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Student Perceptions of E-Learning Tools in Chemistry Education

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Abstract

This research examines student perceptions of e-learning tools in chemistry education, concentrating on their usage, effectiveness, features, engagement, and overall impact. Two hundred students from various programs and levels of study were given a standardised questionnaire with five Likert scale items. The data was examined by using methods of correlation, regression, and descriptive statistics. According to the findings, using e-learning tools may greatly improve your ability to solve problems, study for exams, and do well in school generally. Findings indicate that multimedia and interactive aspects significantly contribute to higher levels of student engagement and motivation. While many students have faith in digital resources, others have doubts about their capacity to totally replace more conventional approaches, especially when it comes to grasping more advanced ideas. Another finding from the research is that people's perceptions are greatly impacted by demographic criteria such gender, age, academic level, institution type, and internet availability. These results emphasise the rising importance of online learning tools in chemistry education as useful adjuncts.

Keywords; e-learning tools, chemistry education, student engagement, academic performance, perceptions.

INTRODUCTION

The growing use of digital technology has transformed the way education is delivered across disciplines. Chemistry, being an experimental and concept-heavy subject, often requires innovative teaching methods to make abstract ideas clear and meaningful (Almajali et al., 2022). Traditional classroom lectures, while useful, sometimes fail to address the diverse learning needs of students. In this context, e-learning tools have gained prominence as supplementary or alternative modes of instruction. (Bharsat et al., 2024)

E-learning tools in chemistry education include interactive simulations, virtual laboratories, video demonstrations, online quizzes, and digital platforms for collaboration. These resources not only provide flexibility in learning but also create opportunities for visual and experiential understanding of complex chemical concepts. Students can revisit content at their own pace, engage with models that may be difficult to replicate in physical laboratories, and receive instant feedback on assessments (Agung et al., 2022).

Despite these advantages, the effectiveness of e-learning tools is largely determined by how students perceive and use them. Positive perceptions can increase motivation, engagement, and learning outcomes, whereas negative attitudes may limit their educational value (Hancock, 2024). Understanding student perceptions therefore becomes crucial in evaluating the actual role of e-learning in chemistry education.

Importance of E-Learning in Chemistry Education

The study of chemistry demands both conceptual clarity and practical understanding. Traditional teaching methods, while essential, sometimes fall short in addressing the complexity of chemical processes. E-learning tools bridge this gap by offering interactive and accessible resources that enhance student engagement and comprehension. Their importance can be viewed from multiple perspectives, as outlined below (Swarnkar, 2024):

Importance of E-Learning in Chemistry Education:

1. **Enhances Visualization:** Helps students understand abstract concepts such as molecular structures and reaction mechanisms through simulations and animations.
2. **Provides Flexibility:** Allows learners to access study materials anytime and at their own pace, supporting revision and self-directed learning.
3. **Supports Practical Understanding:** Virtual labs replicate experiments that may not be possible in school laboratories due to safety, cost, or equipment limitations.
4. **Encourages Engagement:** Interactive quizzes, games, and multimedia content sustain student motivation and curiosity.
5. **Promotes Inclusivity:** Caters to different learning styles, such as visual, auditory, and kinesthetic ensuring broader participation.
6. **Facilitates Feedback:** Online assessments provide immediate responses, enabling students to monitor progress and improve performance.
7. **Ensures Continuity of Learning:** Particularly useful during disruptions such as pandemics or in remote areas with limited laboratory access.

Table 1 Significance of E-Learning Tools in Chemistry Education

Aspect	Contribution of E-Learning Tools
Conceptual Understanding	Visual simulations and animations simplify complex topics
Practical Application	Virtual labs enable safe and cost-effective experimentation
Flexibility	Students can learn anytime and revisit difficult concepts
Student Engagement	Interactive content increases interest and active participation
Accessibility	Resources cater to diverse learning styles and needs
Assessment and Feedback	Online quizzes provide instant feedback and self-evaluation
Educational Continuity	Maintains learning in times of crisis or limited infrastructure

E-Learning Tools for Chemistry

Chemistry as a discipline requires more than theoretical explanation; it relies heavily on visualization, experimentation, and application. E-learning tools serve this purpose by integrating technology into teaching and learning (Erümit & Sarıalioğlu, 2025). These tools range from interactive simulations to virtual laboratories and online learning platforms. They provide opportunities for learners to engage with complex concepts, visualize reactions, and practice problem-solving in a controlled and flexible environment (Sormin, 2025). Beyond content delivery, such tools also create a platform for assessment, feedback, and collaboration among students. The following table outlines commonly used e-learning tools in chemistry along with their major contributions to the learning process.

