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Research Article

Pre-Assessment Study on the CoBCU: Series 1 in Teaching and Learning

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Abstract:

The Comic of Basic Chemistry for You (CoBCU) was developed as an innovative teaching aid to improve students' understanding and engagement in Basic Chemistry. Integrating visual storytelling, self-assessment activities, and Augmented Reality (AR), CoBCU aims to support students with limited chemistry backgrounds. A survey involving 50 university students was conducted to evaluate the usability, motivation, and learning expectations associated with CoBCU. The results indicated strong positive perceptions towards the comic interface, increased learning motivation, and high acceptance of comic-based learning. These findings demonstrate that CoBCU is a promising educational innovation for enhancing chemistry learning experiences.



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1. INTRODUCTION

The task of being an educator is becoming more challenging every year. However, the trust held continues to be implemented in ensuring the development of each student. As everyone knows, in the classroom, the most important thing is the knowledge-sharing activities led by an educator. Today's educators need to equip themselves with the latest educational technology. In the typical landscape of higher education lecture activities, educators do not simply want to complete the syllabus in 14 weeks; today's educators need to be creative and innovative in implementing it. Javed (2024) highlighted that educators should integrate digital tools, such as web-based platforms, MOOCs, and ICT tools, to create personalized and flexible learning experiences as these tools may enhance engagement, collaboration, and critical thinking. Kocasarac & Ndlovu (2024) noted that incorporating technologies such as artificial intelligence can foster hands-on learning.

Comic of Basic Chemistry for You (CobCU) was created as one of the teaching materials to be shared with students. The comic concept was specifically chosen as it combines text and visuals, which enhance comprehension and memory by presenting complex or abstract concepts in an accessible and engaging format (Adi & Mustafa, 2026). The creation of CoBCU is also intended to encourage the current generation, often referred to as digital natives, who prefer technology-integrated learning. Educators must align teaching strategies with these preferences, often requiring rethinking traditional methods and effectively incorporating digital tools (Mohzan & Zubir, 2019). To begin with, series 1 of CoBCU, titled *The Acid Base Chronicle*, was developed into a comic. In this comic series, tutorial questions in the Chemistry Detective section are also applied in this innovation as a self-training tool to ensure knowledge is achieved. To make it more engaging, parts of the comic scene were also created in Augmented Reality (AR), as reported by Ugli et al. (2025), which suggests that AR increases student motivation and engagement by making learning more interactive and visually appealing.

This idea stems from the problem faced by Diploma in Plantation Industry Management (AT120) students who need to take CHM138 Basic Chemistry during the second semester. When refined, this course code has been mapped to PLO 1 Knowledge, PLO 2 Cognitive, and PLO 3 Practical Skills according to the MQF 2.0 framework by the Ministry of Higher Education Malaysia. Of the 3 PLOs mapped, assessment suitability has been set to measure each one, where students need to sit for a quiz, test 1, test 2 to measure knowledge and cognitive achievement, and then need to attend a face-to-face laboratory session and prepare a laboratory report for the final PLO measurement, which is practical skills. However, data on students' PLO achievements indicate that knowledge and cognitive achievements are low. Continuous Quality Improvement (CQI) analysis reports show that this decline in performance is due to several factors, including students who lack a solid chemistry foundation from secondary school. Starting with this problem, educators need to be creative in creating teaching aids that convey chemistry knowledge in an easy-to-understand way, especially for students who lack Basic Chemistry knowledge.

2. LITERATURE REVIEW

Comics have emerged as an effective and versatile teaching tool across various educational contexts, offering unique advantages for knowledge delivery. Their combination of visuals and text enhances comprehension, engagement, and retention of complex concepts. For instance, in STEM education, comics have been used to simplify abstract topics like thermodynamic cycles and fugacity, providing students with "visual notes" that make these concepts more accessible and less intimidating. This approach has been shown to improve students' interest, confidence, and understanding (Landherr, 2019, 2023). Similarly, according to Canbulut & Kilic (2022), in mathematics education, comics contextualize abstract ideas, such as division, in real-world scenarios, making them easier to grasp and to increase academic achievement.

