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Students' Academic Achievement Level in the Use of Digital Learning Platforms for Learning Form 4 Chemistry

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Abstract

This study was conducted to evaluate students' academic achievement in using digital learning platforms for learning Chemistry, as well as to explore the platform-related factors that influence student achievement. A mixed-method research design was used, involving a quantitative approach through pre- and post-tests, and a qualitative approach through semi-structured interviews. A total of 30 Form 4 students from a secondary school in the Johor Bahru district participated in the quantitative data collection, while six students were interviewed for qualitative data. Analysis using the Wilcoxon Signed-Rank Test revealed a statistically significant difference between achievement scores before and after the use of the digital learning platform ($Z = -4.574$, $p < 0.05$). This confirms that digital platform use has a positive effect on students' academic performance in Chemistry. Thematic analysis of the qualitative data identified four key factors influencing the effectiveness of the digital platform: motivation, interaction, platform content, and feedback. The findings indicate that digital learning platforms designed with interactive elements and supported by effective pedagogical strategies can enhance student performance. This study provides important implications for the Malaysian Ministry of Education, teachers, and students in planning and implementing more effective digital learning approaches.

Keywords: Digital Learning Platforms, Academic Achievement, Motivation, Interaction, Platform Content, Feedback

Introduction

The rapid advancement of technology over the past decade has transformed the educational landscape, resulting in the widespread adoption of digital learning platforms worldwide. Digital learning platforms have become increasingly prevalent in academic settings, offering a variety of resources and tools to facilitate the learning experience (Yong Cao, 2024). These platforms encompass a wide range of online systems and tools designed to support and enhance the delivery of education, from learning management systems to interactive multimedia resources. They facilitate access to educational materials, enable remote and flexible learning, and support pedagogical approaches aligned with 21st-century education.

The online learning approach offers various benefits for enhancing students' learning experience, technical skills, and more. Its widespread use exposes students to a broader range of information sources. Students can explore complex chemistry concepts in more engaging and interactive ways. In the context of science education, such as chemistry, these platforms play a crucial role in helping students understand abstract and complex concepts through animations, simulations, and digital assignments that are more engaging and easier to grasp (Khaled Almotairi, 2022). The challenges of studying chemistry are widely acknowledged, especially by students. It involves complex concepts that often make it difficult for students to understand abstract topics, and is particularly challenging when visualizing interactions between molecules at the sub-microscopic level. Therefore, digital learning platforms that combine features such as multimedia elements, gamification, simulations, and others can enhance student engagement and motivation (Yong Cao, 2024).

This study will utilize digital learning platforms for teaching chemistry to assess students' academic achievement after using these platforms. Several studies have found that using digital learning platforms positively impacts students' academic performance. Evidence shows that students who frequently use digital learning platforms tend to perform significantly better than those who are less exposed to such technologies (Venugopal, 2024). The use of digital learning platforms is also highlighted in the study by Khaled H. Almotairi (2022), which states that digital platforms are among the most successful tools currently used in education. Khaled adds that this is because they offer flexible timing, do not require high educational costs, and provide attractive digital content that is stored and accessible to all students and teachers. Interactive teaching materials can assist educators in delivering information easily while maintaining students' consistent focus during the learning process.

Students' academic achievement in chemistry is a key priority for educators. Various modern teaching methods and strategies are referenced and utilized by teachers to be implemented in the teaching and learning process. Many students often express the opinion that chemistry is a difficult subject in which to score high marks in examinations (Rahim & Lee, 2021). According to Rahim and Lee (2021), abstract and complex subtopics such as the mole concept, acids and bases, neutralization, and chemical reaction equations are commonly cited by students as areas of difficulty. Understanding concepts in chemistry requires students to use their imagination, and face-to-face teaching without the integration of technology is seen as one of the main causes of students' lack of understanding in the subject. Therefore, teaching methods and strategies should be adapted to students' learning styles while leveraging technology in instruction.