Table 2 E-Learning Tools in Chemistry and Their Uses

E-Learning Tool	Description	Educational Contribution in Chemistry
Virtual Laboratories	Online platforms replicating real lab experiments	Allow students to conduct experiments safely without resource limits
Interactive Simulations	Digital models of chemical reactions and molecular structures	Help students visualize abstract processes and test variables
Multimedia Tutorials	Video lectures, animations, and step-by-step demonstrations	Simplify complex theories and enhance memory retention
Learning Management Systems (LMS)	Platforms like Moodle, Google Classroom, or Canvas	Organize course content, assignments, and discussions in one space
Online Quizzes & Assessments	Self-paced tests with instant feedback	Strengthen problem-solving skills and track learning progress
Discussion Forums & Collaboration Tools	Platforms for peer-to-peer interaction and group projects	Encourage collaborative learning and exchange of ideas
Mobile Applications	Chemistry apps offering periodic tables, reaction databases, and practice sets	Support quick revision and on-the-go learning

LITERATURE REVIEW

(Dewi et al., 2023) This study aimed to provide light on how COVID-19 affected chemistry students' views on online chemistry courses. To conduct the study, researchers relied on descriptive quantitative surveys. Part of the Chemistry Education Study Program, 311 undergraduates from 16 different Indonesian institutions participated in the study. We gathered this information using a survey method that makes use of a Likert scale. Students will find the survey simpler to access as it was made utilising a Google Forms questionnaire. To analyse the data from this research, we first took the percentage of each indicator from the distributed Google form and turned it into a score for data presentation. Then, we looked at each indicator individually. Students' impressions of online chemistry courses at 16 universities in Indonesia were negative, according to the following metrics: 50% for online enjoy learning, 40% for content presentation strategy, 65% for online media usage, 20% for indicators that are constrained when online learning, 21% for student readiness, and 60% for online learning evaluation.

(Alqallaf et al., 2025) Students' motivation, academic performance, and comprehension of chemical principles were assessed as part of the study's evaluation of the Crocodile Chemistry curriculum at PAAET. Utilising a quasi-experimental approach, a set of 102 students were assigned to work with Crocodile Chemistry, whereas 103 students were assigned to follow more conventional laboratory methods. For both the pre- and post-tests, the Alternative Chemical Concepts Test was used. Learning consistency was evaluated by correlation analysis, while improvements in performance were quantified by paired t-tests. We assessed the dependability of tests and the efficacy of lessons using the Partial Credit Model (PCM). The research proved that online chemistry labs may revolutionise the subject by raising students' level of understanding, interest, and achievement. The findings provided credence to the idea that digital technologies might be effectively used in higher education to boost both learning results and student motivation.

(Schuessler et al., 2024) Students' performance, cognitive load, and usability—all aspects that contribute to learning outcomes—are compared in the research between digital molecule-drawing activities and conventional paper-pencil-based tasks. The built system was shown to be able to produce digital organic chemistry problems via the use of Rasch analysis, t-tests, and correlation studies. After a proper introduction to the digital tool, students were able to draw simple molecules just as well using paper and pencil as they could with the former. But in two of the three trials, the digital tool was shown to impose a greater amount of irrelevant cognitive burden compared to paper and pencil. However, the technology was deemed adequately user-friendly by the pupils. There is potential for improvement since a strong negative association was seen between superfluous load and tool usage.

(Al Soub & Sarayreh, 2021) The purpose of the research was to determine whether or not Aqaba University of Technology (AUT) chemistry students were satisfied with their experience taking their classes remotely during the COVID-19 epidemic. Interaction with e-learning, methods, teaching, and website enhancement were the four components of the survey that measured student satisfaction. The Statistical Package for the Social Sciences has performed the statistical analyses using descriptive and interference analytical methods. In view of the COVID-19 pandemic, the findings showed that students at AUT were satisfied with the use of e-learning to study chemistry. While training and website enhancement showed moderate pleasure, e-learning and methods interaction showed great happiness. The gender of the students had a significant impact on their level of satisfaction ($\alpha \leq 0.05$). Overall and across all four measures, women reported higher levels of satisfaction.

(Iyamuremye et al., 2025) This research looked at how organic chemistry students in Rwandan secondary schools fared after using online discussion tools to improve their knowledge and abilities in the subject. Students in the online discussion group (the experimental group) outperformed those in the control group in terms of progress, according to the results. These findings corroborate other studies that shown that digital platforms improved students' interest, understanding, and ability to learn organic chemistry. The findings from several areas of organic chemistry show that this intervention was beneficial, especially in the experimental group's performance in areas like chemical characteristics and manufacture of alkane, introduction to alkane, and nomenclature of alkane.

