Digital Simulation Exposure and Conceptual Understanding in Chemistry

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ABSTRACT

This quantitative research study explores the relationship between digital simulation exposure and conceptual understanding in chemistry among junior high school students at Liberty Bible Baptist Academy Inc. in Bukidnon, Philippines. The study highlights the challenges students face with complex chemistry concepts, which are often exacerbated by traditional teacher-centered instructional methods. A survey was administered to eighty-seven junior high school students to assess their level of digital simulation exposure and conceptual understanding. Results indicate a significant positive correlation (r = 0.467) between digital simulation exposure and conceptual understanding, suggesting that increased interaction with simulations enhances comprehension of difficult concepts. Despite high engagement levels, students expressed lower perceived value of digital simulations, potentially due to a preference for traditional methods. The findings support the integration of digital simulations into chemistry education to foster deeper understanding and improve student outcomes. Recommendations will be provided for effectively incorporating these tools into the curriculum.

Keywords: digital simulation, chemistry education & conceptual understanding

INTRODUCTION

This quantitative research study aims to explore the relationship of digital simulation exposure and conceptual understanding in chemistry, in the Liberty Bible Baptist Academy Inc., in the province of Bukidnon, Philippines. These enthusiastic students face distinct challenges the complex concepts of chemistry. By exploring into their digital simulation exposure, this study seeks to determine the relationship in conceptual understanding in chemistry. Chemistry, a core science subject, comprises theories, facts, and laws that have been explored and validated through rigorous experimental procedures. It presents a number of difficulties, such as solving equations, interpreting a complicated chemical language, and analyzing representations at the atomic level. Similarly, (Iyamuremye et al., 2021; Musengimana et al., 2022; Nsabayezu et al., 2022), chemistry is among of science subjects that taught in lower secondary schools and there are some concepts in chemistry considered as a challenging topic for students to learn. These difficulties are commonly brought by its abstract in nature.

Science teachers were having trouble explaining ideas to their students in a way that would boost their understanding and curiosity. Numerous suggestions for improvement have been made in response to the problem of students' poor performance in chemistry. The analysis made on chemistry teaching techniques in lower secondary in some consulted studies in different nations, found that teachers are not using the learner-centered approach, which encourage students to play a vital role in their learning process (Beichumila et al., 2022; Musengimana et al., 2022; Watson et al., 2020; Zendler & Greiner, 2020), rather they use teacher-centered approach that encourages memorization. Unfortunately, the focus of such suggestions is on inadequate real-world experience and inappropriate techniques for instruction as the primary reasons for

students' poor chemistry performance. Numerous pupils expressed dissatisfaction with the method of instruction.

The rise of digital technologies in the classroom offers students and teachers new modes of interaction, affording, for example, new ways to access encyclopedic knowledge, iterate on design, or create collaborative artefacts. Digital simulations have particularly flourished in the design and learning of spatial visualization skills, offering students the opportunity to interact fluidly with virtual three-dimensional objects. It has been suggested that the incorporation of interactive computer simulations in the chemistry classes provides a powerful solution to transform the traditional teacher-centered approach into a more student-centered approach (Asedillas et al., 2019; Mwazi et al., 2023).

Moreover, the Enhanced Basic Education Act of 2013 in the Philippine Basic Education Curriculum is a solution to create opportunities that will help all children from the time they enter the classroom until they join the workforce (McCleary, 2012). However, our educational system encourages most of the students to be extrinsically motivated for attendance, for a grade or for requirements purposes (Dichev et al., 2014). According to the 2013 Functional Literacy, Education and Mass Media Survey (FLEMMS) (Philippine Statistics Authority, 2013) of the nearly 4 million out of school children and youth (6-24 years old), 19.1 percent lacks interest in attending school and is higher for males (33.1) compared to females (10.1). The result also showed that the proportion of persons who are out-of-school was higher among the youth (14.5 % to 20.4 %) than among children (1.7 % to 4.9%). Educators face growing challenges on how to increase the student's interest and achievement in learning. Mobile phone content will efficiently address issues such as a universally acceptable language medium, auto-translations, relevance, and the lack of local knowledge.