However, the impact of using digital learning platforms on students' academic achievement or performance is not necessarily uniform. Several factors—such as the level of feedback, interaction, content quality of the platform, and students' motivation—can influence the effectiveness of digital learning (Sadia Javed, 2025). Students face challenges in understanding this subject, including the abstract nature of the material, the complexity of chemistry terminology, and the limited use of real-world examples by teachers to relate to chemistry concepts (Juliana Nkiru Nnoli, 2023). As a result, student engagement, interest, and motivation in chemistry classes may decline. Studies have shown that traditional lecture-based teaching methods, which lack interactive elements, lead to lower academic achievement and weaker self-concept among students (Nmadu, 2023). Therefore, these challenges may become barriers to improving students' academic performance.

Although positive data can be observed, there is still a gap in understanding how specific factors in the use of digital learning platforms affect students' academic achievement, especially in the context of secondary school chemistry education in Malaysia. Many previous studies have either overlooked science subjects or been conducted at the university level. Integrating technology into the complex subject of chemistry is essential for students, as it can create a more dynamic and engaging learning environment. Without such integration, students may struggle to remain focused, interested, and actively involved in their learning process. Therefore, the use of technology to apply digital learning is one step toward helping students improve their understanding of chemistry.

Accordingly, this study will pursue two main objectives: to measure students' academic achievement after using a digital learning platform, and to explore the factors within the platform's use that may influence students' academic performance in the subject of chemistry. The findings from this study will serve as evidence and a source of confidence for educators, particularly secondary school teachers, regarding the impact of digital learning platforms on students' academic achievement in chemistry.

Methodology

The research design used to achieve the two objectives is both quantitative and qualitative. The quantitative study is used to measure students' academic achievement, where data is collected through written tests conducted in a secondary school. The data is observed based on two phases: before (pre) and after (post) the use of the digital learning platform. In the first phase, students will take a written test to assess their knowledge and understanding of the topic, basic Concepts of Acids and Bases. After completing the pre-test, students will use a digital learning platform for the same topic, following physical classroom instruction by the teacher. The digital learning platforms used in this study are PhET Simulation, OLabs and Canva. Once the usage period ends, students will take a second written test (post-test).

The qualitative study is then used to achieve the second objective, which is to explore how factors within digital learning platforms influence students' academic performance in learning chemistry. The qualitative method involves conducting semi-structured interviews. The study population consists of Form 4 secondary school students. A purposive sample is selected from students in a secondary school in the Johor Bahru district. The sample includes 30 Form 4 students from a single class, chosen because their teacher is skilled in using technology and actively integrates digital learning platforms in teaching. For the qualitative approach,

purposive sampling is conducted on the same students who completed the pre-post-tests and actively used the digital learning platforms, including students with varying academic performance levels—excellent, average, and low-achieving. For this method, approximately 6 students are interviewed until data saturation is reached (no new themes emerge). To implement this study, the teacher is selected as the expert to carry out the research procedures. Therefore, a lesson plan (RPH) is developed on the topic of acids and bases to facilitate the teaching sessions using digital learning platforms in the chemistry classroom. The pre- and post-tests consist of 10 objective questions and 2 subjective questions. The post-test uses the same questions as the pre-test, but with a different question order to reduce the likelihood of students relying solely on memory. The time allocated for the test is 30 minutes.

Result and Analysis

The findings of the study will be analysed using descriptive and inferential statistical methods. Descriptive and inferential analyses are conducted to achieve the objective related to students' academic achievement levels, while thematic analysis is used to explore factors within the platform that influence students' academic performance.

Descriptive Analysis: What is the level of students' academic achievement after using digital learning platforms to learn chemistry?

Table 1.1
Achievement Scores from Pre-Test and Post-Test Using a Digital Learning Platform

Student (P)	Pre-Test		Post-Test	
	Score (%)	Level	Score (%)	Level
P1	70	Excellent	80	Excellent
P2	60	Good	80	Excellent
P3	30	Weak	60	Good
P4	40	Average	80	Excellent
P5	75	Excellent	75	Excellent
P6	40	Average	85	Excellent
P7	60	Good	80	Excellent
P8	65	Good	80	Excellent
P9	75	Excellent	85	Excellent
P10	80	Excellent	90	Excellent
P11	70	Excellent	65	Good
P12	35	Weak	65	Good
P13	50	Average	65	Good
P14	40	Average	50	Average
P15	40	Average	70	Excellent
P16	55	Average	75	Excellent
P17	80	Excellent	80	Excellent
P18	65	Good	85	Excellent
P19	60	Good	90	Excellent
P20	70	Excellent	85	Excellent
P21	50	Average	75	Excellent
P22	75	Excellent	85	Excellent
P23	55	Average	70	Excellent