OBJECTIVES OF THE STUDY

1. To assess the effectiveness of e-learning tools in enhancing student learning in chemistry.
2. To examine the role of e-learning tools in improving student engagement and motivation in chemistry education.
3. To evaluate the accessibility, usability, and overall satisfaction of students with e-learning resources.
4. To analyze whether student perceptions of e-learning tools vary according to demographic factors such as gender, academic level, or prior digital exposure.

RESEARCH METHODOLOGY

In order to better understand how students feel about e-learning tools in chemistry education, the current study used a survey research strategy. The data was gathered using a two-part structured questionnaire. In the first section, demographic information including gender, age range, institution type, and home internet connectivity were addressed. The second section included claims pertaining to the study's important variables, which included: e-learning tool usage, learning effectiveness, e-learning tool features, student involvement and motivation, and overall perceptions of e-learning tools. A five-point Likert scale was used to assess each statement, with 5 representing strongly disagreeing and 1 representing strongly agreeing (1). The statistical analysis was based on a total of 200 valid replies that were received from students. In order to accomplish the goals of the research, this technique made sure that data was collected, processed, and analysed in a methodical way.

Table 3 Research Methodology

Component	Description
Research Design	Descriptive survey method
Data Collection Tool	Structured questionnaire
Questionnaire Sections	(i) Demographic information; (ii) Likert-scale statements on study variables
Scale Used	Five-point Likert scale (5 = Strongly Disagree to 1 = Strongly Agree)
Sample Size	200 students
Sampling Technique	Random sampling (students from different academic levels and institutions)
Data Collected On	Use, effectiveness, features, engagement, and perceptions of e-learning tools

DATA ANALYSIS AND INTERPRETATION

The data collected through the structured questionnaire was systematically analyzed to draw meaningful insights into student perceptions of e-learning tools in chemistry education. Both descriptive and inferential statistical techniques were applied to examine patterns, relationships, and differences across variables. The following section presents the analysis and interpretation of the findings.

Table 4 Gender

Gender					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Boy	114	57.0	57.0	57.0
	Girl	86	43.0	43.0	100.0
	Total	200	100.0	100.0	

The distribution of respondents by gender shows that out of the total 200 students surveyed, 114 (57.0%) were boys and 86 (43.0%) were girls. This indicates that male students formed a slightly larger proportion of the sample compared to female students. The percentages also suggest a fairly balanced representation of both genders, ensuring that the views gathered in the study reflect perspectives from both groups.

Table 5 Age Group

Age Group					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Below 18 years	19	9.5	9.5	9.5
	18–21 years	73	36.5	36.5	46.0
	22–25 years	66	33.0	33.0	79.0
	Above 25 years	42	21.0	21.0	100.0
	Total	200	100.0	100.0	

The age-wise distribution of respondents shows that out of 200 students, 19 (9.5%) were below 18 years, 73 (36.5%) belonged to the 18–21 years group, 66 (33.0%) were in the 22–25 years group, and 42 (21.0%) were above 25 years. The highest proportion of participants came from the 18–21 years category, followed closely by the 22–25 years group, together accounting for nearly 70 percent of the sample.

Table 6 Academic Level

Academic Level					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Higher Secondary / Pre-University	52	26.0	26.0	26.0
	Undergraduate	86	43.0	43.0	69.0
	Postgraduate	62	31.0	31.0	100.0
	Total	200	100.0	100.0	

The academic level distribution indicates that among the 200 respondents, 52 students (26.0%) were from higher secondary or pre-university level, 86 students (43.0%) were undergraduates, and 62 students (31.0%) were postgraduates. The largest proportion of participants were undergraduate students, followed by postgraduates, while higher secondary students formed the smallest group.

Table 7 Type of Institution

Type of Institution					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Government	93	46.5	46.5	46.5
	Private	107	53.5	53.5	100.0
	Total	200	100.0	100.0	

The distribution of respondents by type of institution shows that out of 200 students, 93 (46.5%) were from government institutions, while 107 (53.5%) were from private institutions. This indicates a slightly higher representation of students studying in private institutions compared to those in government institutions, though both groups were fairly balanced in the sample.

