The Research Probe
Volume 5 Issue 1 June 2025
DOI: https://doi.org/10.53378/trp.182

Exploring science mnemonics in enhancing retention skills of grade school students

[1]Joana M. Olivete, [2]Cherry Jean E. Dizon, [2]Andrei C. Andaya, [2]Shella Mae G. Masugbod & [2]Raiza L. Samorin

Abstract

Mnemonic devices aid in retaining scientific knowledge by simplifying complex concepts, stimulating curiosity, and engaging students through question-based learning, thereby enhancing their overall learning experience. This study aimed to investigate the effectiveness of mnemonic techniques in improving the retention skills of Grade VI students in science at Caesar Z. Lanuza Elementary School. The study involved 40 Grade VI students selected through convenience sampling. A quantitative research design using pre-test and post-test assessments was employed to measure retention skills before and after the use of mnemonic devices. Results showed a significant improvement, with mean scores increasing from 15.25 to 22.95. The t-value of 31.64 confirmed statistical significance, highlighting the potential of mnemonic techniques in science education. The results suggest incorporation of mnemonic devices into science classrooms to help students learn more effectively. Using various mnemonic techniques can make science content more accessible and engaging, ultimately enhancing students' retention skills. It is also recommended to explore the use of mnemonic devices in subjects beyond science to determine their effectiveness across different content areas.

Keywords: *explore, enhance, mnemonics, retention skills, science, devices*

Article History:

Received: *April 22, 2025* ***Revised***: *May 6, 2025*
Accepted: *June 1, 2025* ***Published online***: *June 30, 2025*

Suggested Citation:
Olivete, J.M., Dizon, C.J.E., Andaya, A.C., Masugbod, S.M.G. & Samorin, R.L. (2025). Exploring science mnemonics in enhancing retention skills of grade school students. *The Research Probe, 5*(1), 189-206. https://doi.org/10.53378/trp.182

About the authors:
[1]Corresponding author. Undergraduate student, Laguna University. Email: joanaolivete04@gmail.com
[2]Undergraduate student, Laguna University

**This paper is presented at the 2nd International Student Research Congress (ISRC) 2025*

1. Introduction

Louis Pasteur once remarked, "*Studying science inspires curiosity and an attitude of discovery*." This assertion underscores the fundamental role of science education in nurturing inquisitive minds and a lifelong passion for learning. However, the abstract and multifaceted nature of scientific concepts often presents cognitive challenges for young learners. In response to this issue, mnemonic devices, strategies designed to aid memory by simplifying and organizing information, offer a promising pedagogical approach (Fung & Oyibo, 2024; Qureshi et al., 2014; Romeike, 2024). By converting complex ideas into memorable associations, mnemonic tools can enhance both understanding and retention, thereby fostering deeper engagement and investigative thinking among students.

Mnemonic devices function as cognitive scaffolds, facilitating the encoding, storage, and retrieval of information (Siagian et al., 2023; Boyle, 2021; Metsämuuronen & Räsänen, 2018). Their application in science education not only supports knowledge acquisition but also encourages learners to develop active recall strategies, ask meaningful questions, and pursue further inquiry into scientific phenomena. These characteristics align with the goals of inquiry-based learning, where students are encouraged to explore and construct meaning through active participation.

Recognizing the potential of mnemonics in enhancing science instruction, the present study was undertaken to evaluate the effectiveness of a self-developed instructional material, the Science Mnemonic Booklet, in improving retention among elementary learners. The booklet, created by the researchers, was designed to be both engaging and accessible, containing a compilation of mnemonic aids tailored to the Grade IV science curriculum, specifically covering topics from the first quarter. It includes key scientific concepts presented through acronyms, rhymes, visual imagery, and association-based strategies, making it a practical and user-friendly learning resource.

This study argues that integrating innovative and learner-centered tools such as mnemonic booklets into classroom instruction can significantly enhance students' cognitive retention. The goal is not only to simplify abstract content but also to ignite curiosity and motivate students to interact more meaningfully with the subject matter. The overarching objective of this study was to investigate the effectiveness of the Science Mnemonic Booklet in enhancing the retention skills of Grade IV students. Though the booklet was originally designed for Grade IV content, the participating Grade VI students served as a suitable sample to evaluate the utility and effectiveness of mnemonic strategies in revisiting and reinforcing foundational scientific knowledge. The research aimed to ascertain whether exposure to mnemonic devices could serve as a meaningful aid to retention, even in content previously learned or reviewed.

