



The Utilisation of Islamic Integrated Science Comics to Teach Primary School Students about Reuse and Recycling

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Abstract: Despite implementing innovative instructional techniques, many students struggle to understand science topics. This mixed-method and action research study explored the effectiveness of Islamic integrated science comics in enhancing students' comprehension and performance on the topic of 'reuse and recycle,' a challenging area for most students. The study involved 50 Year 3 Bruneian primary school students and used quantitative and qualitative data collection methods. A Wilcoxon signed-rank test revealed significant improvements in students' post-test scores compared to their pre-test scores, demonstrating the intervention's success. Interviews with students further supported these findings, as they described the comic-based lessons as enjoyable and collaborative. The results suggest that integrating Islamic themes into science comics significantly improves students' understanding and application of scientific knowledge. This approach makes learning more engaging and aligns with students' cultural and religious contexts, thereby providing a more holistic educational experience. The study's findings have important implications for educators seeking to enhance science education in similar contexts.

Keywords: islamic integrated science, comics, critical thinking, primary students

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INTRODUCTION

Education systems worldwide have been continuously and progressively reforming based on academic performance. These reforms aim to enhance teachers' competence in delivering efficient, effective, meaningful, and lifelong education to their students. Today, schools and teachers are expected to move away from traditional subject-based teaching, which is insufficient for developing critical thinking skills or actively engaging students in the learning process and instead focus on teaching students using conceptual approaches that align with 21st-century competencies and skills (Bautista & Ortega-Ruiz, 2017; Sulaiman & Shahrill, 2015). According to Rotherham and Willingham (2009), integrating 21st-century competencies and skills into teaching and learning has significantly improved student performance.

This approach has led to adopting student-centred learning, which has proven practical and effective in helping students learn, acquire knowledge, and correct misconceptions. By incorporating student-centred learning, students can develop critical thinking and problem-solving skills, enhance their collaborative and communicative abilities, and apply their creativity meaningfully (Stehle & Peters-Burton, 2019). Additionally, integrating 21st-century competencies and skills has played a crucial role in addressing any misconceptions students may have about their acquired knowledge. In Brunei Darussalam (henceforth Brunei), the education system has shifted towards the *Sistem Pendidikan Negara Abad ke21* (abbreviated as SPN21) in line with the 21st-century competencies and skills required to achieve the Brunei Wawasan 2035. This shift was implemented in 2007 (Mundia, 2010). One of the critical changes in the educational system is the emphasis on nurturing and developing students' 21st-century skills, particularly critical thinking. These skills are deemed essential as they can positively impact students' performance in core subjects such as Mathematics, English, and Science (Ministry of Education, 2013; Ebil & Shahrill, 2023).

In the field of science education in Brunei, it was reported that in the 2018 program for International Student Assessment (PISA), only 54% of students could apply their acquired knowledge at a higher critical thinking level. This was compared to the average OECD (Organization for Economic Co-operation and Development) countries, where the percentage was 78% (OECD, 2018; Ebil & Shahrill, 2023). The report highlighted that only a percentage of Bruneian students could draw conclusions or make predictions based on the scientific phenomena they had learned in class (OECD, 2018). These findings indicate a significant lack of critical thinking skills among Bruneian students, which can be traced back to their elementary school education. Previous research findings have shown that despite implementing new pedagogical approaches, such as using group activities and ICT to deliver Science lessons, Bruneian students still lack the necessary 21st-century

competencies and skills, particularly critical thinking and problem-solving skills (Abdullah & Osman, 2010). This suggests that students in Brunei continue to struggle with higher-order thinking skills, which are crucial for mastering scientific knowledge and concepts. These skills are also required in the current SPN21 educational system to help achieve the goals of Brunei Wawasan 2035