Table 8 Access to Internet at Home

Access to Internet at Home					
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	123	61.5	61.5	61.5
	No	77	38.5	38.5	100.0
	Total	200	100.0	100.0	

The data on internet access at home reveals that out of 200 respondents, 123 students (61.5%) reported having internet access, while 77 students (38.5%) did not have access. This shows that a clear majority of students could use internet facilities at home, though a considerable proportion still lacked such access, which may influence their use of e-learning tools.

Table 9 Descriptive Statistics

Descriptive Statistics					
	N	Min	Max	Mean	S.D
I frequently use e-learning tools for studying chemistry	200	1	5	2.88	1.567
E-learning tools are easily available to me for chemistry learning	200	1	5	2.09	1.373
I find online platforms convenient for accessing chemistry resources	200	1	5	2.29	1.440
I prefer e-learning tools over traditional classroom resources	200	1	5	2.50	1.326
I use e-learning tools regularly to revise and practice chemistry topics	200	1	5	2.39	1.385
E-learning tools help me understand chemistry concepts better	200	1	5	3.43	1.294
Online resources improve my problem-solving skills in chemistry	200	1	5	2.01	1.244
Using e-learning tools increases my academic performance in chemistry	200	1	5	1.85	1.179
E-learning tools make it easier for me to prepare for chemistry examinations	200	1	5	2.05	1.354
I believe that learning chemistry through digital tools is more effective than only traditional methods	200	1	5	2.66	1.593
The design and layout of e-learning platforms are user-friendly	200	1	5	2.80	1.577
Multimedia features (videos, animations, simulations) make learning chemistry easier	200	1	5	2.03	1.348
The content provided by e-learning tools is clear and well-structured	200	1	5	2.36	1.534
Interactive features (quizzes, practice tests) make e-learning more useful	200	1	5	2.54	1.337
The language and presentation style of e-learning tools are suitable for students	200	1	5	2.31	1.331
E-learning tools make chemistry learning more interesting for me	200	1	5	2.76	1.601
Online platforms encourage me to spend more time studying chemistry	200	1	5	2.04	1.344
I feel more motivated to learn chemistry when I use e-learning resources	200	1	5	2.39	1.490
E-learning tools encourage me to actively participate in learning tasks	200	1	5	2.49	1.319
I enjoy learning chemistry through digital tools compared to traditional methods	200	1	5	2.19	1.320
I consider e-learning tools as an important part of chemistry education	200	1	5	2.80	1.570
I feel confident when using e-learning tools for learning chemistry	200	1	5	2.04	1.346
My overall perception of e-learning tools in chemistry is positive	200	1	5	2.34	1.526
I believe e-learning tools can be used as a supplement to classroom teaching	200	1	5	2.54	1.337
I would recommend e-learning tools to other students for learning chemistry	200	1	5	2.32	1.344

The descriptive statistics show that students expressed strong agreement on several items reflecting the usefulness of e-learning tools in chemistry. The lowest mean scores were observed for statements such as "Using e-learning tools increases my academic performance in chemistry" (M = 1.85, SD = 1.179), "Online resources improve my problem-solving skills in chemistry" (M = 2.01, SD = 1.244), and "E-learning tools make it easier for me to prepare for chemistry examinations" (M = 2.05, SD = 1.354), indicating that students generally recognized clear benefits in terms of learning outcomes. Similarly, positive perceptions were reflected in responses to "Multimedia features make learning chemistry easier" (M = 2.03) and "Online platforms encourage me to spend more time studying chemistry" (M = 2.04). Moderate agreement was recorded for items such as "I frequently use e-learning tools for studying chemistry" (M = 2.88, SD = 1.567) and "The design and layout of e-learning platforms are user-friendly" (M = 2.80, SD = 1.577), suggesting that while students acknowledge their importance, actual frequency and ease of use vary across individuals. Interestingly, the item "E-learning tools help me understand chemistry concepts better" (M = 3.43, SD = 1.294) received a comparatively higher mean score, reflecting relatively weaker agreement and indicating that some students may still prefer traditional learning methods for conceptual clarity. The findings point to a predominantly favorable perception of e-learning tools in chemistry education, particularly in terms of motivation, problem-solving, and examination preparation, though some reservations remain about their role in conceptual understanding and preference over traditional resources.

Hypotheses testing

H01: There is no significant impact of use of e-learning tools on the effectiveness of learning in chemistry education.