This study contributes to the growing body of research on memory-enhancing instructional strategies in elementary science education. It aims to assist science educators in identifying practical and low-cost interventions that can be easily implemented in the classroom. By demonstrating the positive impact of mnemonic tools on student learning, this research underscores the need for creative pedagogical approaches that support long-term information retention. Furthermore, the findings are expected to inform curriculum planners, school administrators, and educational material developers about the value of integrating mnemonics into instructional resources. This approach not only promotes academic performance but also nurtures the curiosity and discovery-oriented mindset that Louis Pasteur advocated—a mindset essential for success in scientific learning and beyond.

2. Literature Review

2.1. Mnemonics

Mnemonics is the study of memory systems, focusing on techniques for information retention, recall, and comprehension. These devices help students tackle complex subjects, retain knowledge more effectively, and perform better in exams. By organizing information into memorable formats, mnemonics foster deeper understanding, reduce study time, and develop transferable skills applicable in various domains of life. Hence, educators and parents are encouraged to integrate mnemonic strategies into their teaching approaches.

According to Siagian et al. (2023), mnemonic devices are effective tools for enhancing the retention of factual information, particularly in the fields of social sciences and education. These techniques utilize literary tools such as poems, auditory cues, acronyms, acrostics, and visual aids to make learning more engaging and efficient. Similarly, Danielle (2023) emphasized that mnemonic methods, such as deep breathing, rhymes, acronyms, and the Method of Loci, can enhance memory retention during exam preparation. Breaking information into smaller chunks and practicing speed reading also contribute to stronger memory recall. Kelly (2020) also explained that mnemonic devices are beneficial memory aids that promote recall by connecting new information with familiar ideas or patterns. These include rhymes and songs, acronyms, acrostics, and chunking techniques, along with visualization strategies that help learners associate information with strong mental imagery. Linking new knowledge to personal experiences further increases retention. These methods are especially advantageous for students preparing for exams or studying complex subjects.

Mnemonic devices, such as acronyms, rhymes, and visual aids, offer flexible strategies to enhance comprehension and memory across academic fields. Their integration into instructional practices can reduce rote memorization, improve exam performance, and create more engaging learning environments.

2.2. Retention

Learning retention refers to the ability to transfer newly acquired knowledge into long-term memory for future recall (Ginting et al., 2024; Di Filippo et al., 2025; Walsh et al., 2023). According to Walsh et al. (2023), factors affecting retention include interest and motivation, repetition, associations, and multi-channel learning. The Learning Pyramid categorizes methods by effectiveness, suggesting that techniques such as discussion groups, practice by doing, and teaching others have higher retention rates than passive methods like lectures or reading (Letrud & Hernes, 2018).

Mundey (2023) similarly emphasized the importance of retention in education and training. He noted that active engagement, reinforcement, and real-world relevance are key to long-term knowledge retention. The Learning Retention Pyramid reinforces the need for strategies such as repetition and multimodal learning to boost both understanding and memory. Additionally, brain-based techniques, such as teaching others, gaining practical experience, relational learning, and spaced testing, have been proven effective in enhancing long-term recall. Recognizing personal learning habits and avoiding multitasking are also important.

Khazen (2025) highlighted strategies used in colleges and universities to improve retention, such as brainstorming, concept maps, peer activities, think-pair-share, and scaffolding. These methods foster collaboration and activate prior knowledge for deeper learning. Renjisha (2025) also stressed the effectiveness of microlearning, spaced repetition, practice testing, and gamification in increasing retention. Individual learning styles, material complexity, and context play critical roles. Strategies such as linking new knowledge to prior experience and goal setting can make learning more manageable.

Mostrady et al. (2024) pointed out that the brain naturally forgets, and effective teaching must combat this with simulation training, storytelling, active participation, and microlearning. Short sessions with dynamic visual content and real-life applications increase engagement and improve retention rates.

2.3. Science

Science is a body of knowledge built on objective data and systematic experimentation, focused on understanding the physical world and its phenomena. It involves logical thinking, hypothesis testing, and empirical evidence to explain observations (Rubinstein, 2005). Theories like Mendeleev's Periodic Table illustrate how scientific understanding evolves through rigorous testing and evidence-based validation. Science presents cognitive and psychological challenges, including content complexity, abstract thinking, and the need for interdisciplinary knowledge (Gärtner & Clowes, 2023; Honra & Monterola, 2025; Horn et al., 2022). To address these challenges, educators should adopt active learning strategies, reduce reliance on memorization, and simplify technical language to make science more accessible.