Comics also foster creativity and critical thinking. In management education, they have been used to bridge the gap between theory and practice, helping students develop reflective and innovative problem-solving skills (Da Silva et al., 2017). Furthermore, in early childhood education, comics created with ICT tools have been used to teach statistical concepts such as mean and median, using humor and visual storytelling to engage young learners (Panje, 2023).

The narrative and visual appeal of comics make them particularly effective in science education, where they enhance understanding of the nature of science and promote environmental awareness. For example, according to Da Silva et al. (2021) and Asli (2025), comics have been used to teach wind energy concepts, significantly improving students' awareness compared to traditional methods. Additionally, comics support the development of visual literacy, which is crucial for interpreting and understanding visual information, as demonstrated by interventions that improved primary school students' comprehension of educational comics (Golding & Verrier, 2021). Fundamentally, comics are an effective educational tool that helps ease difficult concepts while boosting student interest, imagination, and analytical skills across various learning environments.

The use of comics in education is supported by various theoretical frameworks that highlight their potential to enhance learning outcomes. One key theory is semiotics, which emphasizes the role of visual and textual elements in meaning-making. Comics combine images and text to create a multimodal learning experience, improving comprehension and memory by engaging multiple cognitive pathways (Adi & Mustafa, 2025). This also aligns with Eisner and McCloud's theories of storytelling, which suggest that integrating visuals and narratives fosters deeper understanding.

Another underpinning theory is constructivism, which postulates that learners construct knowledge through active engagement and contextualized experiences. Comics provide relatable, real-world contexts that help bridge abstract concepts with practical applications, as seen in mathematics and science education in studies by Fabillar et al. (2024) and Canbulut & Kilic (2022). The same study shows that comics make abstract topics like division and cell division more accessible by offering visual representations and relatable narratives.

Critical pedagogy also supports the use of comics, as they encourage critical thinking, creativity, and reflective practice. By presenting scenarios that require interpretation and decision-making, comics help students develop problem-solving skills and critical perspectives (Da Silva et al., 2017). Additionally, the study performed by Moretti, Scavarda & Green in 2025 fostered social-emotional learning by promoting empathy and self-reflection, particularly in fields like medicine and philosophy, as this is also supported by findings from the study carried out by Ceric & Ceric in 2022.

Lastly, motivational theories highlight the role of comics in increasing student engagement and interest (Musa et al., 2020; Batrisyia et al., 2020). Their entertaining and interactive nature makes learning enjoyable, which can lead to improved academic performance and sustained attention (Rosidah et al., 2022). Conclusively, the integration of comics into teaching is rooted in semiotics, constructivist learning, critical pedagogy, and motivational frameworks. These theoretical foundations highlight how comics can significantly boost comprehension, foster engagement, and cultivate critical thinking skills across a variety of educational settings.

While the educational potential of comics is well-supported, significant challenges remain in integration, perception, and design. Addressing these barriers through targeted research and professional development will be critical for realizing the full benefits of comics in education.

In summary, the use of comics in education offers significant cognitive benefits, promotes engagement and motivation, supports diverse learning styles, and fosters critical thinking and creativity. By thoughtfully integrating comics into curricula, educators can create a more dynamic and effective learning environment that meets the needs of all students.

3. METHODOLOGY

3.1 Concept and Design

CoBCU is a comic version of the syllabus for CHM138 Basic Chemistry. Various characters have been created to suit a chosen topic. For example, in Series 1: The Acid Base Chronicles, characters such as Dr. Litmus and Mr. Lemon were created to explain the properties of acids. The dialogue in the comic was also created specifically to convey theoretical knowledge for a certain topic. Figure 1 shows the CoBCU logo. It was created so that a uniform main logo can be used for future series.

