A Mixed-Method Study: An Analysis of Chemistry Education Students' Perceptions Regarding the Use of ChatGPT for Organic Chemistry Learning

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Abstract

This study aimed to investigate students' perceptions of using ChatGPT as an learning tool in Organic Chemistry, a course characterized by its abstract topics. A descriptive quantitative approach was utilized, comprising 87 students from the Chemistry Education Study Program at Sriwijaya University. Data was collected by a Likert-scale questionnaire assessing frequency of usage, perceived usefulness, perceived ease of use, prompt effort, and ethical awareness. The results indicated that 98.9% of students utilized ChatGPT to enhance their understanding of Organic Chemistry. Most respondents had positive opinions, with 74% expressing enhanced conceptual understanding and 72% reporting improved learning efficiency. The results suggested that ChatGPT facilitated clearer elucidations of complex topics, including stereochemistry and reaction processes. A thematic analysis also showed students expressed concerns regarding the scientific precision of ChatGPT's elucidations and underscored the necessity for instructor oversight and source validation. This study revealed that ChatGPT suggested potential as a supplementary learning instrument in Organic Chemistry by improving comprehension and learning efficiency, while simultaneously emphasizing the necessity of pedagogical oversight to avert conceptual inaccuracies.
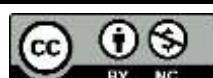
1. Introduction

The education sector is a vital component in realizing the vision of a prosperous Indonesia by 2045. Enhancing educational standards is crucial for cultivating exceptional human resources capable of global competition (Kementerian PPN/Bappenas, 2025). In the era of globalization and the Industrial Revolution 4.0, education is anticipated to generate graduates who possess not only academic intelligence but also the capacity for critical, creative, communicative, and collaborative thinking, together referred to as 21st-

century skills. In this context, institutions bear the need to equip students, particularly in scientific disciplines like chemistry, to adapt to a swiftly evolving world and confront diverse difficulties (Chusna et al., 2025).

The OECD's Programme for International Student Assessment (PISA) score is one indication of education quality in Indonesia. According to the 2022 PISA report, Indonesia scored 69th out of 80 nations, with a score of 383, primarily in scientific literacy. The low PISA score, particularly in tasks requiring analytical and problem-solving skills, suggests deficiencies in student's critical thinking abilities. Critical thinking abilities are the ability to solve problems by examining ideas in a certain direction, allowing a person to sort, integrate, and use data based on needs (Rahardhian, 2022). These skills empower students to produce new and original concepts, enhancing their ability to confront global challenges (Atris Yuliarti Mulyani, 2022). Although PISA examines secondary school students, the findings can provide an early indication of thinking skills that will be carried over to higher education.

The advancement of digital technology, particularly artificial intelligence (AI) technologies such as ChatGPT, has created new issues in education. ChatGPT technology is a strategic breakthrough that helps to meet the Sustainable Development Goals for Quality Education (SDGs 4) by boosting education's availability, quality, and relevance in the digital era (Montenegro-Rueda et al., 2023). ChatGPT technology is widely utilized in education to facilitate self-paced learning, such as answer searches, giving academic information, and assisting in the explanation of unclear material, hence improving the learning process's optimality, efficiency, and accessibility (Taruklimbong & Sihotang, 2023). Furthermore, ChatGPT can help students enhance their language and communication abilities while also providing them with motivation and support (Valova et al., 2024). As a result, incorporating ChatGPT into learning not only simplifies the delivery of learning content, but also enables more flexible, independent, and collaborative continuous education, which meets the expectations of 21st-century education.

However, the use of ChatGPT technology in education requires instructor supervision and assistance. This is because not all of the answers offered by ChatGPT are valid and require further study, especially for topics that involve application and interpretation, as well as non-textual information (Fergus et al., 2023). Relying on ChatGPT as a shortcut for accessing information without prior processing may impair students' critical thinking and independent problem-solving abilities (Capraro et al., 2024). Students miss the in-depth and reflective thinking tasks that are essential components of science education, which can delay the cognitive development required for independent learning (Patac & Patac, 2025).

