in more targeted and structured outputs.	"I write specific requests like 'explain with example problems'." (R5)
Support for personal learning styles	ChatGPT adapts to individual learning preferences such as detailed, concise, or step by step explanations.	"The explanation fits my learning style since I don't like long explanations." (R4)
Comfort in learning	Flexibility and non-judgmental interaction increase students' comfort and confidence during learning.	"I can ask again in a different way without being afraid of being judged." (R2)
Flexibility of explanations	ChatGPT allows dynamic adjustment of explanation depth and format based on continuous user input.	"ChatGPT always adapts, from simple answers to detailed ones depending on the request." (R6)
Independent practice	ChatGPT supports self-directed learning through practice questions, simulations, and immediate feedback.	"I use ChatGPT to create chemistry practice questions similar to exams… so I understand the content better." (R3)

Table 4 shows that flexibility of interaction in the use of ChatGPT is interpreted by students through several interconnected categories that reflect diverse learning experiences. The research findings show that students interpret ChatGPT as a learning medium with high flexibility in adjusting the learning process to individual needs. This flexibility is reflected in ChatGPT's ability to adjust the form, style, level of difficulty, and depth of chemistry material explanations according to student requests. With these characteristics, ChatGPT functions as a personal and adaptive learning support, allowing each student to obtain different learning experiences based on their individual needs and learning preferences. This is in line with the findings of (Zhai, 2023), which state that ChatGPT based systems are able to identify students learning needs and adjust their instructional approaches, thereby supporting more effective learning personalization. (Kasneci et al., 2023) also emphasize that interaction flexibility with generative AI provides significant opportunities for education to be more responsive to individual differences, enabling differentiated learning in digital environments.

Flexibility in adapting to individual needs is reflected in the variety of explanation formats that ChatGPT can provide, such as material summaries, the use of analogies, presentation of practice problems, and step by step solution procedures. These variations help students understand abstract chemistry concepts in clearer and more accessible ways. Students have the freedom to choose explanation formats that best match their learning styles, whether through simplified explanations, illustrations related to everyday life, or detailed calculations. This condition shows that ChatGPT supports student centered learning, as students have control over the methods and approaches used to understand chemistry material. This flexibility is further strengthened through students active roles in directing the learning process. Students can adjust their questions, request follow up explanations, narrow the discussion focus, or regulate the depth of material according to their level of understanding. Continuous interaction allows ChatGPT to adjust responses contextually and gradually in line with student needs. This pattern indicates that students are not merely recipients of information, but also managers of their own learning processes. This active involvement encourages deeper cognitive processing and strengthens self-regulated in chemistry learning,

making the learning process more adaptive and meaningful for each individual (Holmes, 2020; Zhai, 2023).

Adjustment of material difficulty levels becomes an important part of ChatGPT's flexibility in supporting chemistry learning that aligns with students individual needs. Students generally begin the learning process with simple explanations to build initial understanding, then gradually request more detailed descriptions or higher level problems as their understanding increases. This gradual approach helps students build understanding systematically and in a structured manner, while reducing cognitive load that often arises when students are immediately confronted with complex material. In this process, ChatGPT acts as an adaptive learning scaffolding support, following the development of student understanding from basic to advanced stages. This flexibility also affects students comfort and sense of psychological safety, as they feel more free to ask questions, repeat material, and make mistakes without feeling embarrassed or afraid of being judged. This safe and inclusive learning environment encourages students to be more active, confident in exploration, and deeply engaged in the learning process. Thus, the adjustment flexibility offered by ChatGPT not only supports cognitive aspects, but also strengthens learning engagement and sustained understanding of chemistry concepts according to each students needs (Holmes, 2020; Urbina et al., 2021).

In addition to functioning as an alternative source of explanation, ChatGPT is also interpreted as a complement to the teacher's role. ChatGPT does not replace educators, but expands students access to additional explanations that can be tailored to individual needs. Students use ChatGPT to deepen material that has not been fully understood in class, making learning more flexible and continuous. This integration strengthens student centered learning while maintaining the teacher's role as the primary facilitator. These findings show that ChatGPT functions as a complementary tutor, not a teacher replacement, enriching learning resources and helping bridge students understanding gaps (Luckin et al., 2016).

Overall, flexibility in adapting to individual needs through ChatGPT is interpreted by students as the ability to obtain personalized, adaptive learning that aligns with their individual learning characteristics. This flexibility includes variation in explanations, adjustment of questions, regulation of difficulty levels, psychological comfort, and support for independent learning. Thus, ChatGPT flexibility does not only function as a technical feature, but becomes an important foundation in supporting student centered chemistry learning that aligns with their individual needs.