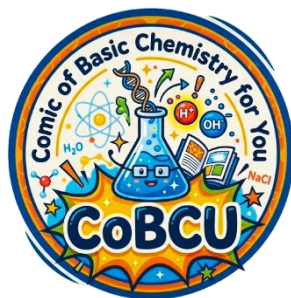


Figure 1. Logo of CoBCU.

An important part of CoBCU also involves student self-learning, implemented using the same comic concept, namely Chemistry Detective, as shown in Figure 2. It is at the end of CoBCU, and the dialogues for the Chemistry Detective segment were created specifically to prompt readers to think about answering questions after finishing the comic. The question was developed to make sure students understand and remember the key concept of the syllabus.



Figure 2. Section of Chemistry Detective in CoBCU.

The final part of CoBCU integrates Augmented Reality (AR) into certain scenes of this comic, as shown in Figure 3. Adopting a structured digital workflow, the AR system is built upon a sequential Input-Process-Intervention-Output-Outcome framework to transition text-based elements into dynamic visualizations as a value-added feature to complement the digital comic. It was developed using an image-target marker system, in which specific panels within the digital comic serve as triggers. When a user scans a designated scene, such as an interactive segment featuring Dr. Litmus and Mr. Lemon, the AR system intervenes by overlaying real-time, interactive multimedia assets. This includes animated chemical characters mapping onto the static panels, and digital storytelling that reinforces the underlying concept.

To systematically implement these value-added Augmented Reality (AR) features within the Comic of Basic Chemistry for You (CoBCU), the project development was structured around an Input-to-Outcome Framework. This five-stage architectural model systematically guides the mechanical transition from static content to active, student-centered cognitive milestones. The framework begins

with the Input Phase, which focuses on establishing core educational baseline materials. These foundational inputs consist of curriculum mapping aligned with the CHM138 Basic Chemistry syllabus, specifically targeting the improvement of Program Learning Outcomes for knowledge (PLO 1) and cognitive skills (PLO 2), alongside narrative worldbuilding through custom characters like Dr. Litmus and Mr. Lemon, and the strategic embedding of image target markers based on specific comic scenarios. Following the generation of these primary assets, the Process Phase operationalizes user engagement through student-initiated technology workflows. During this phase, students independently access the CoBCU e-comic platform, activate the built-in camera on their mobile devices, and actively scan the predefined target markers embedded in individual comic panels.

Once a marker is successfully detected, the framework transitions into the Intervention Phase, deploying real-time digital elements seamlessly over the screen layouts. This immersive technological intervention overlays real-time digital synthesis over static panels, playing custom animations tied directly to the active comic scene and triggering interactive audio-visual storytelling prompts to replace passive reading with active mental modelling. Consequently, this systematic implementation yields the Output Phase, which manifests as the immediate, enhanced user experience metrics built into the tool as a supplementary resource. These functional outputs include the creation of a highly portable and responsive digital learning tool. The deployment of interactive features designed to capture reader attention, and a multimodal delivery approach that blends simplified vocabulary with fluid visual structures.

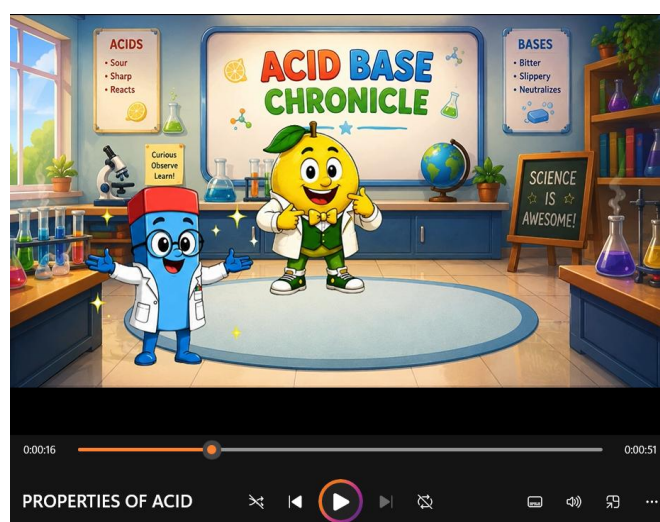


Figure 3. Scene of Augmented Reality in CoBCU.

