AI in Chemistry Education: Student Perspectives on Opportunities and Challenges

Nur Atiqah Zaharullila*

University Technology MARA, Jasin Campus Melaka

***Corresponding Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.909000296

Received: 31 August 2025; Accepted: 06 September 2025; Published: 09 October 2025

ABSTRACT

The application of artificial intelligence (AI) into chemistry education is transforming how students learn, engage, and understand the chemistry concepts. AI tools such as ChatGPT, Gemini, Copilot and others enhance efficiency and support problem-solving, concerns about accuracy, ethics, however depending too much on AI make students worried in using them. This study investigated chemistry students' awareness, perceptions, and ethical considerations regarding artificial intelligence (AI) integration in chemistry learning. A structured questionnaire was administered to 53 diploma students. The instrument consisted of Likert-scale items and demographic questions, which allowed analysis of differences based on age, gender, and prior AI experience. Findings indicated moderate adoption of AI tools, with students using them primarily for literature searches and conceptual explanations but showing reluctance in applying AI to laboratory reports or high-stakes assessments. Students perceived AI as supportive in clarifying complex concepts and improving efficiency, yet expressed concerns about accuracy, academic integrity, privacy, and overreliance. Behavioural intentions remained cautious, with most respondents' undecided about long-term adoption. These results suggest that AI is valued as a supplementary tool in chemistry learning but not yet trusted for critical tasks.

Keywords: Artificial Intelligence, Chemistry Education, Student Awareness, Ethical Concerns, Behavioural Intention

INTRODUCTION

Artificial intelligence (AI) is increasingly applied in higher education, offering new opportunities to enhance teaching and learning in chemistry. Recent studies indicate that students acknowledge the usefulness of AI in simplifying complex chemical principles, enhancing efficiency, and supporting problem-solving through personalized tutoring and real-time feedback [1], [2]. Tools such as ChatGPT, Gemini, and Copilot have been adopted for tasks including literature searches, numerical problem-solving, and conceptual explanations. These applications highlight AI's capacity to complement traditional learning, offering students accessible, time-saving resources [3]. However, research also shows that while students perceive AI as a beneficial assistance, they remain cautious due to limitations such as misinformation, technical inaccuracies, and the lack of contextual reasoning in AI generated outputs [4]. This situation shows that AI is most effective when integrated together with human touch rather than replacing conventional teaching methods.

Despite of perceived usefulness, concerns about academic integrity and ethical implications continue to play a key role in shaping students' acceptance of AI in chemistry. Studies show that students worry about misinformation, technical inaccuracies, overreliance, and the erosion of critical thinking skills [5]. Ethical considerations such as plagiarism, inappropriate assistance in assignments and privacy risks further complicate adoption [6]. Nearly half of students surveyed in higher education contexts expressed uncertainty about whether AI use in coursework constitutes misconduct, reflecting the absence of clear institutional guidelines [7]. Therefore, although AI has considerable potential to enhance chemistry education, its application must be accompanied by systematic training, ethical guidelines, and continuous support from educators to ensure that students benefit from its use without compromising academic integrity or core scientific reasoning skills. The

rapid integration of AI into chemistry education has transformed learning practices, yet its role in chemistry remains underexplored, particularly from the perspective of students. A systematic review by Erümit & Sarıalioğlu (2025) shows a sharp increase in AI applications in chemistry education especially tools like ChatGPT and virtual laboratories and warns of ethical issues such as hallucinations, bias, plagiarism, and information accuracy [8]. Alli (2025) highlights the promise of intelligent tutoring systems and adaptive learning platforms in simplifying chemistry concepts, while stressing that AI must be integrated with conventional pedagogical methods and ethical guidance [1]. Similarly, Munawwarah et al. (2025) report that chemistry students value AI for its effectiveness and interactivity but emphasise the need for balanced integration that complements, rather than replaces, human interaction [9]. The lack of empirical evidence on chemistry students' perceptions highlights the need to investigate their awareness, usefulness, ethical concerns, and behavioural intentions toward AI integration.