4. CONCLUSION

Based on the research findings, students interpret ChatGPT as a flexible learning tool in chemistry across five main aspects: time, place, learning pace, interaction, and adaptation to individual needs. This flexibility reflects a shift from fixed and teacher-centered learning toward more adaptive, student-centered learning environments, where students actively regulate their learning processes according to their individual conditions. ChatGPT enables students to learn beyond temporal and spatial constraints, manage their own learning pace, engage in repeated and pressure-free learning, and participate in dialogic interactions that support deeper conceptual understanding.

From a theoretical perspective, this study contributes to the understanding of flexibility in AI-supported learning by conceptualizing it as a multidimensional construct grounded in students' lived experiences. It extends existing literature on self-regulated learning and adaptive learning technologies by demonstrating how flexibility is not only a technical feature, but also a meaningful learning experience that integrates cognitive, behavioral, and affective dimensions. From a practical perspective, the findings highlight the potential of ChatGPT as a complementary learning facilitator in chemistry education. Teachers can integrate ChatGPT as a supporting tool to provide additional explanations, encourage independent learning, and create more inclusive and psychologically safe learning environments. At the same time, students can utilize ChatGPT to reinforce classroom learning, especially when facing difficulties or learning gaps.

However, this study has several limitations. First, the research focuses only on students from two schools in a specific context, which may limit the generalizability of the findings. Second, data were collected through self-reported responses using open-ended questionnaires, which may not fully capture deeper interaction processes compared to interviews or

observations. Third, the study emphasizes students' perceptions and experiences without directly measuring the impact of ChatGPT on learning outcomes or higher-order thinking skills. Therefore, future research is recommended to adopt more diverse methodological approaches, such as mixed methods or experimental designs, to examine the effectiveness of ChatGPT in improving learning outcomes in chemistry. Further studies could also explore how teachers integrate ChatGPT into classroom practices, investigate its role in developing higher-order thinking skills, and compare its effectiveness with other digital learning tools. In addition, involving more diverse participants across different educational levels and contexts would provide a more comprehensive understanding of the role of artificial intelligence in science education. Overall, this study provides important insights into how students experience and interpret the flexibility of ChatGPT in chemistry learning, emphasizing its role in supporting more adaptive, personalized, and meaningful learning processes.

5. ACKNOWLEDGEMENTS

The researcher would like to thank all the students of class XII in SMA Negeri 5 Samarinda and SMA Kristen Sunodia Samarinda, who have participated in this research. Thanks also go to the chemistry teachers at the school for their support and cooperation during the data collection process. and also to the supervisor lecturer who has greatly assisted and provided suggestions to the researcher in completing this research.

6. REFERENCES

Adiguzel, T., Kaya, M. H., & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. *Contemporary Educational Technology*, *15*(3), 1–13. https://doi.org/10.30935/cedtech/13152

Bond, M., Bedenlier, S., Marín, V. I., & Händel, M. (2021). Emergency remote teaching in higher education: mapping the first global online semester. *International Journal of Educational Technology in Higher Education*, *18*(1), 1–24. https://doi.org/10.1186/s41239-021-00282-x

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing among five approaches*. Sage Publications.

Crompton, H., & Burke, D. (2020). Mobile learning and pedagogical opportunities: A configurative systematic review of PreK-12 research using the SAMR framework. *Computers & Education*, *156*, 103945. https://doi.org/https://doi.org/10.1016/j.compedu.2020.103945

Faza, A., & Lestari, I. A. (2025). Self-Regulated Learning in the Digital Age: A Systematic Review of Strategies, Technologies, Benefits, and Challenges. *The International Review of Research in Open and Distributed Learning*, *26*(2), 23–58. https://doi.org/10.19173/irrodl.v26i2.8119

Hastuti, P., Rahmawati, U. E., Sakkinah, I. S., Arief Pratama, R., Hasanah, Q., Yunita, T., & Wulandari, L. (2025). Adaptive E-Learning: A systematic review of interactive and flexible learning aligned with student styles. *International Journal of Studies in Social Sciences and Humanities IJOSSH*, *2*(2), 66–73. https://doi.org/10.25047/ijossh.v2i2.5588

Holmes, W. (2020). Artificial intelligence in education. In *Encyclopedia of Education and Information Technologies* (pp. 88–103). Springer International Publishing.