3.2 Test Performed

In this study, we aimed to investigate students' general feedback on using CoBCU as an additional learning resource in a basic chemistry class. After the students finished reading and exploring CoBCU, they were asked to answer a questionnaire. The questionnaire used in this study consisted of four main constructs: demographic profile, comic interface, motivation, and expectations, as shown in Table 1.

Table 1. Questionnaire Used in This Study

No.	Question/Statement
a) Demographic Profiles	
1	Gender
2	Did you take Chemistry subject during SPM?
3	Chemistry Performance during SPM

b) Interface of CoBCU	
1	This e-comic is easily carried everywhere
2	The use of color and design layout in this e-comic are interesting
3	The visual presentation in this e-comic is very engaging
4	The words used in this e-comic are simple and understandable
5	The interactive features of this e-comic successfully capture readers' attention
c) Motivation	
1	I think this e-comic give me lots of benefit
2	I prefer to learn about chemistry using this e-comic compared to traditional teaching method in class
3	I am very interested in using this e-comic for the learning process
4	I prefer reading this e-comic to reading lengthy lecture notes.
5	I found this e-comic spark my interest towards Chemistry subject
d) Expectation	
1	I prefer to learn using the e-comic compared to traditional methods in class
2	I would enjoy learning all Chemistry-related topics through this type of learning material
3	I wish this e-comic will be available for all topics in Chemistry subject
4	I would recommend this e-comic to the others

4. FINDINGS

A questionnaire containing systematically arranged questions was developed and administered to the respondents. The target respondents were UiTM students enrolled in the Basic Chemistry (CHM138) course during that semester. The questionnaire consists of four main parts. Part 1 focused on the respondents' demographic information, while Part 2 evaluated their perceptions of the CoBCU interface. Meanwhile, parts 3 and 4 examined the respondents' motivation and expectations after exploring CoBCU. Figures 1, 2, and 3 below illustrate the demographic profiles of the 50 respondents who participated in this survey.