Research has shown that incorporating fun and interactive visuals into science lessons can enhance students' understanding of scientific concepts and increase their interest in the subject (Ferreira et al., 2013). Visuals are beneficial for explaining complex scientific ideas that may be difficult to convey through written text alone (Vavra et al., 2011). Additionally, using visuals during science lessons has been found to positively impact students' behaviour and level of engagement (Cook, 2012; Muliya et al., 2024). One effective method of using interactive visual aids in the classroom is using comics (Farinella, 2018; Jurgens et al., 2024; Koutníková, 2017). Similarly, according to Jackson and Bruegmann (2009), comics are a form of sequential art characterized by the arrangement of text and images commonly found in graphic novels, comic books, webcomics, and comic strips. Furthermore, research has shown that comics are a valuable educational tool. They contain visual elements that enhance comprehension and enable readers to construct their knowledge. This approach is often called 'Visual Teaching and Learning' in science education. Using comics in the classroom can promote a range of activities, such as observation, engagement, questioning, exploration, discussion, and evaluation (Abdi, 2014; Fananta et al., 2019; Gemelli et al., 2024; Şentürk & Selvi, 2023). Additionally, Phoon et al. (2020) postulate that achievement scores between pre- and post-tests revealed a significant improvement in students' knowledge. The students demonstrated high interest, engagement, and enthusiasm when using comics as a learning tool.

Another way to promote the goals of science education in the Brunei primary Science curriculum is by incorporating Islamic values into science teaching; these values include excellence, innate nature, trustworthiness, justice, wisdom, gratitude, morality, reflection, and patience, which could help to produce a holistic educational experience congruence with the cultural and religious values of the students. This can lead to curiosity, open-mindedness, critical reflection, environmental sensitivity, and an appreciation for evidence in students, ultimately fostering higher-order thinking (Harlen et al., 2015; Nuha et al., 2024). Brunei's education policy expects schools to base their education, teaching, and learning on the Qur'an, Hadiths, and reasoning. By integrating Islamic approaches into science and other subjects, students can see the relevance of what they are learning to their daily lives, thus enhancing their critical thinking abilities (Kurniawan & Basuki, 2024; Muhammad & Bakar, 2013). According to research done in West Lombok, Indonesia, the study's findings demonstrated that integrating Islamic principles into science instruction significantly improved students' learning outcomes (Purwati et al., 2018). Another study on students' opinions about how Islam gets incorporated into science, the outcome demonstrates that science has a function in promoting the sustainability of life and religion has a role in the advancement of science. Additionally, the students believe an instructor's understanding of Islam might impact how the material is taught, particularly in biology classes (Agung et al., 2024; Amran et al., 2024; Suciati et al., 2022). Incorporating comics into teaching and learning aligns with the cognitive theory of multimedia learning. Mayer (2014) asserts that multimedia formats, like comics, have been shown to convey messages and promote meaningful communication effectively. The cognitive theory of multimedia learning highlights two key components that support the use of multimedia, including comics, for educational purposes. These components are depicted in the figure below: verbal and visual representation. Figure 1 shows the flow chart of Mayer's cognitive theory of multimedia learning.

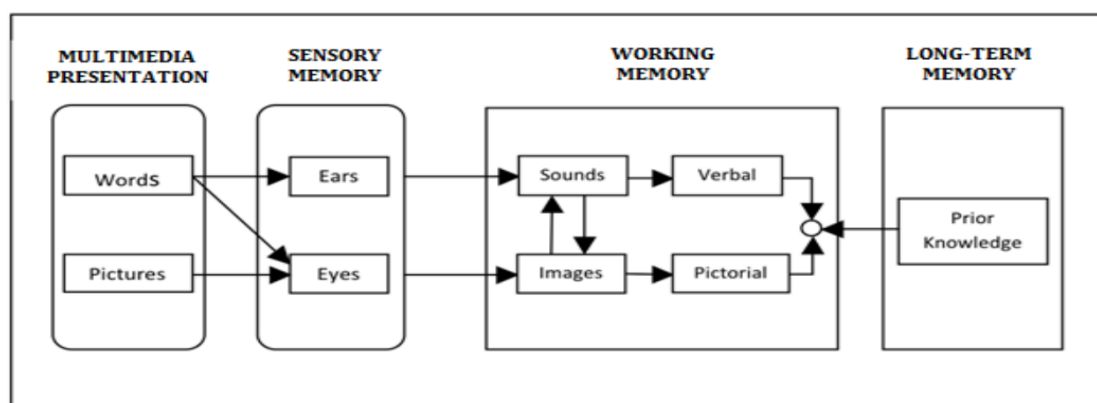


Figure 1. Mayer's Cognitive Theory of Multimedia Learning

Note: The figure was obtained and adapted from Vicneas and Zamzuri (2019). It depicts Mayer's cognitive theory of multimedia learning, which uses multimedia presentation to form long-term memory knowledge.