This study aims, first, to investigate chemistry students' awareness, usage, and perceptions of AI tools in learning, focusing on their usefulness for understanding chemical concepts. Second, to examine students' behavioural intentions toward the future adoption of AI tools.

LITERATURE REVIEW

Artificial intelligence (AI) is increasingly applied in higher education, with chemistry recognized as a field where AI tools can significantly enhance student learning. Studies have shown that AI improves access to knowledge by simplifying complex chemical concepts, creating practice questions, and offering step-by-step solutions. [1], [2]. AI tools demonstrate potential in supporting literature searches, explaining concepts, and solving numerical problems, consistent with the Technology Acceptance Model (TAM), which highlights perceived usefulness and ease of use as key factors influencing adoption [10]. In chemistry education, the use of intelligent tutoring systems and virtual laboratories has strengthened student engagement by providing instant feedback and helping them visualize experiment processes. [1]. However, limitations in contextual reasoning and the risk of inaccuracies in AI-generated outputs highlight the importance of human oversight to maximize the benefits of these technologies [4].

Although AI is widely perceived as useful, concerns over trust, ethics, and academic integrity remain significant. Students express worries about misinformation, excessive dependence, and potential reductions in critical thinking skills when AI replaces independent learning [5]. Ethical issues include plagiarism, academic misconduct, and unclear boundaries between acceptable assistance and malpractice. Surveys indicate that while some students view the use of AI in assignments as cheating, others remain uncertain due to a lack of clear institutional guidelines [6]. These concerns are further heightened by privacy risks, as students fear their data may be exposed or exploited by AI platforms [7]. Overall, the findings suggest that despite recognizing AI's efficiency and accessibility, students remain hesitant about its implications for integrity and authenticity in learning.

Research in chemistry education highlights that students tend to perceive AI as an assistance to complete their task rather than a replacement for traditional learning. Studies by Baker et al. (2024) and Kodkin & Artem'eva (2024) found that students valued AI for clarifying concepts and providing rapid solutions, yet they were reluctant to rely on it for high-stakes tasks such as laboratory reports, where precision and scientific accuracy are critical. This cautious acceptance indicates that chemistry learners balance enthusiasm for innovation with awareness of the risks of overdependence [3],[9]. Consequently, effective integration of AI in chemistry education requires not only technological adoption but also structured training, ethical guidelines, and educator support to ensure that AI enhances learning without compromising essential scientific skills or academic integrity.

Erümit & Sarıalioğlu (2025) documented a decade of growth in AI applications in chemistry education, noting benefits such as adaptive feedback alongside risks of bias, hallucinations, and ethical misuse [8]. Alli (2025) reviewed AI in chemistry pedagogy, highlighting its role in enhancing conceptual understanding through intelligent tutors and adaptive platforms while underscoring the need for ethical integration [1]. Munawwarah et al. (2025) provided empirical evidence from student perspectives, showing that learners appreciate AI's

effectiveness and autonomy-enhancing features but stress that AI should complement not substitute traditional instruction and critical thinking [9].

METHODOLOGY

This preliminary study adopted a quantitative survey approach generated by the author. The items in the survey then been refined by the author to ensure clarity, relevance to chemistry education to examine the perceptions, awareness, and ethical considerations of 53 diploma students regarding the integration of artificial intelligence (AI) in chemistry education. The instrument comprised Likert-scale items (1 = strongly disagree to 5 = strongly agree) to measure the extent of AI tool usage and students' attitudes toward their application in learning chemistry. In addition, demographic questions covering age, gender, and prior experience with AI tools.