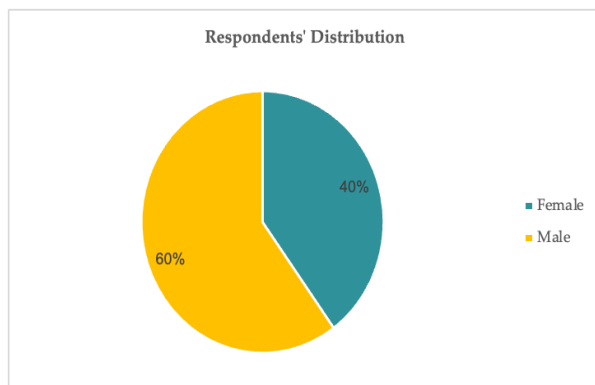


Figure 1. Distribution of Respondents Participating in the Survey

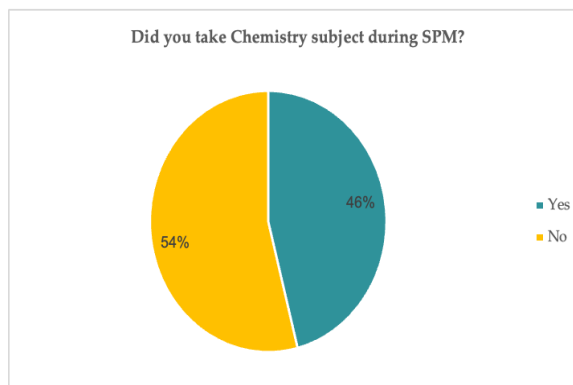


Figure 2. Respondents' Chemistry Background

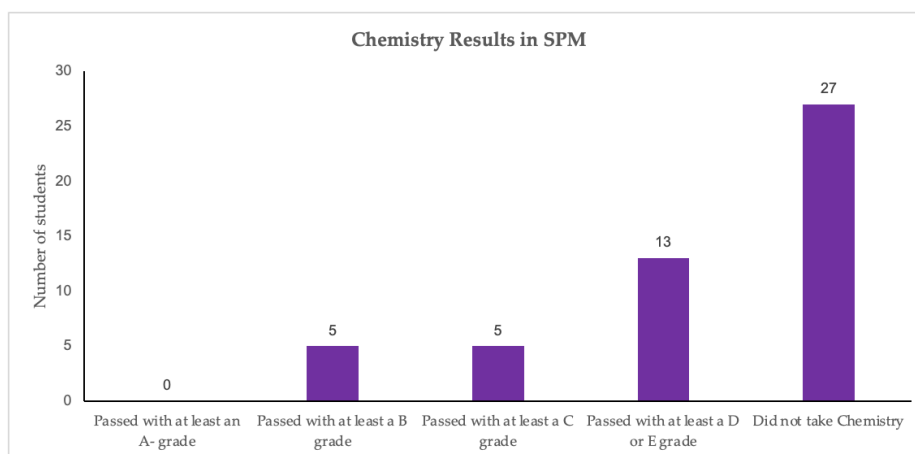


Figure 3. Achievement in the Chemistry Subject during SPM

Figure 1 above shows that the majority of respondents (60%) were male. Figure 2 shows that only 46% of respondents took Chemistry in Sijil Pelajaran Malaysia (SPM), while the remaining 54% did not. Based on the bar chart in Figure 3, among the 46% who took Chemistry during SPM, only 10 respondents (20%) passed the subject with at least a grade C. The next section will discuss the other survey findings.

4.1 Interface of CoBCU

This section will delve into the findings related to the respondents' perception of the comic interface, CoBCU. The summary of the findings is illustrated in the bar chart below.

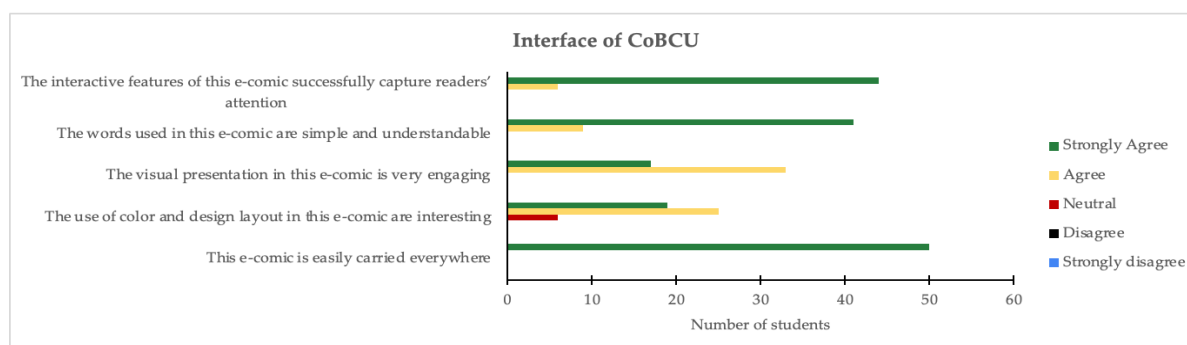


Figure 4. Respondents' Feedback Regarding the Interface of CoBCU

Based on the responses obtained from the respondents, 50% agreed (and 38% strongly agreed) that the use of color and the design layout in CoBCU were interesting, while the remaining 12% neither agreed nor disagreed. In addition, 66% of the respondents agreed that the visual presentation in CoBCU was very engaging, and 88% strongly agreed that the interactive features in CoBCU successfully captured readers' attention. Other than that, all respondents (100%) strongly agreed that CoBCU is an easily portable learning material. The respondents also agreed that the words used in CoBCU were simple and easy to understand, with 82% strongly agreeing and 18% agreeing.

4.2 Students' Motivation after using CoBCU

This section discusses the findings on the respondents' motivation in using CoBCU as one of the learning materials for the Chemistry subject. The summary of the findings is illustrated in the bar chart below.