According to the results released by the National Education Testing and Research Center (2012), fourth-year Filipino students 1 Computer-based simulation and its effect on student's knowledge in Chemistry IJODeL, Vol. 5, No. 2, (December 2019) obtained a mean percentage score of 48.90 in the 2012 National Achievement Test. The mean percentage score in secondary science was reported to be 39.49 percent in the school year 2004 2005, 37.98 percent in the school year 2005-2006 and 40.53 percent in the school year 2011-2012. Although the result manifests an increase in student's achievement compared to previous school years, it is still far from the government's goal which is 75 percent (Macha, et al. 2018).

Additionally, out of 45 participating countries in the Trends in International Mathematics and Science Study (TIMSS) in 2003, the Philippines ranked 41st and 42nd in mathematics and science, respectively (Paul & Scriven, 1987). This suggests that Filipino students are weak in terms of mastery level in mathematics and science when they graduate from high school. The performance of Filipino students in Chemistry obtained 30 percent average correct answers in TIMSS which is way below the international average of 45 percent correct answers. In the male boarding school in Southern Tagalog province, the result of the Grade 10 Chemistry quarter exam for the academic year 2017 2018 is 57 percent with an overall mean score of 24.82 out of 50 (SMSAI-Science, 2018) was a shred of evidence that students really find difficulties in learning the subject.

Existing research on integration of theoretical teaching and practical teaching is one of the core issues in chemistry teaching in high school level. The organic combination of the two will help students deepen their understanding of the structure of matter and reaction mechanism. However, due to time and space constraints, chemical experiments and chemical theory teaching are often divided into two parallel teaching courses. Many students have a separation of mechanism-structure-phenomenon in their learning, and they can only rely on rote learning to learn theories. Knowledge cannot be learned and used lively and truly mastered. With the deepening of information technology in teaching, digital simulation technology has received more and more attention in chemistry teaching. Lastly, according to (Musengimana et al., 2021), hands-on laboratory sessions and experiments have traditionally been the preferred methods of teaching chemistry, as they stimulate creativity, problem-solving skills, and foster observational learning. However, such methods are often hindered by logistical challenges, such as the high cost of equipment, lack of resources, and time constraints for preparation (Ali & Ullah, 2020). This challenge was further accentuated during the COVID-19 pandemic when access to physical laboratories became severely limited (Babinčáková & Bernard, 2020). Several studies indicate that the use of digital simulation enhances students' understanding and performance in chemistry

(Gambari et al., 2018). They also suggest an increase in students' motivation and engagement levels (Mutlu & Acar Sesen, 2016).

The main objective of this research is to explore the relationship of digital simulation exposure and conceptual understanding in chemistry in Liberty Bible Baptist Academy Inc., Valencia City, Bukidnon, with a specific focus on describe the level of digital simulation exposure among students. The ultimate goal is to provide valuable insights and recommendations to science educators in Bukidnon, with the aim of improving understanding complex concepts in chemistry and incorporate digital simulation in the education process.

The research will be conducted during the academic year 2024-2025 in Valencia City, Bukidnon, which will be determined during the planning phase of the study.

Objective of the study

The objective of this study is to determine the relationship between digital simulation exposure and conceptual understanding in chemistry among students. In Liberty Bible Baptist Academy Inc., Valencia City, Bukidnon. Specifically, this study will attempt to:

1. Describe the level of digital simulation exposure among students.
2. Assess the level of conceptual understanding in chemistry among students.
3. Determine the significant relationship between digital simulation exposure and conceptual understanding in chemistry.
4. Provide recommendations for incorporating digital simulations effectively into chemistry education.

Hypothesis of the study

The study examining the relationship between digital simulation exposure and conceptual understanding in chemistry among junior high school students, the following hypotheses were formulated:

(H_0): There is no significant relationship between exposure to digital simulations and the conceptual understanding of chemistry among junior high school students.

(H_1): There is a significant positive relationship between exposure to digital simulations and the conceptual understanding of chemistry among junior high school students.