According to the figure above, the theory can be divided into two main components: verbal (words) and visual (pictures) channels. These two channels can be further classified into three cognitive processes when utilized by multimedia users: (1) verbal and visual mental mode, (2) working memory involvement, and (3) a combination of verbal and visual mental models for knowledge construction and long-term memory induction (Vicneas & Zamzuri, 2019). According to Figure 1, a series of scientific sequences occur before the multimedia user can store the information conveyed by the comic. The user utilizes visual and verbal aids to convey the information to their brain, which involves the use of their ears and eyes to receive the verbal (words) and visual (pictorials) stimuli from the comic (Mayer, 2014; Vicneas & Zamzuri, 2019). This stage is where knowledge construction takes place, as the visuals and verbals complement each other to form specific knowledge. Additionally, sounds play a crucial role in supporting working memory. For example, when someone mentions the word 'Rose' to explain the comic, the users will form a mental picture of a rose (Mayer, 2014; Vicneas & Zamzuri, 2019). When these cognitive processes are combined, they facilitate the establishment and formation of knowledge. Therefore, a multimedia teaching and learning approach, such as using comics, enables students to acquire and construct new knowledge by utilizing both the verbal and visual components of the medium.

Education is widely recognized as a crucial factor in an individual's life. It provides the ability to discern right from wrong, significantly improving one's quality of life, especially for future generations (Roh, 2018). Moreover, education plays a vital role in a country's economic and structural development. By equipping individuals with valuable knowledge, education enables them to apply their learning in real-life situations (Thangeda et al., 2016). A study by Johan and Harlan (2014) supports the notion that education profoundly impacts people's lifestyles in different villages. The study revealed that Village A had a less favourable lifestyle compared to Village B. Upon closer examination, it was evident that Village A lacked knowledge about the risks associated with unhealthy behaviours such as smoking, alcohol consumption, and underage marriage, while Village B had access to proper education, resulting in a higher quality of life and increased social awareness.

Numerous studies have been conducted worldwide to evaluate the effectiveness of different teaching and learning approaches in providing a comprehensive and practical education. Brunei's education system is based on the country's philosophy, which is centred around the Malay Islamic Monarchy concept (Muhammad & Norhazlin, 2010). The Ministry of Education in Brunei has placed great importance on integrating and instilling this concept in the teaching and learning process, intending to produce future generations of learners who are committed to MIB principles and equipped with 21st-century skills (Ministry of Education, 2018; Mundia, 2010). Moreover, Brunei plans to establish an integrated education system incorporating Islamic teachings and values from the Qur'an and the Hadiths. This system emphasizes including Islamic aspects in teaching materials, activities, and school learning environments (Lubis, 2015; Muhammad & Bakar, 2013). This approach has received support from Muslim scholars who argue that a separate education system could result in an unresponsive education system that fails to align with the Islamic identity of students who believe in and practice monotheism. By integrating Islamic values into science teaching, students can better understand the world around them and their place in it. The Qur'an encourages the exploration and understanding of God's creations in the universe, which aligns with the principles of Science (Mustamin & Wahono, 2020).

Teachers can help students develop higher-order critical thinking skills by incorporating Islamic values into science teaching. This approach encourages students to observe and investigate scientific phenomena using logical reasoning. For example, teachers can teach students about the impact of pollution on the earth by relating it to their Islamic knowledge, faith, and morals (Mustamin & Wahono, 2020; Agung et al., 2024). They can stimulate students' thinking by asking questions that explore the religious reasoning ('aql) behind concepts such as cleanliness, environmental destruction, and pollution. Similarly, teachers can address the topic of alcohol and drug consumption by emphasizing the Islamic laws and reasons for their prohibition. Furthermore, teachers can engage students in discussions about their Islamic knowledge and the importance of obeying the restrictions on consuming forbidden food and drinks (Lubis, 2015; Muhammad & Bakar, 2013).

Studies conducted in Indonesia (Nugroho, 2017; Sunhaji, 2018) conveyed positive outcomes from integrating Islamic education in science. This integration led to more meaningful discussions, improved reasoning, and a better understanding of scientific concepts among students. These findings are supported by a study by Lubis (2015), which highlights the significant contribution of Islamic education to lifelong knowledge by developing and enriching the mind and soul. The study also suggests that applying Islamic values and concepts in teaching Science helps students establish a balanced relationship between theoretical scientific concepts and their spiritual beliefs, worldviews, and afterlife considerations. This approach was more beneficial and meaningful for students, as it aligned with their Islamic morals and faith. Similarly, visual aids in the classroom can capture students' attention and potentially improve knowledge retention. Visual aids also enhance students' understanding of complex scientific concepts that may be challenging to convey through written or reading materials (Evagorou et al., 2015; Shabiralyani et al., 2015).