Foster (2023a) noted that science requires specialized knowledge and meticulous methodology due to the complexity and interconnectivity of natural systems. Proficiency in data analysis, mathematical modeling, and continuous learning are essential for success in scientific fields. Similarly, Tekwani (2020), referencing physicist Richard Feynman, explained that the conceptual nature of science, particularly physics, poses difficulties for students. Developing interpretive and logical reasoning skills can improve comprehension and engagement. In support of this, Ichimura (2019) reported that the Philippines ranked last in reading comprehension and second to last in mathematics and science in the 2018 Programme for International Student Assessment (PISA). The findings highlighted the urgent need for interventions targeting disadvantaged students. The integration of mnemonic devices could be one such strategy to enhance students' retention and understanding of science concepts.

Foster (2023b) also discussed biology as a hard science, emphasizing its reliance on the scientific method, quantitative data, and controlled experiments. Although historically tied to natural history, modern biology involves rigorous methodologies that demand strong retention skills. Mnemonics can serve as effective tools to support students in managing this complexity. Johnson (2023) classified biology as the easiest among hard sciences due to its focus on life forms, but noted it still involves complex concepts and quantitative analysis. He compared it to soft sciences like economics and sociology, which study human behavior within populations. The use of mnemonic devices can ease the cognitive load and support retention in subjects like biology.

Shermer (2024) critiqued the traditional hierarchy of sciences, ranking them as "hard," "medium," and "soft," as overly simplistic. He advocated for integrative science, which blends data, theory, and narrative to make scientific knowledge more coherent and accessible. Narratives help synthesize complex information, reinforcing that science is not merely about data but also about understanding through storytelling. Mnemonic devices align with this philosophy by creating meaningful structures for recalling information.

2.4. Theoretical Framework

This study adopted George A. Miller and Richard Shiffrin's Information Processing Theory as the theoretical foundation of the investigation. The connection between both studies lies in their reliance on a framework that remains a cornerstone of cognitive psychology. The Information Processing Theory provides a foundation for understanding cognitive functions by focusing on how individuals attend to, store, and retrieve information.

Miller's (1956) seminal work introduced the concept of short-term memory capacity, suggesting that individuals can hold approximately seven (plus or minus two) items of information at a time. Although more recent studies propose that the actual capacity may be slightly lower, Miller's contribution remains influential. Building on this, Atkinson and Shiffrin (1968) proposed a three-stage model of memory: sensory memory, short-term memory (also referred to as working memory), and long-term memory. Sensory memory briefly processes incoming stimuli and retains only the information deemed important. Short-term memory then filters this information, holding it for approximately 15 to 20 seconds. Through cognitive strategies such as maintenance rehearsal, information can be transferred into long-term memory, which is believed to have unlimited capacity. Long-term memory encompasses different types of information, including imagery (mental pictures), declarative knowledge (facts and experiences), and procedural knowledge (skills and activities).

The present study, which investigates the effectiveness of science mnemonics in enhancing the recall abilities of Grade VI students, aligns directly with this theoretical framework. In accordance with the principles of Information Processing Theory, mnemonic devices assist in organizing information and reducing cognitive load. By employing strategies that enhance the encoding, storage, and retrieval of information, the study aims to optimize memory retention and recall, demonstrating a practical application of this enduring psychological model.