MATERIALS AND METHOD

The research design for this study was quantitative, specifically utilizing a descriptive approach to investigate the relationship of digital simulation exposure and conceptual understanding in chemistry among junior high school students in Valencia City, Bukidnon. The study was conducted at Liberty Bible Baptist Academy Inc., Valencia City Bukidnon, which was chosen due to its significant number of junior high school students exposed to digital simulation. The study's respondents included eighty-seven junior high school students who were studying conducted at Liberty Bible Baptist Academy Inc., Valencia City Bukidnon. The data-gathering procedure followed ethical considerations, with the school principal being provided an ethical statement and the respondents receiving comprehensive information about the study before their voluntary participation. Privacy was kept throughout the study, and respondents provided informed consent. The main resource for data collection was a survey questionnaire. The survey questionnaire aimed to uncover the junior high school student's digital simulation exposure experience and challenges faced in understanding chemistry. The questionnaire guide was piloted and refined to ensure its clarity and effectiveness. SPSS analysis was applied to the collected data, involving a meticulous encoding, and interpretation of the data collected in each variable. This analysis aimed to identify means, correlation, and cronbach's alpha that would provide an accurate and comprehensive understanding of the digital simulation exposure experience and challenges faced in Understanding chemistry in Liberty Bible Baptist Academy Inc., junior high school level.

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RESULTS AND DISCUSSION

This section includes the presentation of data gathered and the comprehensive discussion, interpretation, and implication of the findings of the study. Results were presented in tables, which were then analyzed and interpreted.

Table I Summary Of Digital Simulation Exposure in Chemistry

Indicators	Mean	Descriptive Rating	Qualitative Interpretation
Effectiveness of Digital Simulations	3.86	Agree	High Exposure
Engagement and Motivation	3.71	Agree	High Exposure
Perceived Value and Usefulness	3.67	Agree	High Exposure
Overall Mean	3.75	Agree	High Exposure

Legend

Range	Descriptive Meaning	Qualitative Interpretation
4.51-5.00	Strongly Agree	Very High Exposure
3.51-4.50	Agree	High Exposure
2.51-3.50	Neutral	Moderate Exposure
1.51-2.50	Disagree	Very Little Exposure
1.00-1.50	Strongly Disagree	No Exposure at all

As shown in the Table 1 effectiveness of digital simulations has the highest mean of 3.86, followed by engagement and motivation with a mean of 3.71 meanwhile, perceived values and usefulness had the lowest mean of 3.67, where the overall mean is 3.75, in which qualitatively interpreted as high exposure. The findings are supported with (Mayer, 2005), simulations allow students to interact with and manipulate chemical processes that are otherwise difficult to visualize, making abstract concepts more tangible. This hands-on approach enhances both comprehension and retention of knowledge. The study conducted by Khaleel Younis (2017) on the effect of scientific inquiry simulations of chemistry practical on students' perspectives at secondary school found that students appreciate the simulated learning environment and develop higher perceptions of their learning. According to Nsabayezu et al. (2022) found that using digital simulation in the teaching and learning process facilitates students to understand scientific phenomena since they visualize complex concepts.

Furthermore, the slightly lower score for perceived value and usefulness implies that the students recognize the benefits of digital simulations, they may not view them as indispensable for their chemistry learning. This could be due to a number of factors, including the possible preference for traditional teaching methods or a lack of familiarity with fully utilizing digital tools. Some students might also question the real-world

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applicability of digital simulations, especially in chemistry, where hands-on laboratory experience is often emphasized. According to Taber (2018), while simulations are effective in teaching theory and abstract concepts, they may not fully replicate the experiential learning that comes from working with physical chemicals in a laboratory.

Table II Summary On Conceptual Understanding in Chemistry
Legend

Range	Descriptive Meaning	Qualitative Interpretation
4.51-5.00	Strongly Agree	Transformative Impact
3.51-4.50	Agree	Significant Impact
2.51-3.50	Neutral	Moderate Impact
1.51-2.50	Disagree	Minimal Impact
1.00-1.50	Strongly Disagree	No Impact

Table 2 presents the summary of the level of conceptual understanding in chemistry of junior high school students. As shown in the table application of knowledge has the highest mean of 3.75. Followed by conceptual understanding with a mean of 3.63 while engagement with digital tools has a mean of 3.59 in which the lowest mean. Generally, the overall mean of conceptual understanding in chemistry is 3.66. The table implies that junior high school students have a significant impact level of conceptual understanding in chemistry. This study's result support McTighe and Wiggins (2013), a robust understanding of scientific concepts, combined with the ability to apply them in practical contexts, is essential for deep learning. Furthermore, the integration of digital tools in education, as shown by Hattie (2017), enhances student engagement and learning outcomes, particularly when those tools are used to visualize abstract concepts and facilitate active problem-solving.

