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Effective Strategies for Memorizing Mathematical Formulas in a Literature Review Study

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Abstract

Mathematics is often perceived as a difficult subject due to the large number of formulas that students must understand and memorize. This condition can lead to learning difficulties and trigger mathematics anxiety, which may reduce students' ability to retain mathematical concepts. This study aims to examine various effective strategies for memorizing mathematical formulas based on previous research. The research employed a qualitative approach using a literature review method involving 30 relevant scientific articles obtained from several academic databases. Data were collected through a literature study, while the analysis was conducted by identifying, comparing, and synthesizing findings from the collected literature. The results show that strategies for memorizing mathematical formulas can be categorized into four main groups: audio-musical and artistic strategies, digital technology and gamification innovations, cognitive strategies through mnemonics and kinesthetic tools, and structured drill methods. These strategies have been shown to improve memory retention, learning motivation, and students' learning outcomes. The findings indicate that the application of creative and multisensory learning strategies can help students memorize mathematical formulas more effectively.

Keywords: *learning strategies; memorizing mathematical formulas; mnemonic; gamification; memory retention.*

1. Introduction

Mathematics is often perceived as a frightening subject and becomes a "nightmare" for students due to the complexity of symbols and the large number of formulas that must be mastered (Indriani et al., 2021). Ideally, students should be able to understand and retain mathematical concepts meaningfully; however, reality in the field shows low retention ability and conceptual understanding, resulting in learning outcomes that do not meet the minimum mastery criteria (Nasuti & Rejeki, 2026). This problem is further exacerbated by the phenomenon of math anxiety, which causes students to avoid interaction with numbers and formulas. Theoretically, this difficulty is closely related to Cognitive Load Theory (Sweller, 2011), where mathematics often triggers a high intrinsic cognitive load due to its abstract nature. Without appropriate retention strategies, formulas tend to remain only in short-term memory and are easily forgotten when students face high-pressure situations such as exams. This is in line with the findings of Hidayat et al. (2022), which state that students' failure in solving complex problems is often not caused by a lack of logical ability, but rather by retrieval failure of basic formulas stored disorganizedly in memory.

The urgency of this research lies in the need to transform memorization methods from mere mechanical repetition into enjoyable cognitive strategies that can reduce math anxiety. Studies in the past five years have explored various innovations, such as the HARUMPALA method that transforms formulas into song lyrics (Ramadhani et al., 2024), mnemonic strategies to support long-term memory in trigonometry (Rahmawati, 2019), and the use of creative media such as E-Comics (Dewi & Wijayanti, 2025) and the LudoMatik game (Febrianti & Kriswandani, 2025). The integration of visual and auditory approaches aligns with the Dual Coding principle, enabling the brain to build two mental representation pathways and increasing the likelihood of successful information retrieval (Sari & Pratama, 2023). In addition, physical techniques such as the method of closing one's eyes have been shown to improve concentration when memorizing formulas (Rofi'ah, 2021), while drill methods combined with singing are effective in improving basic multiplication memorization (Murti, 2023). Despite the abundance of studies on single interventions, there remains a research gap in the limited number of literature reviews that comprehensively synthesize these memorization strategies to determine their effectiveness based on the characteristics of the material and educational level. There is no systematic guideline for educators to determine the effectiveness of strategies based on material characteristics, for example, the difference between memorizing visual geometry formulas and procedural algebraic formulas (Pratiwi, 2024). Therefore, the purpose of this study is to conduct an in-depth literature review to map and analyze various effective strategies for memorizing mathematical formulas and their implications for students' learning outcomes.

2. Research Method

This study employs a qualitative approach using a literature review method. A literature review is the process of identifying, analyzing, evaluating, and synthesizing previous research (Milya Sari, 2020). It consists of a survey of books, scientific articles, and other relevant sources related to the research topic in order to gain a comprehensive understanding of a particular issue. The data sources in this study are derived from scientific articles and prior studies relevant to the topic under investigation, namely strategies or techniques for quickly memorizing mathematical formulas in learning. These sources are obtained from various websites and academic databases such as Google Scholar, national journals, and other academic repositories.