At the university level, students encounter abstract and conceptually demanding courses such as Organic Chemistry. A significant challenge consists in learning the three levels of chemical representation—macroscopic, microscopic, and symbolic, which are crucial for comprehensive knowledge. Most student struggle to associate observable phenomena with molecular structures and symbollic representations, especially when using English-language instructional materials, leading them to rely on alternative online sources alternatives that may lack reliability (Rahmawati & Irawati, 2023). Moreover, strudents encounter difficulties in understanding reaction mechanisms, such as identifying reaction type, explaining reaction pathway, and predicting product reaction (Pratama et al., 2023). Challenges are especially apparent in stereochemistry, where students must visualize three-dimensional molecular structures and associate them with chemical reactions. As a result, students frequently memorize reactions without understanding the underlying causes and mechanisms. Integrating ChatGPT into learning models such as Problem-Based Learning (PBL) or Project-Based Learning (PjBL) and into learning media offers a promising solution to overcome these challenges by enhancing conceptual understanding and fostering critical thinking skills among students in Organic Chemistry (Jere & Mpeta, 2025).

Although ChatGPT's potential as a learning tool, there is less research investigating how chemistry education students perceive and use this technology in the context of complex Organic Chemistry topics. Therefore, this study aimed to study students' perceptions of ChatGPT's application in an Organic Chemistry course. The findings of this study are expected to benefit chemistry lecturers by providing insights into students' learning needs and technology use, curriculum developers by informing the integration of artificial intelligence into Organic Chemistry learning designs, and students by supporting more effective and engaging learning experiences. Furthermore, this research contributes to practical solutions for Organic Chemistry learning in the digital age by providing empirical evidence to support the development of instructional models and learning media that leverage ChatGPT to enhance conceptual understanding and foster students' critical thinking and problem-solving skills required for the 21st century.

2. Materials and Methods

This study used a mixed-methods approach, incorporating descriptive quantitative analysis alongside thematic analysis for open-ended responses. A survey was conducted to collect data, and 87 students completed the questionnaire. The respondents were undergraduate students enrolled in the Chemistry Education program at the Faculty of Teacher Training and Education, Sriwijaya University. Participants

were chosen by a purposive selection method, comprising students registered in the Organic Chemistry course.

The survey questions were adapted from prior research (Yik & Dood, 2024). The questionnaires covered student demographics, including gender (male or female), age, and the types of activities facilitated by ChatGPT. Inquiries regarding ChatGPT utilization encompassed aspects such as frequency of use, perceptions of ChatGPT use, perceived usefulness of ChatGPT, and prompting efforts when utilizing ChatGPT for Organic Chemistry learning. A Likert scale was used for inquiries related to ChatGPT usage, featuring four response options rated from 1 to 4: 1 signifies Strongly Disagree, 2 denotes Disagree, 3 represents Agree, and 4 indicates Strongly Agree. The questionnaire was evaluated by two experts: a Chemistry Education lecturer from the Faculty of Teacher Training and Education (FKIP) and a Chemistry lecturer from the Faculty of Mathematics and Natural Sciences (FMIPA) at Sriwijaya University. A thematic analysis was performed utilizing open-ended questions to ascertain students' perceptions of ChatGPT's usage. Data processing was conducted utilizing Microsoft Excel on Windows 10. Descriptive statistics, including means and standard deviations per aspect were calculated to summarize response patterns, as shown as **Table 1**.

Table 1. Mean and standard deviations for aspects of questionnaire

Aspect	Mean	Standard Deviation
Perceptions on the Use of ChatGPT	2.7529	0.0716
Perceptions on ChatGPT's Efficacy	2.8977	0.0994
Strategies for Prompting and Verifying	2.9540	0.0787

This study establishes the following research questions:

1. What is the perception of Chemistry Education students at Sriwijaya University concerning the utilization of ChatGPT in the Organic Chemistry learning process?