Figure 1

Conceptual framework of the study

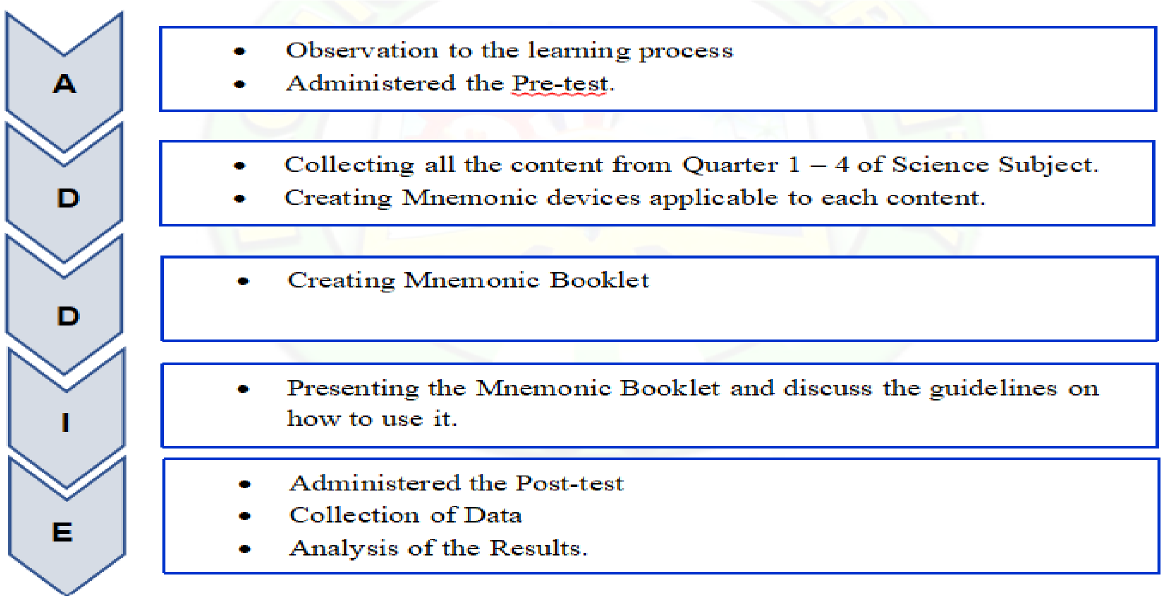

Figure 1 presents the ADDIE model developed by Florida State University. The model presents the process and the corresponding actions taken.

A (Analysis): Following a thorough observation of the learning process to assess students' needs, a pre-test was administered to determine their baseline knowledge and identify areas requiring improvement. This step helped establish the focus areas for developing the mnemonic booklet.

D (Design): The science curriculum content from Quarters 1 to 4 was collected and systematically organized. Each topic was paired with an appropriate mnemonic strategy to facilitate student recall of complex scientific concepts.

D (Development): The designed mnemonic devices were compiled into a comprehensive mnemonic booklet. This booklet served as a supplementary learning resource to help students reinforce and retain key science principles.

I (Implementation): Students were introduced to the mnemonic booklet and given guidance on how to use it effectively. This ensured that learners understood how to maximize the tool's potential for enhancing memory and learning outcomes.

E (Evaluation): A post-test was conducted to assess the effectiveness of the mnemonic booklet. The test data were analyzed to evaluate how well the booklet improved students' comprehension and retention of science topics.

3. Methodology

3.1. Research Design

The study employed a quantitative research design, which involves the collection and analysis of numerical data. This methodology facilitates the identification of patterns, calculation of averages, making of predictions, examination of cause-and-effect relationships, and generalization of findings to broader populations. A non-probability sampling technique called convenience sampling was used based on ease of accessibility. This selection procedure may be influenced by variables such as participants' willingness to participate in the study, availability at a given time, and geographic proximity.

3.2. Research Participants

The study was conducted at a public elementary school in Biñan, Pagsanjan, Laguna, Philippines. The school operates under the jurisdiction of the Department of Education and falls within the educational management of the 4th District of Laguna. The school serves as an elementary institution offering education in a monograde class organization. The study involved 40 Grade VI students selected through convenience sampling.

3.3. Research Instrument

The study used pre-test and post-test questionnaires to collect the necessary data. Three research instruments were utilized. The first tool was the pre-test, which consisted of thirty (30) questions designed to evaluate the respondents' capacity for science retention. The second tool was the intervention material, a booklet of mnemonic devices developed by the researchers. Created using the Canva app, the booklet incorporated references from Grade 6 science modules to design mnemonics based on previously covered content. Finally, a post-test was administered after the intervention process. To ensure the validity of both the pre-test and the science mnemonic booklet, the researchers sought the assistance of two master teachers from Laguna Senior High School for content evaluation and review.

3.4. Data Gathering Procedure

A letter requesting permission to conduct the study was sent to the research adviser, the research coordinator, and the school principal. Upon approval, the researchers employed convenience sampling to select participants due to their accessibility, which helped ensure the reliability of the results. Pre-test questionnaires were first distributed to assess participants' retention skills related to the use of mnemonic devices. The intervention material, a booklet containing science-focused mnemonic devices, was then presented to the participants. Subsequently, post-test questionnaires were administered. After data collection, the responses were tallied, interpreted, and analyzed using appropriate statistical tools.

3.5. Statistical Treatment of Data

The data were evaluated using statistical tools such as mean and standard deviation to determine the effectiveness of the mnemonic devices in enhancing the retention skills of Grade 6 learners. Higher mean scores indicated that the instructional materials were more effective, while lower scores suggested less effectiveness. To determine if there were significant differences in the students’ retention skill levels between the pre-test and post-test, a t-test for two paired samples was used.