The data collection technique is conducted through a literature study, which involves searching for and gathering relevant literature such as scientific articles and previous research related to learning strategies, memorization techniques, and mathematics education. The data analysis technique is carried out by reading, reviewing, comparing, and synthesizing or summarizing various findings from the collected literature. Subsequently, the information obtained is analyzed to identify various effective strategies for memorizing mathematical formulas. The results of the analysis are then systematically organized to provide an overview of effective strategies that can help students recall mathematical formulas quickly and accurately.

3. Results and Discussion

3.1 Research Findings

Based on a literature review of 30 relevant scientific articles, this study successfully maps various innovative strategies for memorizing mathematical formulas. The main finding indicates that the greatest obstacle faced by students in memorization is not memory capacity, but rather the delivery method, which tends to be mechanical and monotonous. The strategies identified in the literature are classified into four main pillars: (1) Audio-Musical and Artistic Strategies, (2) Digital Technology and Gamification Innovations, (3) Cognitive Strategies through Mnemonics and Kinesthetic Teaching Aids, and (4) Reconstruction of Structured Drill Methods.

Quantitatively, the majority of the literature (approximately 70%) reports an increase in learning mastery above 75% after the implementation of these strategies. For example, the use of E-Comic media shows an effectiveness rate of 76.8% (Dewi & Wijayanti, 2025), while mnemonic methods increase mastery from 12.50% to 93.75% (Hidayah et al., 2025). These data indicate that creative strategy interventions have a significant impact on students' ability to retain formulas.

Table 1: The mapping results of 30 journal articles on strategies for memorizing mathematical formulas are summarized

No	Strategy Category	Example Methods/Media	Main Authors (Year)	Key Findings
1	**Audio-Musical**	HARUMPALA, Singing Method	Ramadhani (2024); Zulfitria (2019)	Increases motivation and facilitates memory retention through familiar song rhythms.
2	**Digital & Gamification**	E-Comic, Wordwall, LudoMatik	Dewi (2025); Utami (2025); Febrianti (2025)	Dynamic visualization improves average scores from 49.28 to 82.85.
3	**Cognitive & Mnemonic**	Mnemonics, Jarimatika	Hidayah (2025); Quraisy (2022)	Simplifies complex formulas; increases learning mastery up to 87%.
4	**Repetition (Drill)**	Structured Practice	Rukmini (2022)	Strengthens memory synapses through repetition, increasing scores up to 80.47%.

3.2 Discussion

This section provides an in-depth analysis of how each strategy works in supporting memory retention and why these strategies are considered effective in the mathematics education literature.

1. Internalization of Formulas through Audio-Musical and Artistic Strategies

One of the most widely discussed strategies for addressing math anxiety is the musical approach. This strategy utilizes rhythm and melody to package rigid mathematical information. For instance, the implementation of the HARUMPALA (Hafalan Rumus Pakai Lagu) method in studies by Ramadhani et al. (2024) and Pratama et al. (2023) demonstrates that modifying popular song lyrics with mathematical formulas effectively improves students' memory. From a neuroscience perspective, music stimulates the limbic system and temporal lobe, which regulate emotions and long-term memory. This finding is supported by Zulfitria (2019), whose study at SD Muhammadiyah 12 Pamulang shows that the singing method not only facilitates memorization but also significantly increases learning motivation. Students tend to retrieve information more easily during exams because the melody functions as a memory cue. The literature concludes that at the elementary level, emotional engagement through art is key to preventing formulas from being perceived as a heavy cognitive burden.

2. Digital Transformation and Gamification in Interactive Learning

With the rapid development of technology, recent literature shows a shift toward interactive media. The use of interactive E-Comics provides a stronger visual impact compared to conventional textbooks. Dewi and Wijayanti (2025) report an effectiveness score of 76.8%, indicating that comics present formulas in concrete visual narratives, allowing students to visualize applications before memorizing them. Additionally, the integration of platforms such as Wordwall with the RADEC model (Read, Answer, Discuss, Explain, and Create) produces highly impressive results. Utami and Harahap (2025) report an increase in average scores from 49.28 (pre-test) to 82.85 (post-test). This success highlights that gamification elements, as seen in LudoMatik (Febrianti & Kriswandani, 2025), reduce student stress levels. In this context, memorization occurs incidentally, as students focus on gameplay while formulas are absorbed as tools to win.