RESULT AND DISCUSSION

This study comprised of 53 respondents, from diploma level chemistry students. Data were collected through an online survey platform, ensuring voluntary participation and anonymity. Responses were analyzed using descriptive statistics to determine overall patterns in awareness, usefulness, and ethical concerns. Frequencies and percentages were calculated to illustrate trends in student perceptions, while demographic comparisons were performed to identify variations based on gender, age group, and AI experience. This approach provided a preliminary understanding of how chemistry students perceive AI integration and highlighted both the educational opportunities and challenges linked to its use.

a) b)

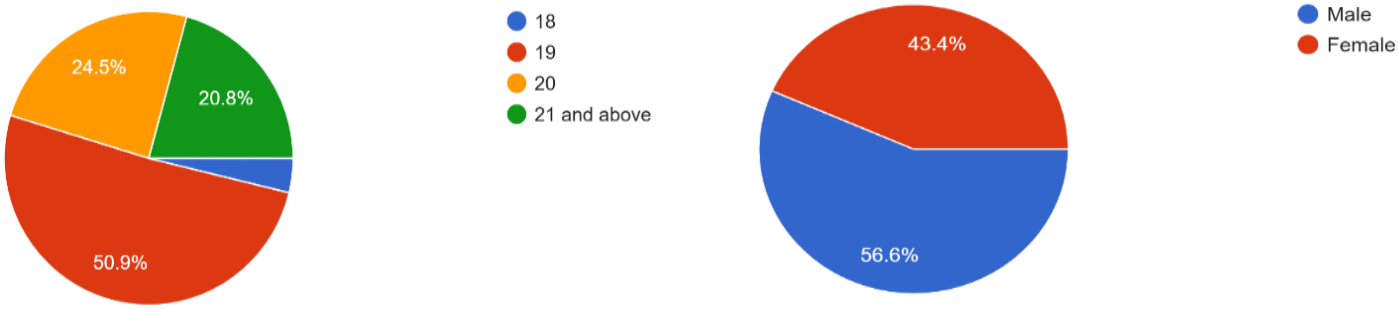

Figure 1. Demographic distribution of the 53 respondents: (a) percentage by age group and (b) percentage by gender.

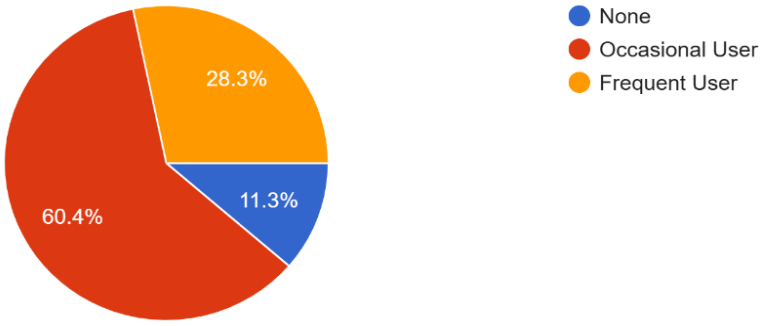

Figure 2: Respondents experienced with Al tools

The demographic analysis revealed that nearly half were 19 years old, representing diploma students in their second semester and above, while the rest were 20 years or older. The gender distribution was relatively balanced (57% female, 43% male), and most respondents identified as occasional users of AI, with 28% frequent users and only 11% reporting no prior use. This pattern suggests that exposure to AI tools in chemistry learning is already common among students, though not yet fully embedded in their daily academic practices. These findings provide insight that although students acknowledge AI's potential benefits in simplifying chemistry concepts and saving time, they remain hesitant to fully depend on it, underscoring the need for structured training

and clear guidelines to help students critically evaluate AI outputs and integrate them responsibly into their studies.

TABLE 1 Students' Awareness and Usage of AI Tools in Chemistry Studies

Items	5	4	3	2	1
I have used AI tools (e.g., ChatGPT, Gemini, Copilot) to assist with my chemistry studies.	13.2	30.1	35.85	18.8	1.89
I use AI to search for literature and research papers related to chemistry.	13.2	30.1	37.7	11.3	7.55
I rely on AI to generate or check chemistry lab reports.	5.66	13.2	32.0	26.4	22.6
I consult AI tools to solve numerical or theoretical chemistry problems.	9.43	32.0	37.7	11.3	9.43