Several studies have shown that various factors contribute to students' performance in the classroom. These factors include student interest, teaching methods teachers employ, and the quality of teaching and

learning materials used (Friesen et al., 2018; Jurgens et al., 2024; Spiegel et al., 2013). In the field of science, research has found that many students struggle with understanding conceptual knowledge. This difficulty hampers their ability to construct knowledge and apply concepts to real-life situations (Vavra et al., 2011). One way to capture students' interest and help them understand complex scientific concepts is by using a variety of teaching and learning aids (Cook, 2012). Comics can be a valuable teaching resource and popular among children and young adults. Studies have shown that comics can enhance students' engagement and motivation in learning (Bolton-Gary, 2012; Hosler & Boomer, 2011).

Various researchers have highlighted the numerous benefits of incorporating comics into Brunei classrooms (Azamain et al., 2020; Batrisyia et al., 2020; Musa et al., 2020; Phoon et al., 2020; Shahrill et al., 2022; Sanı et al., 2022). These benefits include increased motivation and interest in specific topics, improved focus during class, reduced language barriers, alternative ways of understanding concepts, enhanced peer discussion, and the ability to apply newly acquired knowledge authentically through a constructivist approach (Koutníková, 2017; Sjøberg, 2010). Additionally, Comics present vibrant depictions of graphic narratives, combining vivid imagery and text to create a unique storytelling experience. While there are numerous genres of comics, they all share the common feature of conveying messages or information through speech bubbles. Moreover, contemporary comics feature various characters, including iconic superheroes, popular artists, and beloved cartoon figures, catering to specific target audiences (Spiegel et al., 2013). According to a study conducted among 6th-grade chemistry students in Germany on using comics, positive findings were reported. The students expressed positive insights on how the comic helped them comprehensively read scientific information and instructions. The comic also captured their interest and attention, making them more responsive during tasks. Furthermore, it induced whole classroom discussions and collaborations (Affeldt et al., 2018). The current study aims to investigate the effectiveness of Islamic integrated science comics in improving students' understanding and performance in 'reuse and recycle'.

An Islamic-integrated comic has several benefits in engaging and boosting students' interest and understanding of science. It has the potential to help overcome the current challenges faced by students in Brunei. Many students struggle with understanding Science concepts, which hampers the development of their higher-order critical thinking skills in the subject. This study aims to investigate the effectiveness of Islamic integrated science comics in improving students' understanding and performance in 'reuse and recycle', which is one of the challenging science topics for most students. The three research questions are: What are students' prior conceptions of 'reuse and recycle'? What is the effectiveness of Islamic integrated Science comics in improving students' understanding of 'reuse and recycle'? And lastly, how do students perceive Islamic integrated Science comics lessons on 'reuse and recycle'?

METHODS

The study used the mixed methods approach to expand the design, enabling us to collect quantitative and qualitative data (Creswell, 2014). Two research instruments were used to answer the research questions: the diagnostic online pre-tests and post-tests and the online interviews on the intervention lessons. This study was designed by employing action research adapted from Stringer (1996), whereby three cycles were conducted accordingly. Action research is essential in educational research. It is a strategy for teachers to develop as researchers and use their research to improve teaching and student learning (Müller & Hagner, 2002). Stewart et al. (2010) have identified three components of action research: the 'Look, Think, and Act' cycle. The informed judgement of practitioners to address complex challenges is best done with the help of action research. The practitioner can critically reflect on practice and continuous learning cycles with action research. Its iterative nature allows the testing and perfection of techniques until the most effective approach is found. This improves competency and expertise (Kemmis, 2007; Bradbury-Huang & Reason, 2007). A total of 50 students of Year 3 from a local primary government school in the Brunei-Muara District were recruited for this study using convenient sampling. Before enrolling in the study, the participants and their parents/guardians were given the participant's information sheet. Once they agreed to participate in the study, a consent form was provided for them to fill out. The study received ethical approvals from the faculty Ethics committee and the relevant department at the Ministry of Education.