3. Cognitive Strategies: Mnemonics, Jarimatika, and Kinesthetic Association
For highly complex material, mnemonic techniques emerge as a systematic and effective solution. Hidayah et al. (2025) demonstrate that mnemonic strategies help students simplify complex information into memorable acronyms or humorous phrases. Their findings show a dramatic increase in mastery from 12.50% to 93.75%. This approach is particularly effective for subjects involving numerous symbols, such as trigonometry and algebra. On the other hand, kinesthetic tools such as Jarimatika (Quraisy et al., 2020) provide a different approach. Students engage not only visually and auditorily but also physically. By associating numbers and patterns with finger movements, students build motor neural pathways that strengthen memory retention. The literature indicates that this cognitive-kinesthetic strategy is especially beneficial for active learners, as they "do" mathematics rather than merely memorizing it.

4. Reconstruction of the Drill Method: Structured and Sustained Practice
Although often criticized, this literature review confirms that drill methods remain essential as reinforcement strategies, provided they are modified to avoid monotony. Effective drill methods in recent studies are structured and often incorporate elements of competition. Rukmini et al. (2022) demonstrate this through classroom action research at SMP Negeri 5 Tinambung, where students' memorization of basic multiplication improves significantly from 50.68% to 80.47%. This strategy operates on the principle of habituation. The more frequently formulas are applied across varied problem types, the stronger the neural connections formed. The literature concludes that drill functions as a "finishing stage" or memory consolidation phase after conceptual understanding is developed through other methods such as music or digital media. Consistent repetition ensures the transfer of information into long-term memory.

3.3 Implications

The findings of this literature review provide important contributions to mathematics teaching practices in schools:

1. **Transformation of the Teacher's Role as a Creative Facilitator**
   Teachers are no longer merely sources of mechanical memorization but are required to act as creative facilitators by integrating various strategies. They must be capable of transforming rigid formulas into more engaging media, such as songs, digital comics, or interactive games.
2. **Enhancement of Students' Self-Efficacy and Motivation**
   The use of varied strategies such as gamification and mnemonics significantly reduces math anxiety. Practically, this creates a positive learning environment where students feel more confident and no longer perceive formulas as intimidating.
3. **Optimization of Multisensory Learning**
   This study emphasizes the importance of accommodating diverse learning styles (visual, auditory, and kinesthetic). A multisensory approach ensures that all students have equal opportunities to achieve learning mastery.
4. **Utilization of Technology as an Innovative Solution**
   The integration of technology in mathematics learning is essential. Media such as E-Comics and digital quiz platforms serve not merely as entertainment but as strategic tools to build mental models that support long-term retention.

3.4 Research Limitations

Despite providing a comprehensive overview, this study has several limitations:

1. **Data Scope**:
   The review is limited to selected scientific literature and may not cover all innovative strategies implemented globally.
2. **Methodology**:
   As a literature study, this research does not involve direct experimental validation to compare the effectiveness of strategies under controlled conditions.
3. **Accessibility**:
   Some technology-based strategies require infrastructure (devices and internet access) that may not be equally available across all schools in Indonesia.

4. Conclusion

Based on the findings of the literature review, it can be concluded that effective strategies for memorizing mathematical formulas do not rely solely on mechanical repetition, but also on the use of creative and multisensory learning approaches. Various strategies such as audio-musical methods, digital media and gamification, mnemonic techniques and kinesthetic aids, as well as structured drill practices have been proven to improve students' formula retention and learning outcomes.
The integration of these strategies can help reduce math anxiety and enhance students' learning motivation. Therefore, teachers need to develop more innovative mathematics instruction by utilizing these approaches so that the process of memorizing formulas becomes easier, more engaging, and more meaningful for students.

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