P24	80	Excellent	75	Excellent
P25	50	Average	80	Excellent
P26	70	Excellent	85	Excellent
P27	45	Average	70	Excellent
P28	80	Excellent	90	Excellent
P29	65	Good	75	Excellent
P30	75	Excellent	85	Excellent

Table 1.2
Comparison of Pre-Test and Post-Test Achievement Levels

Score Percentage (Academic Level)	Pre-Test		Post-Test	
	Number of Students	Percentage (%)	Number of students	Percentage (%)
80-100	4	13.3	17	56.7
70-79	8	26.7	8	26.7
50-69	11	36.7	5	16.7
40-49	5	16.7	0	0
0-39	2	6.7	0	0
Mean, μ	12.0333		15.4333	
Standard Deviation, σ	3.03410		1.90613	

Based on Table 4.2, the post-test results (μ = 15.4333) are better than the pre-test results (μ = 12.0333) following the learning session using the digital platform.

Table 1.3
Normality Test for Academic Achievement Scores

Term / Item	Statistic	df	Sig.
Pre-Test	.930	30	.049
Post-Test	.920	30	.027

Based on Table 4.3 above, the p-values for both the pre-test (p = 0.049) and post-test (p = 0.027) are less than 0.05. This indicates that the data are statistically non-normal or do not meet the assumption of normality. Therefore, a non-parametric statistical test was selected for the subsequent analysis, specifically the Wilcoxon Signed-Rank Test, to assess the difference in academic achievement scores before and after the intervention using the digital learning platform.

Table 1.4
Wilcoxon Signed-Rank Test Statistic

Items	**Value**
Number of Sample	30
Z	-4.574
Asymp. Sig (2-tailed)	< .001
Hypothesis result	H_0 is rejected

Based on the results of the Wilcoxon Signed-Rank Test, the value obtained was Z = -4.574 with p < 0.001. Since p < 0.05, the null hypothesis is rejected**.** This shows that there is a statistically

significant difference between the pre- and post-intervention achievement scores (i.e., before and after using the digital learning platform).

Therefore, the null hypothesis (H_0)—which states that there is no significant difference in academic performance before and after the intervention—is rejected. Conversely, the alternative hypothesis (H_1) is accepted, confirming that the digital learning platform had a positive impact on students' academic performance in Chemistry.

Thematic Analysis: How do factors within the digital learning platform influence students' academic achievement levels?

Factor	**Motivation**	
Theme 1	**Digital Platforms Enhance Students' Motivation to Learn Chemistry**	
Number	**Sub-theme**	**Respondent Comment**
1	Ease of understanding and access increases interest	*" I can understand what I'm learning more easily."* - R1 *"Online or digital platforms are easier for me when revising lessons."*-R4
2	Engaging and interactive activities increase learning enjoyment	*"It has various activities related to the topic I'm learning."* - R2 *"Digital learning is more engaging and helps me focus better when the teacher is teaching."* - R5
3	Effectiveness depends on individual learning preferences	*"It depends on the individual because everyone understands things differently."* - R3 *"Everyone learns in their way. So, the way they understand and learn chemistry is also different" - R6*
Factor	**Interaction**	
Theme 2	**Digital Platforms Enhance Two-Way Teacher-Student Interaction**	
Number	**Sub-theme**	***Respondent Comment***
1	Opportunities to ask questions and receive immediate feedback	*"I can ask the teacher questions if I don't understand what I'm learning" – R5* *"I think that learning chemistry using digital platforms can help improve interaction" – R1*
2	Creates a friendly and collaborative learning environment	*" Online learning increases interaction between teachers and students in a cheerful atmosphere" – R2* *"It increases interaction between students and teachers" – R4* *"Using digital platforms in class makes class activities more engaging and interaction with friends and teachers creates a happier learning environment" – R6*
3	Access to additional information encourages discussion	*"Online platforms offer more knowledge or information about Chemistry" – R3*
Factor	**Platform Content**	
Theme 3	**The content of digital learning platforms supports understanding and makes chemistry learning more effective**	
Number	**Sub-theme**	**Respondent Comments**
1	Multimedia content facilitates concept understanding	*"I understand Chemistry lessons better because the content on the platform is clear and the multimedia materials are interesting."* - R1