4. Results and Discussion

The level of students Retention skills as gleaned in their scores during pre-test in terms of using mnemonics in science subject.

Table 1

Mean level of students' retention skills (pre-test)

Criteria	Mean (Score)	SD (Score)	Interpretation
Retention Skills	15.25	4.02	Moderate

Legend: 0-10 (Very Low),11-15 (Low),16-20 (Moderate), 21-25 (High), 26-30 (Very High)

Table 1 presents the pre-test results assessing students' retention skills prior to the introduction of mnemonic devices. The data reveal that students achieved an average retention score of 15.25, which falls under the "Moderate" category. This indicates that, on average, the students possessed a foundational level of knowledge in science, demonstrating familiarity with certain concepts, yet lacking in consistent mastery or deeper comprehension. Their ability to recall information appeared limited to basic recognition rather than analytical or applied understanding.

The standard deviation of 4.02 suggests substantial variability in students' performance. This wide range of scores implies that while some learners had developed relatively stronger retention capabilities, others struggled to grasp or retain key scientific concepts. Such disparities emphasize the heterogeneity of the classroom, where students have differing cognitive strengths, prior knowledge, and learning styles. Consequently, the data highlight a pressing need for targeted and differentiated instructional interventions aimed at addressing individual learning gaps and improving the collective retention capacity of the class.

The moderate scores observed before the implementation of mnemonic strategies offer critical insight into the students' cognitive development. Although many had acquired basic factual knowledge, their retention and recall skills were not yet fully developed to meet higher-order learning demands. This underlines the importance of adopting teaching techniques that do more than convey information, they must actively support long-term memory formation and cognitive retrieval.

The result aligns with the recommendations of Almoslamani (2022) and Wang (2023), who argue that effective learning retention extends beyond rote memorization and short-term recall. Students must focus not just on passing examinations but on deeply internalizing and understanding the material. For instance, approach such as the Protégé Effect, where teaching learned material to others reinforces one's own knowledge, and relational learning, encourages connecting new information with pre-existing knowledge frameworks. Both strategies are proven to enhance comprehension and long-term memory. In addition, Polack and Miller (2022) emphasize the benefits of practice testing, which not only improves recall but also helps reduce test-related anxiety. However, caution is raised on multitasking, a singular focus on one topic at a time allows deeper cognitive engagement. In addition, the spacing effect, a technique where students space out study sessions over time to reinforce learning and enhance retention rather than relying on last-minute cramming, is another beneficial strategy.

Within the context of the present study, the implementation of mnemonic devices is grounded in this body of evidence. Mnemonics serve as powerful tools that engage various cognitive functions, such as association, imagery, and sequencing, to support both short-term recall and long-term retention. These strategies are especially effective in subjects like science, where learners often encounter complex terminologies and abstract concepts. By simplifying and organizing information into memorable formats, mnemonics help students make sense of the content and anchor it more effectively in their memory.

Ultimately, introducing mnemonic-based learning interventions has the potential to foster greater focus, confidence, and academic achievement among learners. As the results in subsequent sections will show, such approaches not only enhance immediate recall but also contribute to sustained academic performance across various science topics.

Table 2

Mean level of students' retention skills (post-test)

Criteria	Mean (Score)	SD (Score)	Interpretation
Retention Skills	22.95	4.05	High

Legend*:* 0-10 (Very Low), 11-15 (Low), 16-20 (Moderate), 21-25 (High), 26-30 (Very High)

Table 2 presents the post-test results measuring students' retention skills after the implementation of mnemonic devices. The data reveal a substantial improvement, with the mean score rising to 22.95, which elevates the class's overall performance to the "High" category. This significant increase indicates that the majority of students greatly enhanced their ability to recall and retain information following the intervention. Additionally, the standard deviation of 4.05 suggests a relatively consistent level of performance across the class compared to the pre-test results. This reduced variability implies not only an overall improvement in retention skills but also a narrowing of performance gaps among students, pointing to more equitable learning gains.

The marked improvement in post-test scores clearly demonstrates the effectiveness of mnemonic strategies as powerful cognitive tools that aid memory retention. The shift from moderate to high proficiency, coupled with more uniform results, suggests that mnemonic devices provided students with a structured, accessible framework to process, organize, and store scientific information more efficiently. This aligns with cognitive psychology principles that emphasize the role of meaningful associations and organized retrieval cues in strengthening memory.