The Home Learning Pack (HLP) is a resource book developed to aid students in catching up and progressing in their learning activities under minimum supervision. Students were required to respond to a diagnostic test question to evaluate their understanding of the topic 'Reuse and Recycle'. The students were given a maximum of 30 minutes to complete the task, which consisted of five multiple-choice questions and three short-answer open-ended questions that required advanced thinking skills. Prior conception refers to students' understanding and mastery of a topic and the identification of any learning problems they may have encountered (Esomonu & Eleje, 2020). Students were given a pre-test and post-test in the form of Higher-Level Thinking questions before using the comic. The pre-test consisted of five open-ended questions that required

higher-order thinking skills. Each student was given one hour to answer these questions. The post-tests were administered three times, corresponding to each cycle (Cycle 1, Cycle 2, and Cycle 3) after the completion of each intervention lesson. The diagnostic, pre and post-test questions were checked and screened thoroughly according to the Science Brunei syllabus, scheme of work, Star Science textbook and workbook Year 3. Experienced primary Science teachers who have been working for more than ten years and a trained clinical supervisor validated the questions before the usage. Lastly, a semi-structured interview was conducted with six students based on their learning ability in search of emerging themes. The students' learning ability profiles were obtained from the students' subject teachers. Figure 2 illustrates the flow chart of the three cycles of the intervention.

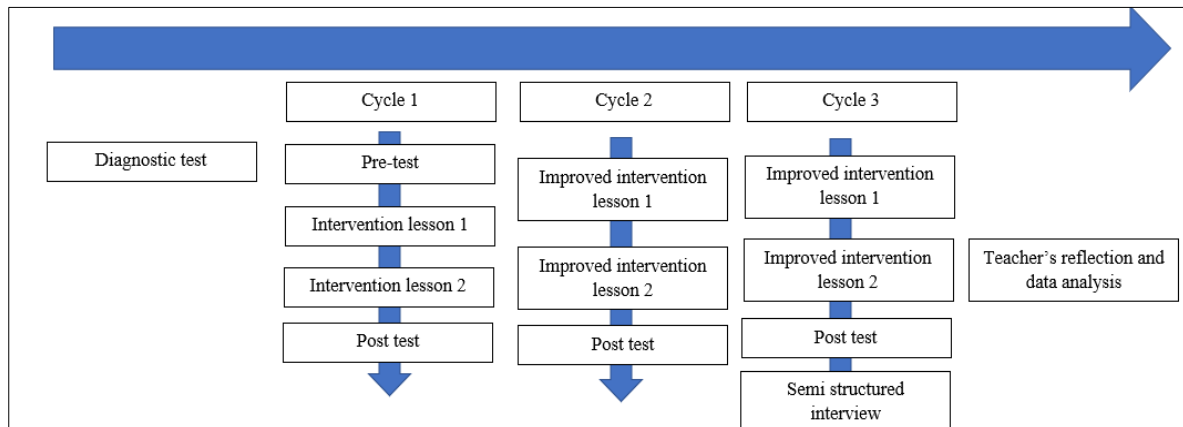


Figure 2. Flowchart of the Lesson Interventions of the Three Cycles

In all three cycles, the intervention from the lesson plan and reflection lasted two hours and went through three stages. Using the topic reuse and recycle and with the aid of the Year 3 STAR Science Textbook and slides from the comic. First is the 'Look' stage, where the teacher-researcher (also the first author) gathers pre-and post-test data and evaluations of the lessons from the previous cycle in the case of the second and third cycles and uses the pre-test for the first cycle. The data was then assessed in the 'Think' stage, where the teacher-researcher tried to determine if the post-test data aligned with the evaluations of the lessons. During this stage, the teacher-researcher highlighted possible reasons for the student's answers and scores based on the cycle post-test and evaluations. These reflections served as a guide to identify what went well and what went wrong during the intervention and develop possible action plans for the next stage. Lastly, in the 'Act' stage, the interventions were conducted twice in two hours using the WhatsApp application as the primary teaching and learning mode. In the first intervention, the lessons were improvised to provide essential vocabulary (bilingual) related to the main words used in the comic. The teacher-researcher's voice reading the comic in different tones was also added. In the second intervention, the students were given comic pages from the previous lesson to help them recall the subject matter. Critical vocabulary and the teacher-researcher's voice reading the comic were also provided. For the written activity in both interventions, the students were asked to answer questions in their Star Science workbook and the post-test, respectively.