The results on AI awareness and usage among 53 respondents show that 43% (13.21% strongly agree, 30.19% agree) reported using AI tools such as ChatGPT, Gemini, and Copilot, while 36% remained neutral and about 21% disagreed, indicating that exposure is moderate but not yet universal. For literature and research searches, 44% agreed or strongly agreed that they used AI, with 38% neutral and 19% disagreeing, reflecting that AI is recognized as helpful in retrieving references but still not a primary tool. In contrast, reliance on AI for lab reports was low, with only 19% agreeing, 32% neutral, and nearly half (49%) disagreeing, suggesting reluctance to depend on AI for tasks requiring accuracy in scientific reporting. For solving numerical or theoretical problems, 41% agreed or strongly agreed, 38% were neutral, and 21% disagreed, showing cautious adoption for problem-solving tasks. These observations suggest that students are experimenting with AI primarily for general support such as literature searches and conceptual explanations, while hesitancy appears stronger in areas requiring precision and originality. The inference is that students acknowledge AI's potential but lack full confidence in its reliability, particularly for technical or graded tasks. The key insight is that while AI tools have permeated chemistry learning, their use remains supplementary, shaped by cautious trust and selective application, emphasizing the need for clear guidelines and training to strengthen students' ability to evaluate and responsibly integrate AI in their studies.

TABLE 2 Students' Perceptions of AI Usefulness in Chemistry

Items	5	4	3	2	1
AI helps me understand complex chemical concepts better than traditional resources**.**	16.98 %	28.30 %	35.85 %	13.21 %	5.66 %
Using AI improves my ability to solve numerical chemistry problems.	15.09 %	35.85 %	33.96 %	13.21 %	1.89 %
AI suggestions enhance the clarity and structure of my lab reports.	7.55 %	30.19 %	41.51 %	16.98 %	3.77 %
Overall, AI makes studying chemistry more efficient.	16.98 %	32.08 %	39.62 %	7.55 %	3.77 %

The findings on perceived usefulness show that 45% of students agreed or strongly agreed that AI helps them understand complex chemical concepts better than traditional resources, while 36% remained neutral and 19% disagreed, suggesting that although AI can simplify topics, inconsistent quality limits full trust. Similarly, 51% reported that AI improved their ability to solve numerical problems, yet one-third stayed neutral and about 15% disagreed, indicating selective confidence in AI's problem-solving support. For lab reports, usefulness was less convincing: only 38% agreed that AI enhanced clarity and structure, while the largest share (42%) remained neutral and nearly 21% disagreed, reflecting doubts about AI's precision in scientific writing. On overall efficiency, 49% agreed or strongly agreed that AI makes studying chemistry more efficient, but 40% were neutral and 11% disagreed, highlighting mixed confidence in its reliability. These observations indicate that students recognize AI's value as a supplementary aid for learning and efficiency but hesitate to rely on it for tasks requiring accuracy and critical reasoning. The insight gained is that AI is appreciated as a supportive tool in chemistry education, yet its perceived usefulness is moderated by uncertainty and cautious trust, underscoring the need for educator guidance to optimize its role while preventing overdependence.

TABLE III Students' Perceptions of AI Ease of Use in Chemistry Learning

Items	5	4	3	2	1
AI tools for chemistry are easy to learn and use.	16.98 %	30.19 %	35.85 %	13.21 %	3.77 %
I can quickly get the information I need from AI without much effort.	15.09 %	35.85 %	35.85 %	7.55 %	5.66 %
I rarely encounter technical problems when using AI for chemistry tasks.	5.66 %	20.75 %	45.28 %	22.64 %	5.66 %

The results on perceived ease of use indicate that most students found AI tools relatively manageable, with 47% agreeing or strongly agreeing they are easy to learn and use, though 36% were neutral and 17% disagreed, suggesting that while generally accessible, however some students may require additional asisstance. Similarly, 51% agreed that they could quickly obtain needed information with minimal effort, but 36% remained neutral and 13% disagreed, reflecting recognition of AI's efficiency tempered by doubts over accuracy or completeness of responses. On technical reliability, most students were neutral (45%), with only 26% agreeing and nearly 29% disagreeing, implying that while technical issues are not severe, they still affect overall confidence. These observations infer that students generally perceive AI tools as user-friendly and efficient, but concerns about reliability and occasional technical challenges reduce their overall confidence.