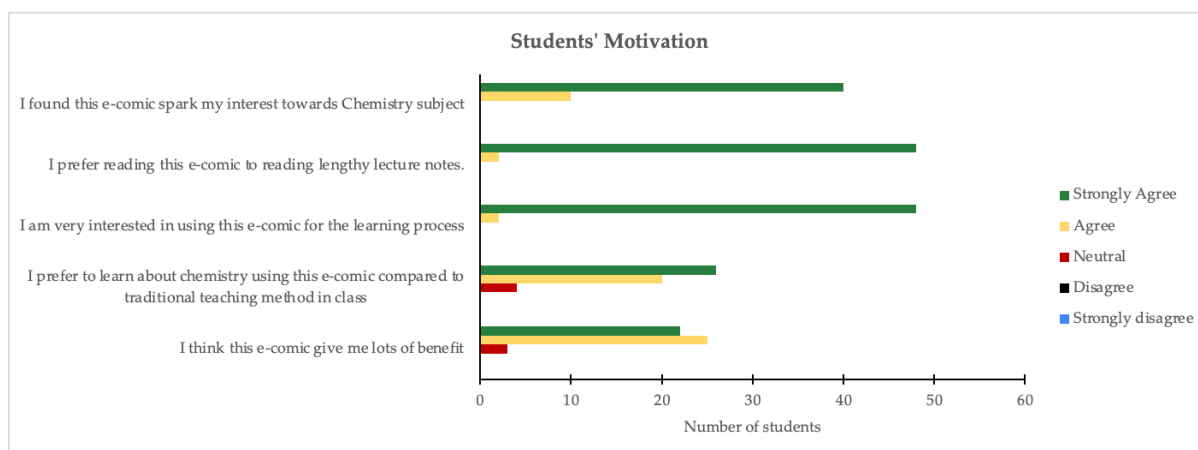


Figure 5. Respondents' Feedback Based on their Motivation after using CoBCU

After using CoBCU as one of the learning materials in Basic Chemistry class, 80% of the respondents felt that their interest in the subject had increased. All respondents preferred using CoBCU to learn Chemistry rather than reading lengthy lecture notes, with 96% strongly agreeing and 4% agreeing. Besides that, most respondents were interested in using CoBCU as one of the learning materials for Basic Chemistry. Furthermore, 52% of the respondents strongly agreed and 40% agreed that they preferred using comics to learn Chemistry rather than relying on traditional classroom teaching methods, while the remaining 8% were neutral. Overall, 50% of the respondents agreed, while 44% strongly agreed, that CoBCU offers many benefits, particularly in enhancing academic performance in Basic Chemistry, whereas the remaining 6% were unsure.

4.3 Expectations of the Students

The bar chart below shows the summary of findings regarding the expectation of respondents after learning Basic Chemistry using CoBCU.