Before the data analysis, normality testing was conducted using the Shapiro-Wilk test. The output did not indicate normal distribution. Hence, non-parametric statistics were used for the data analysis. All the quantitative data was analyzed using RStudio statistical software. The diagnostic test was analyzed using descriptive statistics. The Wilcoxon Signed-Rank test was employed to compare the differences between each cycle. The results from the pre-and post-test were then compared to determine if there were any significant differences in the participants' understanding of using the Islamic integrated Science comic. The qualitative analysis focused on the students' responses from the semi-structured interviews. These responses were analyzed thematically to identify any emerging themes. The analysis followed the adapted version of Braun and Clarke's (2012) thematic analysis approach. Based on Figure 6, the thematic analysis involved six sequential processes. The teacher-researcher began by familiarising themselves with the data and transcribing the audio responses into written words. Any responses in Malay were translated into English and marked with brackets and italics. The audio responses were thoroughly listened to and transcribed. The transcriptions were read and reread to ensure a thorough understanding of the data and to avoid missing significant responses. Once all the audio responses were transcribed into written form, the transcripts were carefully reviewed to identify potential themes. Significant responses were highlighted as potential themes, and the teacher-researcher looked for keywords that could provide answers to the research questions. The codes were then narrowed down into their potential themes by reading and rereading them to ensure they belonged together. Next, the generated themes

were reviewed to ensure their suitability. The themes were carefully defined following the codes, serving as a validation process to ensure each code was correctly assigned to the appropriate theme. The methodology employed in this study was influenced by the research conducted by Braun and Clarke (2012) and Kiger and Varpio (2020), who offered valuable insights and direction about the application of theme analysis.

RESULT AND DISCUSSION

This section elaborates on and highlights findings and discussions. The findings are presented according to the three research questions. To answer this question, descriptive statistics were employed. The results were determined through means and percentages. Table 1 shows the descriptive statistics.

Table 1. Descriptive analysis for diagnostic test

Marks scored (out of 10)	No. of students (N=50, %)	Mean score	Median score	Min. score	Max. score	IQR range
8	3 (6%)	5.96	6	2	8	2
7	14 (28%)					
6	17 (34%)					
5	12 (24%)					
4	2 (4%)					
3	1 (2%)					
2	1 (2%)					
1	0 (0%)					
0	0 (0%)					

Note: *Min. = minimum score. *Max. = maximum score. *IQR = interquartile range. The percentages of scores, mean, median, minimum, maximum and interquartile range were obtained using R statistical software.

The diagnostics test revealed that most of the students had a good understanding of the topic 'Reuse and Recycle'. They could answer the questions, particularly the lower-order level questions, which involved defining reuse and choosing a symbol for recycling. This suggests that they grasped the basics of the topic. However, only three students (6%) could answer the higher-order level questions. An example of such a question is: "One way to reduce waste is by practising reuse, such as giving unwanted items to someone else. This practice is emphasized in Islam to minimize wastage. Can you think of another way to reduce waste based on Islamic principles?". In addition, 8% of the students scored between 2 and 4 marks, which is considered a Grade D. These scores were below the passing mark of 5. The findings demonstrated that most students seem to have a reasonable grasp of the material, as indicated by the peak in scores around 6 and 7. The teacher-researcher used these findings to customize the lesson plan and the Islamic integrated Science comic. The aim was to ensure that the desired learning outcomes would be achieved by the end of the third cycle. This was done by focusing on higher-order thinking concepts. These approaches are supported by literature, which suggests that diagnostic scores are valuable in addressing students' common misconceptions and difficulties with specific topics. These scores can be used to develop appropriate instructional strategies (Esomonu & Eleje, 2020). The Wilcoxon signed-rank tests conducted on the three cycles using the pre and post-test scores revealed a significant improvement in the students' scores. This indicates that the Islamic integrated Science comic effectively promoted the students' knowledge on the topic 'Reuse and Recycle'. The detailed findings are tabulated in Table 2.

Table 2. Wilcoxon signed-rank test's results of the three cycles

Cycle number	N	Average mean		Mean difference	Median score (Md)		Median difference	Effect size (r)	P-value
		Pre-test	Post-test		Pre-test	Post-test			
Cycle 1	50		9.88	4.14		10	4	0.786	<0.001
Cycle 2		5.74	9.18	3.44	6	9	3	0.861	<0.001
Cycle 3			9.89	4.15		10	4	0.871	<0.007

Note: The Wilcoxon signed-rank test was performed non-parametrically using R statistical software. The R statistical software directly provided the average mean, median score, and P-value using the Wilcoxon signed-rank test script. The effect size (r) was manually calculated using the formula $r = z/(\sqrt{N})$, where z was obtained from R statistical software, and N was the total sample size (50).