2. To what extent do students assess the effectiveness of ChatGPT in enhancing their understanding of the principles and mechanisms of complex Organic Chemistry reactions?

3. What strategies do students utilize to engage ChatGPT, and to what extent do they assess the accuracy of the responses obtained?

4. How do students perceive the use of ChatGPT in the future educational models and media for learning Organic Chemistry?

5. What challenges and risks do students perceive in utilizing ChatGPT as a learning tool for Organic Chemistry, specifically with reliance and the authenticity of information?

3. Results and Discussions

This study involved 87 students from the Chemistry Education Study Program at Sriwijaya University, currently enrolled in Organic Chemistry I. The questionnaire data were evaluated by descriptive quantitative and thematic analysis (Ahmed et al., 2025). The demographic data showed that the most respondents were female (86.21%), while 13.79% were male. Nearly all respondents (98.85%) reported having used ChatGPT to support their Organic Chemistry learning (Figure 1). The frequency of ChatGPT use varied among students, as shown in Figure 2, indicating different levels of engagement with the tool. These results indicate that ChatGPT has been adopted by students as part of their learning activities in Organic Chemistry (Vieriu & Petrea, 2025).
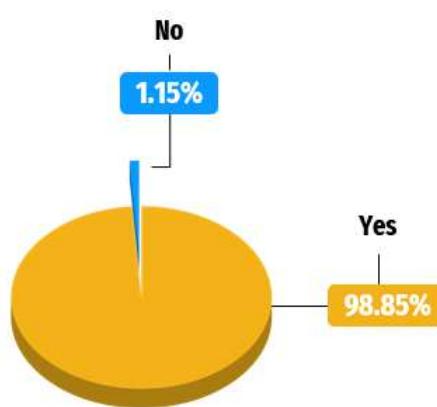

**Figure 1.** Proportion of students use ChatGPT for Organic Chemistry learning
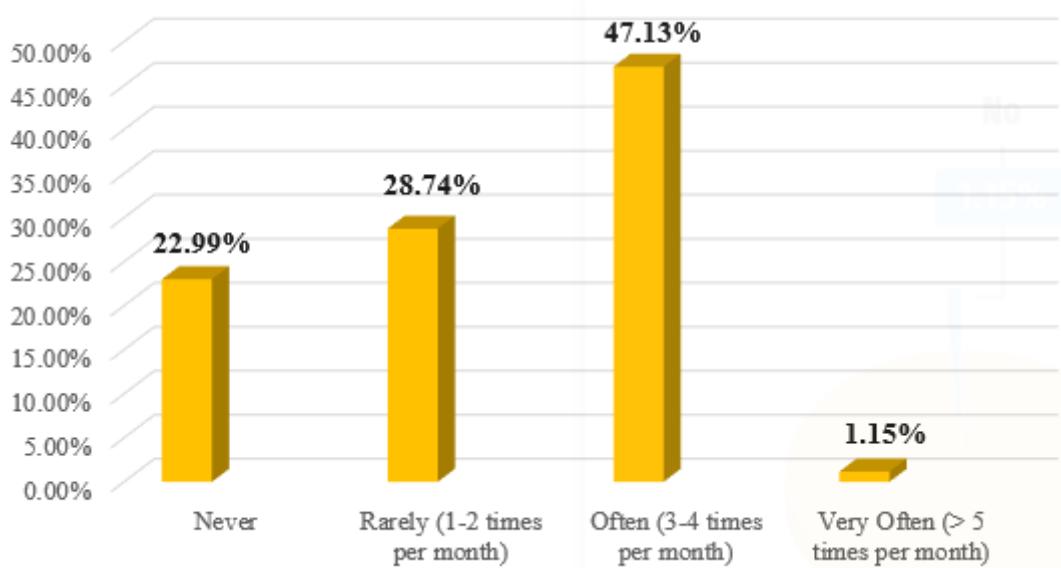
Figure 2. The frequency of ChatGPT usage

Student Perceptions on the Use of ChatGPT in Organic Chemistry Education

The results showed that most students held positive perceptions of ChatGPT as a learning support tool. A total of 90.81% of respondents agreed or strongly agreed that ChatGPT is useful for learning Organic Chemistry. In addition, 79.31% of students reported using ChatGPT in almost all the tasks that require them to find information, and 71.26% used it to support their understanding of organic chemistry reactions work. These findings supported the previous study that indicate that ChatGPT has become a key resource for students to assist with accessing and clarifying course content (Novita et al., 2024).