Supporting this, Siagian et al. (2023) affirm that mnemonic devices are well-established, effective methods for improving retention of factual knowledge, especially within social sciences and education. These devices utilize a variety of techniques, such as poems, acronyms, acrostics, auditory signals, and visual aids, that engage multiple sensory and cognitive channels. By leveraging these literary and sensory cues, mnemonics transform complex and abstract content into memorable and manageable units. This not only makes learning more organized and engaging but also enhances students' ability to internalize and recall information.

In the context of this study, the efficacy of mnemonics is strongly reflected in the improved post-test results. The mnemonic booklet, tailored to the Grade 6 science curriculum, clearly helped learners develop stronger comprehension and recall abilities. This highlights the practical value of mnemonic strategies as effective instructional interventions, particularly in science education where content is often dense and terminology challenging. By reducing cognitive load and promoting active encoding, mnemonics can foster deeper understanding and sustained academic performance.

Overall, these findings contribute to the growing evidence that integrating mnemonic devices into classroom instruction not only boosts short-term recall but also supports long-term retention and mastery of scientific concepts. This approach has the potential to create more inclusive learning environments by assisting students with varying abilities and learning preferences, ultimately enhancing educational outcomes across diverse learner populations.

Table 3

Significant difference in students' retention skills before and after using mnemonic devices

Criteria	Mean (Pre-Test)	Mean (Post-Test)	t-value	Significance Level	Critical Value	Interpretation
Retention Skills (Score)	15.25	22.95	31.64	0.05	2.023	Significant

**t-value>critical value, significant*

Table 3 presents the significant difference in students' retention skills before and after the use of mnemonic devices. Statistical analysis using a paired t-test yielded a t-value of 31.64, which far exceeds the critical value of 2.023 at the 0.05 significance level. This result confirms a statistically significant improvement in students' retention performance following the intervention. The increase in mean scores from 15.25 to 22.95 provides strong empirical evidence that mnemonic devices had a considerable and positive impact on enhancing retention levels. Furthermore, the substantial increase in scores, accompanied by a reduction in score variability, underscores the effectiveness of the mnemonic-based intervention in producing both meaningful and consistent gains in student learning outcomes.

This statistical outcome validates that the observed improvement in students' retention was not due to chance or random variation, but rather a direct result of the mnemonic intervention. The clear and marked contrast between the pre-test and post-test results highlights the powerful role mnemonic devices can play in enhancing students' cognitive capacities to retain and recall information. This effect is especially crucial in content-heavy subjects such as science, where complex terminology and abstract concepts often present learning challenges.

Supporting this, Jamil and Aqeel (2019) emphasize the well-established efficacy of mnemonic devices in improving recall abilities within science education. These tools simplify complicated concepts by breaking them down into more manageable and memorable formats, thereby increasing students' capacity to grasp and retain scientific knowledge. Similarly, a meta-analysis by Wang et al. (2019) demonstrated the broadly positive effects of mnemonic strategies on academic performance, particularly in science-related disciplines. By organizing scientific information into smaller, easier-to-understand units, mnemonics facilitate more effective knowledge retention and recall.

The incorporation of mnemonic strategies into instructional practices offers a practical, evidence-based approach to improving educational outcomes. As the findings of this study suggest, these techniques serve as powerful cognitive scaffolds that help bridge comprehension gaps, enhance memory retention, and ultimately promote academic success across diverse student populations. Beyond immediate exam preparation, mnemonics contribute to the development of deeper learning and long-term mastery of complex scientific material. Therefore, integrating mnemonic devices into science education represents a valuable pedagogical approach with the potential to support learners of varying abilities and backgrounds, fostering both confidence and competence in challenging subject matter.

5. Conclusion

This study highlights the effectiveness of mnemonic devices as a teaching tool to help students retain more information in science. By simplifying complex scientific concepts into memory patterns or associations, mnemonics boost student interest and sustain engagement through an interactive, question-based approach. These modern tools transform learning experiences by making the process more enjoyable and efficient. The main objective of the study was to assess how well mnemonic devices could enhance the science recall abilities of 40 sixth-grade students selected through convenience sampling.

To evaluate the students' retention skills before and after the use of mnemonic devices, the study employed a quantitative research design and administered both pre-test and post-test assessments. The findings revealed a significant improvement in students' retention performance, with the mean score increasing from 15.25 in the pre-test to 22.95 in the post-test. A t-value of 31.64 confirmed statistical significance, validating the effectiveness of mnemonic devices in improving learning outcomes. These results demonstrate that mnemonic strategies can serve as valuable aids in science education, helping students understand and remember content more effectively.