Kasneci, E., Sessler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., Gasser, U., Groh, G., Günnemann, S., Hüllermeier, E., Krusche, S., Kutyniok, G., Michaeli, T., Nerdel, C., Pfeffer, J., Poquet, O., Sailer, M., Schmidt, A., Seidel, T., … Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, *103*, 102274–102285. https://doi.org/https://doi.org/10.1016/j.lindif.2023.102274

Kassab, S. E., Rathan, R., Taylor, D. C. M., & Hamdy, H. (2024). The impact of the educational environment on student engagement and academic performance in health professions education. *BMC Medical Education*, *24*(1). https://doi.org/10.1186/s12909-024-06270-9

Luckin, R., Holmes, W., Griffiths, M., & Pearson, L. B. F. (2016). *Intelligence Unleashed An argument for AI in Education*. Pearson.

Mahmudah, R. (2023). Dalam Pembelajaran Biokimia. *Jurnal Pendidikan Dan Pembelajaran*, *2*(2), 20–29. https://doi.org/https://doi.org/10.51574/hybrid.v2i2.1361

Martin, F., & Borup, J. (2022). Online learner engagement: Conceptual definitions, research themes, and supportive practices. *Educational Psychologist*, *57*(3), 162–177. https://doi.org/https://doi.org/10.1080/00461520.2022.2089147

Mayer, R. E. (2024). The Past, Present, and Future of the Cognitive Theory of Multimedia Learning. *Educational Psychology Review*, *36*(1), 1–25. https://doi.org/10.1007/s10648-023-09842-1

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). Sage Publications.

Nursafitri, R., & Munajat, N. (2025). Penggunaan Teknologi Chatgpt Terhadap Efisiensi Penyelesaian Tugas Karya Ilimiah di Kalangan Mahasiswa (Mahasiswa UIN Sunan Kalijaga). *Pendas: Jurnal Ilmiah Pendidikan Dasar*, *10*(01), 86–98. https://doi.org/https://doi.org/10.23969/jp.v10i01.23347

Ocak, C., Kopcha, T. J., & Dey, R. (2023). An AI-enhanced pattern recognition approach to temporal and spatial analysis of children's embodied interactions. *Computers and Education: Artificial Intelligence*, *5*, 100146. https://doi.org/https://doi.org/10.1016/j.caeai.2023.100146

Prastika, N. D., Anjarwati, D., Awaliah, M. A. S., Hartandi, D., Rahmadani, A., & Erika, F. (2024). Kajian Literatur Pemanfaatan Teknologi Artificial Intelligence untuk Meningkatkan Keterampilan Abad 21 Siswa dalam Pembelajaran Kimia. *Jambura Journal of Educational Chemistry*, *6*(1), 47–60. https://doi.org/10.37905/jjec.v6i1.23644

Qudratuddarsi, H., Agung, A., & Yanti, M. (2025). "Status Quo" ChatGPT Dalam Pengajaran dan Pembelajaran Fisika: systematic literature review. *phydagogic : Jurnal Fisika Dan Pembelajarannya*, *7*(2), 111–118. https://doi.org/10.31605/phy.v7i1.4645

Taruklimbong, E. S. W., & Sihotang, H. (2023). Peluang dan Tantangan Penggunaan AI (Artificial Intelligence) dalam Pembelajaran Kimia. *Jurnal Pendidikan Tambusai*, *7*(3), 26745–26757. https://doi.org/https://doi.org/10.31004/jptam.v7i3.11167

Turan, Z., Kucuk, S., & Cilligol Karabey, S. (2022). The university students' self-regulated effort, flexibility and satisfaction in distance education. *International Journal of Educational Technology in Higher Education*, *19*(1), 1–19. https://doi.org/10.1186/s41239-022-00342-w

Urbina, S., Villatoro, S., & Salinas, J. (2021). Self-regulated learning and technology-enhanced learning environments in higher education: A scoping review. *Sustainability (Switzerland)*, *13*(13), 1–12. https://doi.org/10.3390/su13137281

Yaseen, H., Mohammad, A. S., Ashal, N., Abusaimeh, H., Ali, A., & Sharabati, A. A. A. (2025). The Impact of Adaptive Learning Technologies, Personalized Feedback, and Interactive AI Tools on Student Engagement: The Moderating Role of Digital Literacy. *Sustainability (Switzerland)*, *17*(3), 1–27. https://doi.org/10.3390/su17031133

Zawacki-Richter, O., Marín, V. I., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, *16*(1), 1–27. https://doi.org/10.1186/s41239-019-0171-0

Zhai, X. (2023). ChatGPT User Experience: Implications for Education. *Journal of the Association for Information Science and Technology*, *3*(01), 1–18. https://orcid.org/0000-0003-4519-1931