		"It meets my needs for learning Chemistry. I enjoy it when the teacher uses multimedia during lessons." - R6
2	Interesting and high-quality content enhances focus	*"It has engaging content, and the quality is good."* - R2 *It's an effective channel for delivering accurate information."* - R4
3	Need for teacher support and suggestions for improvement	*"I still need help from the teacher to explain the content rather than just watching and memorizing it" – R3* *"My suggestion for improvement is to add key terms that can help improve exam scores." – R5*
Factor	**Feedback**	
Theme 4	**Online feedback aids understanding, but still requires a human touch**	
Number	**Sub-theme**	***Respondent Comments***
1	Digital platform feedback is clear and easy to understand	*"I received clear and useful feedback after activities and quizzes."*-R1 *"Yes, it's very clear and easy to understand."* - R2 *"The quality is good"* - R5
2	Automated feedback helps, but lacks contextual explanation	*"I feel both (digital and human feedback) help me understand." - R6* *"I think the teacher or classmates are easier to approach because they can discuss questions directly during Chemistry lessons." - R3* *"Getting feedback from the teacher is easier to understand and remember." - R4*
3	Combining digital and teacher feedback improves understanding	*"It really helps me understand Chemistry, especially difficult topics." – R6*

Discussion

The results of the Wilcoxon Signed-Rank test showed a significant improvement in students' academic performance after using the digital learning platform. This confirms that the use of elements such as videos, interactive quizzes, and simulations helps students understand chemistry concepts better and improves their assessment performance. These findings align with those of Venugopal (2024) and Tuharea et al. (2023), who found that well-designed interactive digital content enhances student achievement in science subjects. With the integration of technology, students now have access to a variety of resources and opportunities for interactive learning beyond the traditional classroom (Yong Cao, 2024).

Qualitative findings from the semi-structured interviews highlighted four main factors that can influence students' academic achievement in learning chemistry. The first factor is motivation, where it was observed that students showed more interest and focus when the digital learning platform used included engaging activities and visual materials. Previous studies state that the use of multimedia technology in digital learning content has a positive influence on students when combined with engaging explanations and effective teacher support (Jumiati Tuharea, 2023). The second factor is interaction, where students stated that digital platforms allowed them to interact more actively with teachers and peers, as this helped improve understanding through discussion. Interaction is important for building students' understanding, resolving confusion, and increasing their active participation. As evidence, students' positive attitudes toward digital learning showed increased engagement through peer interaction (Brooke Hollister, 2022). The third factor is platform content, where

the digital platform used for teaching had clear content, interactive multimedia, and an organized structure, making it easier for students to understand chemistry concepts. This finding is supported by previous studies that showed digital platforms combining visual media and interactive activities contribute significantly to academic achievement, especially in STEM subjects (Venugopal, 2024). Finally, the fourth factor is feedback. Digital platforms have automated feedback that provides immediate informational support. However, teacher feedback is considered deeper and more effective for student understanding. A study by Fan (2024) found that a combination of automated and teacher feedback is the best strategy to improve student performance. Overall, these factors ultimately enhance students' understanding of chemistry concepts, thereby facilitating improvement in their academic achievement in chemistry tests.

Conclusion

This study aims to evaluate the impact of using digital learning platforms on students' academic achievement in Chemistry, as well as to explore the key factors within these platforms that influence achievement. The findings indicate a significant improvement in students' academic performance after using the digital platform, demonstrating the effectiveness of this method in enhancing understanding of chemistry concepts.

Factors such as student motivation, teacher-student interaction, platform content, and feedback were identified as key elements contributing to the success of digital learning. These findings support the need for platforms to be designed to be interactive, comprehensive, and aligned with appropriate pedagogical approaches.

The implications of this study include the need for the Ministry of Education (MOE) to strengthen digital implementation in education, for teachers to adapt their teaching strategies, and for students to build self-directed learning capabilities. Although there are some limitations, this study provides a strong foundation and guidance for stakeholders to enhance the effective use of technology in education.

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