This study recommends the use of mnemonic devices such as acronyms, rhymes, and visual imagery to improve retention of students in science. Regular practice, combined with a thorough understanding of the material, can significantly enhance their effectiveness. For teachers, integrating mnemonic techniques into science instruction is highly recommended. Consistent application of these tools can reinforce student comprehension and promote long-term retention. For schools, adopting mnemonic devices in the classroom can lead to increased engagement and a more enjoyable learning environment, ultimately contributing to improved academic performance. Lastly, future researchers are encouraged to explore the use of mnemonic devices across various subjects beyond science. Doing so could offer broader insights into their adaptability and effectiveness, potentially benefiting a wider range of students across different academic areas.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was not supported by any funding.

Institutional Review Board Statement

This study was conducted in accordance with the ethical guidelines set by Laguna University. The conduct of this study has been approved and given relative clearance(s) by Laguna University.

AI Declaration

The author declares the use of Artificial Intelligence (AI) in writing this paper. In particular, the author used, *Quillbot in searching appropriate literature, summarizing key points and paraphrasing ideas*. The author takes full responsibility in ensuring proper review and editing of contents generated using AI.

References

Almoslamani, Y. (2022). The impact of learning strategies on the academic achievement of university students in Saudi Arabia. *Learning and Teaching in Higher Education: Gulf Perspectives*, *18*(1), 4–18. https://doi.org/10.1108/LTHE-08-2020-0025

Atkinson, R. C., & Shiffrin, R. M. (1968). Human memory: A proposed system and its control processes. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation* (Vol. 2, pp. 89–195). Academic Press.

Boyle, A. (2021). The mnemonic functions of episodic memory. *Philosophical Psychology*, *35*(3), 327–349. https://doi.org/10.1080/09515089.2021.1980520

Danielle. (2023, September 14). How to remember what you read using mnemonic devices. *Iris Reading*. https://irisreading.com/how-to-remember-what-you-read-using-mnemonic-devices/

Di Filippo, F., Pasquale, M., De Biasi, G., Faiella, F., Amboni, M., & Viggiano, A. (2025). The most effective way to obtain long-term memory is to increase first presentation duration of single words. *Cogent Education, 12*(1). https://doi.org/10.1080/2331186X.2025.2498864

Foster, J. (2023a, November 5). Examining the challenging nature of scientific pursuits. *Jamie Foster Science*. https://www.jamiefosterscience.com/why-is-science-so-hard/

Foster, J. (2023b, November 5). Is biology a hard science? Examining the field’s rigor. *Jamie Foster Science*. https://www.jamiefosterscience.com/is-biology-a-hard-science/

Fung, K., & Oyibo, K. (2024). Examining the effectiveness of mnemonics serious games in enhancing memory and learning: A scoping review. *Applied Sciences*, *14*(23), 11379. https://doi.org/10.3390/app142311379

Gärtner, K., & Clowes, R. W. (2023). Interdisciplinarity in cognitive science and the nature of cognition. In O. Pombo, K. Gärtner, & J. Jesuíno (Eds.), *Theory and practice in the interdisciplinary production and reproduction of scientific knowledge* (Vol. 31, pp. 195–215). Springer. https://doi.org/10.1007/978-3-031-20405-0_9

Ginting, D., Woods, R. M., Barella, Y., Limanta, L. S., Madkur, A., & How, H. E. (2024). The effects of digital storytelling on the retention and transferability of student knowledge. *SAGE Open*, *14*(3). https://doi.org/10.1177/21582440241271267

Honra, J. R., & Monterola, S. L. C. (2025). Enhancing biology students’ cognitive flexibility through problem-based learning moderated by transdisciplinary thinking. *The Journal of Educational Research*, 1–11. https://doi.org/10.1080/00220671.2025.2525245

Horn, A., Urias, E., & Zweekhorst, M. B. M. (2022). Epistemic stability and epistemic adaptability: Interdisciplinary knowledge integration competencies for complex sustainability issues. *Sustainability Science, 17*, 1959–1976. https://doi.org/10.1007/s11625-022-01113-2

Ichimura, A. (2019, December 4). Philippine students perform poorly in reading, math, and science in international student assessment. *Esquiremag.ph*. https://www.esquiremag.ph/politics/news/pisa-philippine-students-a00304-20191204

Jamil, F., & Aqeel, M. (2019). Effectiveness of mnemonics in enhancing academic performance: A meta-analysis. *Journal of Educational Research, 112*(3), 341–356.