However, the results also showed a tendency toward increased reliance on ChatGPT. About 59.77% of students reported frequently using ChatGPT answers as their primary source of information for completing tasks, and 54.02% indicated relying heavily on ChatGPT to support their thinking processes. These findings suggest that while students perceive clear benefits from ChatGPT use, there is a risk of reduced independent cognitive engagement if ChatGPT is used without adequate guidance. The integration of ChatGPT with digital literacy can stimulate students' knowledge acquisition and improve their capacity to annalyze information derived from ChatGPT (Sugiarto & Ahmad Farid, 2023). As a result, ChatGPT should be integrated into learning models to improve critical thinking abilities through student interaction with the platform (Ekowijayanto & Ulvia, 2025; Nasr et al., 2025).

Student Perceptions on ChatGPT's Efficacy to Help Understand Organic Chemistry Principles

Most students perceived ChatGPT as effective in supporting conceptual understanding (see **Table 2**). A total of 88.51% of respondents agreed that ChatGPT helped accelerate the search for and processing of information. In addition, 78.71% reported that ChatGPT provided more structured and relevant explanations than search engines such as Google. Furthermore, 78.16% of students indicated that ChatGPT supported their understanding of abstract concepts, including stereochemistry and complex reaction mechanisms, while 84.71% stated that ChatGPT explained conceptss in simpler terms than traditional textbooks.

Table 2. Student Perceptions on ChatGPT's Efficacy

Statement	Percentage of agree and strongly agree (%)
ChatGPT saves time	88.51
Better than Google/search engines	74.71
Easy to use to find relevant information	79.31
Understand basic concepts that are difficult to grasp in textbooks	78.16
Understand 3D concepts (stereochemistry)	48.28

Convenient to use ChatGPT for practice problems	67.82
Simpler explanations	79.31
Easier to learn reaction mechanisms	74.71
Helps find problem-solving strategies	83.90
Only as a learning tool, not a primary resource	97.70 (positive)

Nevertheless, only 51.72% of students reported using ChatGPT as a learning tool rather than as a primary resource of information. This finding indicates that ChatGPT is acknowledged for its significant educational role as a scaffolding tool, acting as a cognitive aid to facilitate the understanding of complex topics (Daher et al., 2023). However, if students excessively rely on it as their primary resource without cross-referencing other scientific materials, it may deminish their academic literacy and decrease the quality of learning (Nopita & Dangin, 2025).

Students' Strategies for Prompting and Verifying ChatGPT Answers

Based on the responses of the questionnaire, most students reported using explicit and detailed prompts to obtain more relevant responses from ChatGPT (94.25%). In addition, 57.47% of respondents compared ChatGPT-generated responses with other sources such as textbooks and scientific articless, while 63.22% used ChatGPT to generate alternative solutions for comparison. However, 33.33% of students reported experiencing inaccuracies in ChatGPT-generated responses. These results indicate that students acknowledge the necessity of scientifically verifying the responses; nevertheless, not all consistently use this verification method. This signifies that students' proficiency in using ChatGPT requires enhancement, particularly in the field of science education, which demands accuracy and conceptual coherence, to ensure that the use of ChatGPT effectively improves scientific reasoning skills.