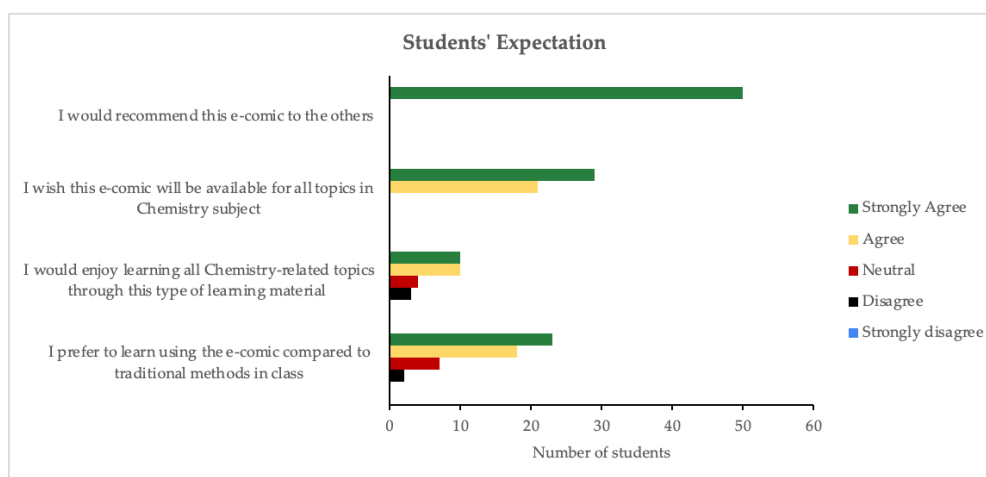


Figure 6. Respondents' Expectation after using CoBCU

Based on the graph above, 82% of the respondents preferred using CoBCU in the learning process compared to traditional methods, while 4% did not prefer to use it. The graph indicates that 66% of the respondents strongly agreed and 20% agreed that they would enjoy learning Chemistry-related topics through comics such as CoBCU. However, a very small number of respondents (6%)

disagreed that they would enjoy learning Chemistry-related topics through comics. The remaining 8% of the respondents were unsure. It can also be seen from the chart that 58% of the respondents strongly agreed that CoBCU should be available for all topics in Basic Chemistry, while 42% agreed with this statement. Overall, CoBCU received very positive feedback from all respondents, as they would recommend this learning material to others as an additional resource in learning Basic Chemistry.

5. DISCUSSION

The implementation of Comic of Basic Chemistry for You (CoBCU) represents a pivotal intervention designed to address the persistent issue of low academic achievement among Diploma in Plantation Industry Management (AT120) students in the CHM138 Basic Chemistry course. The documented decline in performance, specifically concerning the Programme Learning Outcomes (PLOs) related to knowledge (PLO 1) and cognitive skills (PLO 2), was directly traceable to students lacking a solid chemistry foundation from secondary school. The survey findings unequivocally support this assessment, revealing that a substantial majority (54%) of the 50 respondents did not enroll in Chemistry during Sijil Pelajaran Malaysia (SPM), and of the total cohort, only a mere 20% had achieved a foundational passing grade of C or better. This profound gap in prior knowledge mandates an urgent departure from conventional instruction, justifying the development of creative teaching aids and the integration of digital tools, a necessity universally advocated by modern educational frameworks (Javed, 2024; Kocasarac & Ndlovu, 2024). CoBCU, conceived as a comic series titled *The Acid Base Chronicle*, is a successful realization of pedagogical innovation that aligns with the learning preferences of contemporary digital natives (Mohzan & Zubir, 2019).

The immediate success of CoBCU is anchored in its effective interface and design, which garnered exceptional feedback from the students. The visual presentation of CoBCU was deemed "very engaging" by 66% of respondents, and the interactive features successfully captivated the attention of 88% of readers. This positive perception is a direct result of adhering to the core tenets of semiotics, where the strategic combination of visual and textual elements in a comic format optimizes meaning-making and creates a compelling multimodal learning experience (Adi & Mustafa, 2026). Crucially, the simplicity of the language used was universally praised, with 100% of respondents agreeing it was easy to understand, a critical design feature for a cohort with acknowledged foundational deficits. By simplifying complex concepts like acid-base chemistry, CoBCU functions as an educational bridge, transforming abstract or intimidating material into an accessible narrative. This approach resonates with findings in engineering education, where comics have been shown to boost student confidence and comprehension of similarly abstract topics such as thermodynamic cycles and fugacity (Landherr, 2019, 2023).