Johnson, A. (2023, May 1). Which are the hard sciences? *ScienceOxygen*. https://scienceoxygen.com/which-are-the-hard-sciences/

Kelly, M. (2020, March 14). Mnemonic devices for students. *ThoughtCo*. https://www.thoughtco.com/mnemonic-devices-tools-7755

Khazen, M. (2025). The impact of teaching through the concept mapping strategy on the educational achievement of sixth graders in sciences. *Creative Education*, *16*, 299–329. https://doi.org/10.4236/ce.2025.163019

Letrud, K., & Hernes, S. (2018). Excavating the origins of the learning pyramid myths. *Cogent Education, 5*(1). https://doi.org/10.1080/2331186X.2018.1518638

Metsämuuronen, J., & Räsänen, P. (2018). Cognitive-linguistic and constructivist mnemonic triggers in teaching based on Jerome Bruner's thinking. *Frontiers in Psychology, 9*, 2543. https://doi.org/10.3389/fpsyg.2018.02543

Mostrady, A., Sanchez-Lopez, E., & Gonzalez-Sanchez, A. F. (2024). Microlearning and its effectiveness in modern education: A mini review. *Acta Pedagogia Asiana, 4*(1), 33–42. https://doi.org/10.53623/apga.v4i1.496

Polack, C. W., & Miller, R. R. (2022). Testing improves performance as well as assesses learning: A review of the testing effect with implications for models of learning. *Journal of Experimental Psychology: Animal Learning and Cognition, 48*(3), 222–241. https://doi.org/10.1037/xan0000323

Qureshi, A., Rizvi, F., Syed, A., Shahid, A., & Manzoor, H. (2014). The method of loci as a mnemonic device to facilitate learning in endocrinology leads to improvement in student performance as measured by assessments. *Advances in Physiology Education, 38*(2), 140–144. https://doi.org/10.1152/advan.00092.2013

Renjisha, R. (2025). The effectiveness of microlearning and spaced repetition in knowledge retention across different age groups: A comparative analysis of cognitive performance and memory consolidation. *International Journal of Teacher Education Research Studies, 2*(2), 69–73. https://doi.org/10.5281/zenodo.15689698

Romeike, B. F. M. (2024). Peer creation and sharing of mnemonics in collaborative documents for pathology education: A pilot study. *BMC Medical Education*, *24*(1), 742. https://doi.org/10.1186/s12909-024-05743-1

Rubinstein, G. (2005). Knowledge creation. In *Encyclopedia of Social Measurement* (pp. 409–416). Academic Press. https://doi.org/10.1016/B0-12-369398-5/00553-3

Shermer, M. (2024, February 20). The really hard science. *Scientific American*. https://www.scientificamerican.com/article/the-really-hard-science/

Siagian, D. T., Maida, N., Irianto, D. M., & Sukardi, R. R. (2023). The effectiveness of mnemonic device techniques in improving long-term memory in learning in elementary schools: A literature review. *Equator Science Journal, 1*(1), 24–30. https://doi.org/10.61142/esj.v1i1.4

Siagian, D. T., Maida, N., Irianto, D. M., & Sukardi, R. R. (2023). The effectiveness of mnemonic device techniques in improving long-term memory in learning in elementary schools: A literature review. *Equator Science Journal, 1*(1), 24–30. https://doi.org/10.61142/esj.v1i1.4

Tekwani, M. (2020, January 14). Why is physics considered to be a difficult subject? *LinkedIn*. https://www.linkedin.com/pulse/why-physics-considered-difficult-subject-mukesh-tekwani

Walsh, M. M., Krusmark, M. A., Jastrembski, T., et al. (2023). Enhancing learning and retention through the distribution of practice repetitions across multiple sessions. *Memory & Cognition*, *51*, 455–472. https://doi.org/10.3758/s13421-022-01361-8

Wang, Q. (2023). Memorization strategy and foreign language learning: A narrative literature review. *Frontiers in Psychology*, *14*, 1261220. https://doi.org/10.3389/fpsyg.2023.1261220

Wang, Y., Beydoun, M. A., Li, J., Liu, Y., & Moreno, L. A. (2011). Do children and their parents eat a similar diet? Resemblance in child and parental dietary intake: Systematic review and meta-analysis. *Journal of Epidemiology & Community Health*, *65*(2), 177–189. https://doi.org/10.1136/jech.2009.095901