Perceptions of ChatGPT Integration in Learning Models and Materials

The results indicated that students generally supported the integration of ChatGPT into Organic Chemistry learning models and media. A total of 83.9% respondents agreed that ChatGPT could be integrated in learning models such as Project-Based Learning (PjBL) and Problem-Based Learning (PBL), and 91.95% supported its use in developing learning media. The thematic analysis of open-ended responses indicated that students perceived ChatGPT as helpful for explaining abstract concepts, particularly reaction mechanisms and stereochemistry, due to the illustrations and phrases used by ChatGPT to facilitate their learning. Several students emphasized the significance of lecturer supervision when using ChatGPT to ensure the content's accuracy and relevance. Overall, students perceived ChatGPT as a collaborative learning tool, with the lecturer acting as a facilitator and ChatGPT assisting in

the development of their ideas. These findings correspond with the previous research highlighting the potential of AI in education to enhance adaptive and personalized learning, depending upon its application within a suitable pedagogical framework (Coppin, 2025).

Challenges and Risks of Using ChatGPT to Learn

While students predominantly expressed positive sentiments toward ChatGPT, several challenges were recognized. The challenges included excessive reliance on ChatGPT, constraints in depicting three-dimensional and visual concepts like stereochemistry, and the presence of misinformation, as shown as **Figure 3**. This finding extends upon prior research that solely examined limitations in chemistry in a generic context (Nguyen & Sirichokcharoenkun, 2023). The results suggest that ChatGPT cannot substitute for lecturers or traditional learning materials and should be used with academic supervision, especially in abstract courses like Organic Chemistry.

"ChatGPT can't be used as the only way to learn because it often makes mistakes when preparing answers."

"To keep things interesting and avoid boredom, it's important to use media and learning methods with the help of technology or other tools."

"To make a learning model with ChatGPT, it might help to make the reactions, formulas, or calculation instructions clearer. Sometimes, seeing replies or calculations in ChatGPT makes it harder to understand."

"ChatGPT and other technologies like it should be used as learning tools, not just to swiftly answer questions, but also to show how reaction mechanisms work when they are hard to describe. The best ways to show abstract ideas make it easier to comprehend organic reactions mechanism.

"Researchers may be able to improve the learning concepts, since ChatGPT is still too abstract for solving stereochemistry problems."

Figure 3. Responses regarding the limitations of ChatGPT usage

The results of this study indicate that Chemistry Education students at Sriwijaya University typically hold positive perceptions of ChatGPT as learning tool in Organic Chemistry. ChatGPT was regarded as improving learning efficacy and conceptual comprehension. The findings underscore the necessity for pedagogical practices that foster critical assessment and responsible utilization of AI-assisted learning tools (Jere & Mpeta, 2025; Montenegro-Rueda et al., 2023). This study also identified pedagogical ambivalence. ChatGPT facilitates the quick comprehension of abstract concepts in students; nevertheless, excessive use may hinder their self-reflection and analytical abilities. A gap persists between students' ability in using ChatGPT to its maximum potential and their capacity to evaluate scientifically the accuracy of the material. Therefore, a pedagogical strategy is essential that conveys the technical aspects

of ChatGPT while also enhancing students' critical thinking and digital literacy skills (Kodkin & Artem'eva, 2024).

5. Conclusions

The research findings indicated that students use ChatGPT as a resource in understanding abstract concepts and enhancing the efficiency of Organic Chemistry learning. Most students used ChatGPT well; nonetherles, they often depended on ChatGPT-generated responses without scientific validation. Students expressed strong enthusiasm for the integration of ChatGPT in digital learning models and media. The primary concerns identified included the potential for dependency on ChatGPT, its inadequate ability to graphically elucidate concepts like stereochemistry, and the possibility of disseminating misinformation. To maximize the benefits of ChatGPT for enhancing students' critical thinking skills and conceptual comprehension, it should be used carefully, with much attention, and under the supervision of the lecturer.

This study was limited by its small sample size derived from a single university and by its dependence on self-reported questionnaire data. The future studies must include larger and more diverse samples while examining the impact of ChatGPT on educational outcomes, critical thinking, and conceptual understanding in Organic Chemistry.

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