Bozkurt et al. (2020) also highlights the role of digital tools in promoting active learning environments, where students can experiment with simulations, test hypotheses, and receive immediate feedback. While the students in this study report a strong engagement with digital tools, further research could explore how these tools might be more strategically integrated into lessons to enhance both understanding and application.

A.Correlation between Digital Simulation Exposure and Conceptual understanding in Chemistry

Indicators	Mean	Descriptive Rating	Qualitative Interpretation
Conceptual Understanding	3.63	Agree	Significant Impact
Engagement with Digital Tools	3.59	Agree	Significant Impact
Application of Knowledge	3.75	Agree	Significant Impact
Overall Mean	3.66	Agree	Significant Impact

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The aim of this study was to determine the relationship of digital simulation exposure and conceptual understanding in chemistry which is analyzed using Pearson-Product moment correlation that was shown in Table 3.

Table III Statistical Significance of The Results Using Pearson Correlation

SCALE	Conceptual Understanding in Chemistry	Decision	Remarks
Digital Simulation Exposure	.467(**) .000	Rejected H_0	Significant

**Correlation is significant at the 0.01 level (2-tailed).

The statistical significance between the study's variables is displayed in Table 3. It was discovered that exposure to digital simulations and conceptual knowledge of chemistry are significantly correlated. The correlation value is .467, which is significant at the 0.01 significance level. Consequently, the study's hypothesis is rejected. the results of this research, students who engage actively in digital simulation have a higher chance of developing a deeper comprehension of difficult chemistry ideas. They can improve students' conceptual understanding and, eventually, their academic performance in chemistry by encouraging more exposure to digital simulation. This emphasizes the value of experiential science instruction and further exposure to digital simulation.

Recent studies have shown that exposing digital simulation suggestively increases students' understanding of chemistry concepts. For example, Almasri (2022); Salame & Makki (2021); Supriyatman & Sukarno (2014); Suratno & Aydawati (2017) show that computer simulations help students to learn difficulty chemistry topics. This is because computer simulations provide visual representation of complex system and abstract concepts that are really hard to understand. For instance, simulations show how atoms and molecules interact with each other. The study further recommended that computer simulations are powerful tool for chemistry education, as they provide with students a dynamic and interactive learning environment that complements what where been difficult to understand in the traditional teaching methods. In study by Salame and Makki (2021) compared the use of a simulated learning environment and traditional methods with respect of students' perceptions found that both approaches have affected students' perceptions.

CONCLUSION

The objective of the study was to investigate the connection between students' exposure to digital simulations and their conceptual knowledge of chemistry at Liberty Bible Baptist Academy Inc. in Bukidnon, Philippines. The study's goals were to determine the degree of exposure to digital simulations, assess students' conceptual knowledge of chemistry, ascertain the importance of the relationship between these two variables, and offer suggestions for the successful incorporation of digital simulations into chemistry instruction.

A positive correlation was found between digital simulation exposure and conceptual understanding, with notable Pearson coefficients indicating significant relationships .467. This concludes that higher exposure with digital simulations correlates with better conceptual understanding in chemistry. The significance of encouraging using digital simulation to enhance students' comprehension and application of chemical fundamentals is highlighted by this research, since it has implications for their academic achievement and future scientific pursuits.

Given the positive outcomes associated with digital simulation exposure, it is recommended that educators incorporate these tools more strategically into their teaching practices. This could involve designing lessons that actively engage students with simulations that visualize complex chemical processes and concepts. Additionally, further research could explore specific strategies to enhance the perceived value and usefulness of these tools among students.

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