TABLE IV Students' Ethical Concerns and Trust Toward AI in Chemistry

Items	5	4	3	2	1
I am concerned that AI might provide inaccurate information in chemistry.	22.64 %	35.85 %	33.96 %	7.55 %	0.00 %
Using AI to complete assignments feels like academic misconduct.	16.98 %	22.64 %	49.06 %	11.32 %	0.00 %
I worry about data privacy when using AI tools.	22.64 %	24.53 %	43.40 %	9.43 %	0.00 %
AI should be used only as a supplementary tool alongside traditional teaching.	24.53 %	30.19 %	41.51 %	3.77 %	0.00 %

The results on ethical concerns and trust show that more than half of the respondents (58% agree or strongly agree) were concerned that AI might provide inaccurate information in chemistry, with another 34% neutral, indicating strong awareness of potential misinformation risks. On academic integrity, 40% agreed that using AI to complete assignments feels like misconduct, while almost half (49%) were neutral, reflecting uncertainty due to the absence of clear institutional guidelines. Regarding data privacy, nearly half of the students (47%) expressed concern, while 43% remained neutral, highlighting awareness of risks in sharing personal or academic information with AI tools. Finally, 55% agreed that AI should only serve as a supplementary tool to traditional teaching, with 42% neutral and minimal disagreement, emphasizing student preference for AI as an aid rather than a replacement. These observations shows that while students recognize the benefits of AI, they remain cautious about its reliability, ethical implications, and data security. The insight is that trust in AI remains conditional and suggesting that successful integration in chemistry education requires explicit guidelines, institutional policies, and educator oversight to maintain academic integrity while maximizing AI's supportive role.

TABLE V Students' Behavioural Intentions Toward AI Adoption in Chemistry

Items	5	4	3	2	1
I plan to continue using AI tools for chemistry assignments in the future.	5.66 %	15.09 %	58.49 %	15.09 %	5.66 %
I intend to recommend AI tools to my peers for learning chemistry.	5.66 %	18.87 %	60.38 %	11.32 %	3.77 %
I would be willing to pay for premium AI tools that assist with chemistry learning.	5.66 %	5.66 %	32.08 %	30.19 %	26.42 %

The results on behavioural intentions show that most students remain undecided about long-term use of AI in chemistry learning, with 58% neutral and only 21% agreeing or strongly agreeing that they plan to continue using AI tools for assignments, while 21% disagreed, indicating uncertainty and cautious adoption. A similar trend was observed in recommending AI to peers, where 60% were neutral, 25% agreed, and 15% disagreed, suggesting that although students may recognize the potential of AI, they are reluctant to formally endorse it without stronger evidence of consistent benefits. Willingness to pay for premium AI tools was particularly low, with more than half of respondents (57%) disagreeing or strongly disagreeing and only 11% agreeing, while 32% remained neutral, reflecting scepticism about the added value of paid services compared to free alternatives. These observations infer that students currently view AI as supplementary rather than essential in their academic practices, and adoption is restrained by concerns about reliability and cost. The key insight is that while students acknowledge AI's usefulness, their behavioural intentions indicate hesitancy to fully integrate or invest in it.

CONCLUSION

This preliminary study concludes that chemistry students demonstrate moderate awareness and selective use of AI tools, recognizing their usefulness in simplifying concepts, solving problems, and improving study efficiency, yet remaining cautious about accuracy, ethical concerns, and overreliance. While students perceive AI as easy to use, they prefer it as a supplementary aid rather than a replacement for traditional teaching, and their behavioural intentions reflect hesitation to fully integrate or invest in AI without clearer guidance and proven reliability. Overall, the findings highlight the need ethical frameworks and institutional support to ensure AI is effectively and responsibly integrated into chemistry education. This study provides important insights into how chemistry students perceive and use AI, highlighting both opportunities and challenges in integrating such tools into education.

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