For the first cycle and referring to [Table 2](#), a Wilcoxon signed-rank test indicated a statistically significant improvement in the student's scores ($p < 0.001$) with a large effect size ($r = 0.786$). The median score increased by 4 points from the pre-test ($Md = 6$) to the post-test ($Md = 10$). In the second cycle, the Wilcoxon signed-rank test also revealed a statistically significant improvement in the student's scores ($p < 0.001$) with a more significant effect size ($r = 0.786$). The median score increased by 3 points from $Md = 6$ in the pre-test to $Md = 9$ in the post-test. The mean average also showed a significant increase in scores with the post-test. Lastly, for comparing pre and post-test scores in the third cycle, the Wilcoxon signed-rank test demonstrated a statistically significant improvement in the student's scores with a large effect size ($r = 0.871$). The median score increased by 4 points from the pre-test to the post-test. The average mean also showed higher scores than the pre-test, with an increase of 4.15 points. This increase was also higher than the post-test scores from Cycles 1 and 2. Overall, there was an increase in scores between the post-tests and the pre-test, indicating higher marks in the post-tests. These results indicate significant improvements in the students' knowledge of 'Reuse and Recycle' before and after the intervention lessons using the Islamic integrated Science comic. Regarding identifying the best or most effective cycle in improving students' knowledge of the topic, Friedman's Two-Way ANOVA revealed statistically significant improvements across all three cycles.

Table 3. Friedman's Two-Way Anova of the three cycles

Cycle number	P-value	Median score (Md)
Cycle 1		8
Cycle 2	<0.002	9
Cycle 3		10

Note: Friedman's Two-Way Anova was run non-parametrically using R statistical software.

[Table 3](#) above suggests significant differences in students' scores across the three cycles. Cycle 1 has a median score of 8 ($Md = 8$), Cycle 2 has a median score of 9 ($Md = 9$), and Cycle 3 has the highest median score of 10 ($Md = 10$). Based on Friedman's Two-Way ANOVA, it can be concluded that Cycle 3 was the most effective ($Md = 10$). These findings suggest that the instructional strategies used in Cycle 3, such as providing the comic as a digital flipbook with voice audio, maintaining critical vocabularies, and giving total pages of the comic, effectively improved student performance. Similar findings have been reported in other studies, which found significant improvements in student knowledge when comics were used as the primary tool for teaching and learning. Comics were found to be more engaging than plain text and were influential in delivering complex scientific concepts. The use of colourful pictures, characters, and speech bubbles in comics helped students better understand scientific concepts compared to traditional textbooks. Overall, these studies support the idea that comics can enhance students' understanding and knowledge of science ([Affeldt et al., 2018](#); [Fananta et al., 2019](#); [Koutníková, 2017](#); [Phoon et al., 2020](#)).

The findings were reported based on semi-structured interviews on the intervention lessons. The emerging themes were derived using thematic analysis adapted from [Braun and Clarke \(2012\)](#). The student's views on using the comic were identified as comic structure, enrichment activity, and empowerment of scientific knowledge. This refers to the components of the comic, such as fonts, colours, layouts, and characters. The students expressed that the comic captured their interest in learning the topic due to its attractive colours and characters. For example, student I03 said, "I like the characters, teacher. The Proboscis boy and the Hornbill girl are so cute. I have not seen them on TV". This finding is consistent with the study conducted by [Spiegel et al. \(2013\)](#), who concluded that characters in comics are carefully chosen to maximize learning potential by manipulating the visual context. Furthermore, the students highlighted that the comic helped them to understand the topic better visually. Student I01 mentioned, "The comic was nice, teacher. I like to look at it; easy to understand because of the pictures and colour". This finding aligns with a study by [Özdemir \(2017\)](#), where students mentioned that they found Science more enjoyable and engaging when using comics, thanks to the visual aspects such as exciting characters and colourful layouts that facilitated their learning.