Furthermore, the complete consensus among respondents (100% strong agreement) regarding CoBCU's portability highlights its utility as a flexible, modern learning material, supporting ubiquitous learning environments necessary for today's dynamic educational landscape. The impact on student motivation is one of the most compelling findings, demonstrating CoBCU's capacity to shift student attitudes towards a subject previously perceived as challenging. A significant 80% of respondents reported an increased interest in Basic Chemistry after engaging with the e-comic. This motivational surge is a direct validation of motivational theories, which correlate high engagement and enjoyment with improved attention and enhanced academic performance (Rosidah et al., 2022; Musa et al., 2020; Batrisyia et al., 2020). The student preference was decisive: 96% strongly preferred using CoBCU to learn Chemistry rather than relying on lengthy lecture notes, and 92% favoured the e-comic over traditional classroom teaching methods. This marked preference for the comic format confirms its effectiveness in catering to diverse learning styles and signals a student-driven demand for a constructivist learning environment. In a constructivist framework, knowledge is actively built through relatable, contextualized experiences (Fabillar et al., 2024). CoBCU delivers this by contextualizing chemical principles in narratives, mirroring how the medium has been used to clarify division in mathematics by linking abstract ideas to real-world scenarios (Canbulut & Kilic, 2022).

Moreover, CoBCU facilitates the development of higher-order cognitive skills, directly contributing to the attainment of PLO 2. The inclusion of the "Chemistry Detective" section, designed as a self-training mechanism with tutorial questions, strategically transitions students from passive knowledge reception to active engagement. This mechanism is a cornerstone of critical pedagogy, fostering reflective practice and aiding students in bridging theory and application to develop problem-solving capabilities (Da Silva et al., 2017). By requiring students to apply comic content to solve practical problems, CoBCU encourages the critical thinking and creativity highlighted in the literature as key benefits of using comics in various disciplines, including management education (Da Silva et al., 2017). The multimodal nature also supports visual literacy, essential for interpreting the complex diagrams and visual information inherent in science education (Golding & Verrier, 2021; Da Silva et al., 2021).

The integration of Augmented Reality (AR) within selected comic scenes further distinguishes CoBCU as a forward-thinking pedagogical tool. AR, by making learning more interactive and visually appealing, significantly increases student motivation and engagement (Ugli et al., 2025). This immersive technology addresses the need for educators to integrate ICT tools and artificial intelligence to foster hands-on learning, as proposed by Kocasarac & Ndlovu (2024). The use of AR allows for the dynamic visualization of abstract chemical processes, offering a superior alternative to static textbook diagrams. This is particularly vital for students without a strong background, as it provides a robust, visual anchor for conceptual understanding. The combined effect of engaging interface, heightened motivation, and cognitive scaffolding resulted in 94% of respondents believing that CoBCU offers significant benefits, particularly in enhancing their academic performance in Basic Chemistry.

Finally, the students' expectations solidify the imperative for the expansion and institutionalization of CoBCU. The overwhelming consensus—with 58% strongly agreeing and 42% agreeing—that CoBCU should be expanded to cover all topics in Basic Chemistry represents a clear mandate from the end-users for scalable innovation. This demand for comprehensive, technology-integrated content underscores the successful alignment of the teaching strategy with the needs of the digital native demographic. The successful application of theoretical frameworks—semiotics, constructivism, critical pedagogy, and motivational theory—demonstrates that CoBCU is a validated, student-centric, and scalable solution for improving PLO attainment. Its widespread endorsement, reflected by the fact that all respondents would recommend CoBCU to others, confirms its value as a permanent and effective supplemental resource for foundational chemistry courses, capable of fostering a reflective, motivated, and ultimately successful learning environment for students with diverse educational backgrounds.

6. CONCLUSION

In conclusion, CoBCU has high potential to become one of the most innovative facilitation tools in the educational field. This is supported by most of the respondents, as they agree CoBCU is beneficial to them, in which they can learn about the basic knowledge of chemistry. The results also showed that all respondents agreed that CoBCU is fun to engage with, suggesting it may increase students' motivation to learn this CHM138 course. Although most respondents did not have a chemistry background in secondary school, they showed a strong interest in using CoBCU in their learning activities. However, further research involving student participation and PLO attainment should be conducted to fully assess the effectiveness of CoBCU in teaching and learning, with the hope that using CoBCU as part of learning tools will lead to higher attainment of knowledge and cognitive skills than previous results. CoBCU also intends to continue with many more series covering the entire syllabus related to basic chemistry.

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