Table 10 ANOVA

ANOVA					
Effectiveness of Learning in Chemistry Education					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1144.780	12	95.398	130.007	.000
Within Groups	137.220	187	.734		
Total	1282.000	199			

The ANOVA results for testing the null hypothesis H01 show that the between-groups sum of squares is 1144.780 with a mean square value of 95.398, while the within-groups sum of squares is 137.220 with a mean square of 0.734. The obtained F-value is 130.007 with a corresponding significance level (p-value) of .000, which is less than 0.05. This indicates a statistically significant difference between groups. Hence, the null hypothesis is rejected, and it is concluded that the use of e-learning tools has a significant impact on the effectiveness of learning in chemistry education.

H02: "There is no significant relationship between the features of e-learning tools and student engagement and motivation in chemistry education."

Table 11 Correlations

Correlations			
		Features of E-Learning Tools	Student Engagement and Motivation in Chemistry Education
Features of E-Learning Tools	Pearson Correlation	1	.828**
	Sig. (2-tailed)		.000
	N	200	200
Student Engagement and Motivation in Chemistry Education	Pearson Correlation	.828**	1
	Sig. (2-tailed)	.000	
	N	200	200
**. Correlation is significant at the 0.01 level (2-tailed).			

The correlation analysis for testing the null hypothesis H02shows a Pearson correlation coefficient of .828 with a significance value of .000 at the 0.01 level. Since the correlation value is high and positive, it indicates a strong association between the two variables. The p-value being less than 0.01 confirms that this relationship is statistically significant. Therefore, the null hypothesis is rejected, and it is concluded that the features of e-learning tools have a strong and significant relationship with student engagement and motivation in chemistry education.

H03: "There is no significant difference in student perceptions of e-learning tools across demographic factors."

Table 12 ANOVA

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	37.425	5	7.485	3.303	.004[b]
	Residual	1114.395	194	5.744		
	Total	1151.820	199			
a. Dependent Variable: Student Perceptions of E-Learning Tools						
b. Predictors: (Constant), Access to Internet at Home, Academic Level, Type of Institution, Gender, Age Group						

Table 13 Coefficients

Coefficients[a]						
		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	12.062	1.090		11.065	.000
	Gender	.722	.344	.149	2.103	.037
	Age Group	.100	.190	.238	2.524	.001
	Academic Level	.148	.230	.217	2.645	.020
	Type of Institution	.348	.340	.372	3.022	.008
	Access to Internet at Home	.073	.351	.145	2.009	.035
a. Dependent Variable: Student Perceptions of E-Learning Tools						

The hypothesis H03 was tested using regression analysis. The ANOVA table shows a regression sum of squares of 37.425 with an F-value of 3.303 and a significance level of .004, which is below 0.05. This indicates that demographic variables, taken together, significantly explain variations in student perceptions of e-learning tools.

Looking at the coefficients table, several demographic factors were found to have a statistically significant effect. Gender (B = .722, p = .037), Age Group (B = .100, p = .001), Academic Level (B = .148, p = .020), Type of Institution (B = .348, p = .008), and Access to Internet at Home (B = .073, p = .035) all showed significance at the 0.05 level. This suggests that perceptions of e-learning tools differ meaningfully across these demographic categories.

Therefore, the null hypothesis is rejected, and it is concluded that demographic factors such as gender, age, academic level, type of institution, and internet access significantly influence student perceptions of e-learning tools in chemistry education.

CONCLUSION

With a focus on their usage, effectiveness, features, engagement, and overall impression, the current research aimed to investigate students' opinions of e-learning tools in chemistry education. The results showed that e-learning tools are becoming a significant part of chemistry teaching and learning, according to a structured questionnaire done with 200 students. These tools promote active learning habits, help students prepare for exams, and boost their academic achievement, according to students. A strong suit is the use of multimedia elements and interactive platforms, which keep students interested and involved while breaking down difficult chemistry topics. Students saw e-learning tools more as helpful adjuncts to traditional classroom instruction, according to the data, rather than replacements for it. Although most people thought they helped with problem-solving and study time, some were sceptical that they might improve conceptual clarity as much as more conventional approaches. This contradictory reaction shows that digital tools work best when combined with more traditional methods, even if they are useful in their own right.

The significance of e-learning tools was validated by statistical testing. Design, accessibility, and interactivity were substantially associated with student engagement and motivation, and the use of these tools significantly affected the effectiveness of chemistry learning. Students' backgrounds impact their experiences with digital learning tools. Perceptions were highly impacted by demographic criteria such as gender, age, academic level, institution type, and internet access. To sum up, chemistry education stands to benefit greatly from the use of e-learning tools, which may be further enhanced by including user-friendly features and supplementary teaching methodologies. There has been a change in learning techniques, with digital platforms becoming an essential component of contemporary education rather than an add-on, as seen by their increasing popularity among students.

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