This involves using activities during intervention lessons that aligned with the primary tool, which was a comic. Three interviewed students briefly mentioned that they found reading the comic aloud through role-playing with their siblings and following the teacher-researcher's voice to clarify the content of the comic. Student I02 commented, "We did the role play activity using the comic as the teacher instructed... It was fun... I understand it easier... I understand, teacher...". These findings were further validated by the results of Friedman's Two-Way Anova test, which indicated that the third cycle was the most effective cycle during the research. In this cycle, the teacher-researcher enhanced the lessons by integrating role-playing and reading aloud with the teacher-researcher's voice as instructional strategies when using the comic to deliver the lesson. These strategies were found to be beneficial and aligned with the hypothesis that the use of comics in teaching and learning is based on the theory of cognitive theory of multimedia learning. According to [Mayer \(2014\)](#),

comics engage both the verbal and pictorial components of the brain to convey messages. When students receive and store these messages from the comics, it facilitates more meaningful learning as their working memory supports the newly acquired knowledge. Consequently, this leads to a more straightforward and meaningful construction of knowledge.

This theme focused on the integration of Islamic values within the comic. The teacher-researcher defined this theme as incorporating Islamic values (such as faith, deep thinking, and reasoning using 'aql) that promote and facilitate learning in science. Four of the six interviewed students expressed their thoughts on integrating Islamic values, which helped them understand the importance of cleanliness. The students mentioned that they should keep clean because it is mentioned in the book and because it is a part of their faith (Iman). For example, I05 argued, "The comic said we have to keep clean because Shaytan does not like cleanliness... we have to keep clean because Allah asked us... we will gain pahala, right?". Similarly, I03 stated, "The comic said Allah loves those who are clean and not wasteful... we will gain pahala (good deeds). We should not waste... clean... healthy... reuse recycle, don't waste things". Another student mentioned, "In our religious school, our religious teacher said that cleanliness is part of our faith... and those who love wasting food will befriend Shaytan... just give the food to friends and siblings to share".

Based on these responses, it is evident that the students could reflect on and connect their knowledge of Islamic values with the topic of 'Reuse and Recycle'. In conclusion, the integrated Science comic has proven effective and beneficial in improving the student's knowledge and understanding of the topic. The findings support the results of other research studies conducted elsewhere. These studies found that integrating or internalizing Islamic values, such as using in-depth reasoning ('aql) to understand why certain things are forbidden, such as the destruction of the environment, can help students grasp challenging scientific concepts and facilitate meaningful learning. Moreover, this integration observed positive effects on students' academic performance (Nugroho, 2017; Lubis, 2015; Mustamin & Wahono, 2020; Nuha et al., 2024).

This investigation contributes significantly to the field of science education by illustrating the efficacy of incorporating cultural and religious contexts into instructional materials. More specifically, the research underscores the positive influence of Islamic integrated science comics on students' comprehension and achievement in the subject of 'reuse and recycle.' Students who engaged with these comics exhibited notable advancements in their performance on post-tests, signifying a deeper grasp of scientific principles. Furthermore, comic-based lessons were perceived as enjoyable and immersive, cultivating a favorable outlook towards science and instilling a lasting interest in the discipline. By linking scientific ideas with Islamic principles, the research advocates for meaningful learning experiences that enable students to establish connections with information more efficiently. These results offer valuable insights for educators and policymakers, indicating that culturally embedded educational resources can yield considerable benefits. Additionally, the study presents practical suggestions for developing and implementing such resources, guaranteeing their accessibility and relevance to students. In essence, this study uncovers fresh prospects for novel pedagogical approaches tailored to diverse student cohorts, illustrating that the integration of cultural and religious contexts can substantially enrich student involvement, comprehension, and performance in science education.

CONCLUSION

In conclusion, this research elucidated that using Islamic integrated science comics significantly amplifies students' comprehension and performance in the subject of 'reuse and recycle.' Results obtained from Wilcoxon signed-rank tests, student interviews, and reflections from teachers who also participated in the research illustrated the favorable influence of this approach, indicating that students perceived the comics as enjoyable, captivating, and efficacious in linking scientific principles with Islamic ethics. These outcomes suggest that incorporating cultural and religious contexts into educational resources can nurture profound learning and sustained enthusiasm for science. The study proposes that such comics can serve as a beneficial instrument for educators and offer guidance for the Ministry of Education in improving students' grasp of intricate scientific subjects. Nevertheless, constraints of the study, such as selective sampling and online data gathering, impact the applicability of the results. Subsequent research should contemplate in-person instruction to guarantee meaningful learning encounters. Educators are encouraged to adequately prepare for the proper integration of Islamic values and craft comics with easily understandable language to enhance student performance.

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