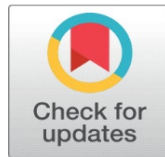
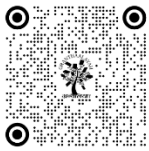


# ACCELERATING LEARNING THROUGH VEDIC MATHEMATICS: A COMPARATIVE AND PEDAGOGICAL INVESTIGATION

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## ABSTRACT

Vedic Mathematics, an ancient computational framework derived from Indian scriptures and later systematized by Bharati Krishna Tirthaji, provides simplified and intuitive techniques for arithmetic operations. This study explores its pedagogical value in enhancing computational speed and accuracy among high school students. Using a quasi-experimental design involving 60 students divided into control and experimental groups, the study identifies a statistically significant improvement in calculation speed and error reduction in the Vedic Mathematics-trained group. The paper also discusses the integration of Vedic techniques into contemporary curricula, the cognitive benefits observed, and the limitations in applicability beyond foundational arithmetic. Implications for teaching practice and directions for further research are proposed.

**Keywords:** Vedic Mathematics, Mental Math, Curriculum Integration, Cognitive Load, Educational Pedagogy, Computational Efficiency

## 1. INTRODUCTION

Mathematics is not merely a subject but a foundational discipline that nurtures analytical reasoning, structured problem-solving, and mental agility. In today's educational landscape—shaped by rapidly advancing technologies, diverse learner needs, and global competency frameworks—mathematics education must not only convey computational skills but also foster flexibility in thinking and confidence in application.

Despite curriculum reforms and instructional innovations, many students continue to perceive mathematics as abstract, intimidating, or mechanical. Conventional algorithm-based instruction often emphasizes rote procedures over intuitive understanding, which can lead to disengagement and mathematical anxiety, especially in foundational arithmetic learning. As educators and researchers seek pedagogical models that offer both efficiency and engagement, alternative computational frameworks such as Vedic Mathematics have gained renewed attention.

Vedic Mathematics, a system of mental calculation rooted in ancient Indian scriptures, offers a collection of heuristic techniques that simplify seemingly complex arithmetic operations. Codified in the early 20th century by Jagadguru

Swami Bharati Krishna Tirthaji, the system is based on 16 sutras (aphorisms) and 13 sub-sutras that provide elegant strategies for a wide range of mathematical tasks, including multiplication, division, squaring, and algebraic manipulation. These techniques often utilize pattern recognition, complementary numbers, and symmetry—skills aligned with the goals of modern cognitive mathematics education.

Proponents argue that Vedic Mathematics enhances computational fluency, encourages creative thinking, and fosters confidence in problem-solving, particularly when introduced at an early stage. Some techniques such as Urdhva-Tiryagbhyam ("vertically and crosswise") and Nikhilam Navatashcaramam Dashatah ("all from 9 and the last from 10") have been noted for their potential to reduce cognitive load by minimizing procedural steps. The alignment of such techniques with principles of Cognitive Load Theory and constructivist learning underscores their pedagogical relevance.

Yet, empirical research on the actual impact of Vedic Mathematics within contemporary classrooms remains limited. Questions about its effectiveness, applicability across different learner profiles, and integration into mainstream curricula are still being explored. Moreover, debates persist over the historical authenticity and universality of the system, prompting the need for evidence-based inquiry rather than purely cultural or ideological promotion.

This paper seeks to fill that gap by evaluating the effectiveness of Vedic Mathematics in improving student performance in basic arithmetic operations. Specifically, it investigates whether students trained in Vedic methods outperform their peers who are taught using conventional strategies in terms of speed, accuracy, and mathematical confidence. The study further explores the pedagogical feasibility, benefits for diverse learners, and the challenges of curricular integration. Through this comparative and analytical lens, the research contributes to a more informed understanding of how traditional knowledge systems can be harmonized with contemporary educational goals.

## 2. HISTORICAL BACKGROUND AND CONCEPTUAL FOUNDATION

Vedic Mathematics is a system of mental mathematics that claims its origins in the Atharva Veda, one of the four foundational texts of ancient Indian wisdom. The system, however, was formally reconstructed and systematized in the early 20th century by Jagadguru Swami Bharati Krishna Tirthaji Maharaj, a scholar, mathematician, and Shankaracharya of Govardhana Matha. His seminal work, *Vedic Mathematics* (1965), compiled a unique collection of computational strategies grounded in what he interpreted as mathematical sutras embedded within Vedic literature.

The system comprises 16 primary sutras (aphorisms) and 13 sub-sutras, which function as general and specific procedural rules for solving a wide array of mathematical problems. These sutras offer methods for operations involving arithmetic, algebra, geometry, trigonometry, and even calculus, though their greatest pedagogical impact is observed in elementary and intermediate-level mathematics. Some of the most widely applied sutras include:

Nikhilam Navatashcaramam Dashatah ("All from 9 and the last from 10"): Used primarily for subtraction and multiplication of numbers close to base powers of 10, this technique reduces computation to a series of complements, streamlining complex subtraction operations.

- Urdhva-Tiryagbhyam ("Vertically and crosswise"): A general multiplication technique applicable to all cases, including large-digit multiplication. It enables simultaneous vertical and crosswise computation, effectively reducing multi-step calculations to a single visualized process.
- Paravartya Yojayet ("Transpose and apply"): Typically used for solving algebraic equations, especially in simplifying expressions or performing division of polynomials.

These sutras are not simply procedural tools but are reflective of pattern-based reasoning and visual-spatial logic, which contrast sharply with the step-based algorithms taught in modern Western pedagogy. Tirthaji emphasized that these techniques were not mere shortcuts but universal principles applicable to a wide range of mathematical domains.

However, the authenticity and Vedic origin of these sutras have been the subject of scholarly debate. George Gheverghese Joseph (2000), in his work *The Crest of the Peacock*, argues that while the sutras are elegantly constructed and pedagogically useful, there is no direct evidence of their presence in the original Vedic texts. Critics note the lack of Sanskrit manuscripts predating the 20th century that include these specific sutras in a mathematical context. As such, the classification of the system as "Vedic" is more philosophical and cultural than literal or textual.

Despite these concerns, the educational value of Vedic Mathematics lies in its heuristic approach, which emphasizes mental computation, number sense, and cognitive flexibility. Its intuitive, pattern-driven strategies often align with

principles of constructivist learning and cognitive load theory, offering learners alternative pathways to engage with abstract numerical concepts.

Moreover, the system aligns with contemporary calls for multicultural and decolonized curricula that respect and incorporate non-Western contributions to knowledge. Vedic Mathematics, regardless of its debated antiquity, presents a pedagogical bridge between ancient insights and modern mathematical instruction—especially in contexts where learners benefit from visual, kinesthetic, or non-linear learning styles.

### 3. RESEARCH DESIGN AND METHODOLOGY

This study adopted a quasi-experimental pre-test/post-test control group design to examine the effectiveness of Vedic Mathematics in enhancing computational performance among high school students. A total of 60 students were selected from a CBSE-affiliated secondary school in Hoshiarpur. Participants were initially matched based on prior academic performance in mathematics (as per school records and baseline assessments) to ensure equivalence in baseline ability. Following this matching process, students were randomly assigned to one of two groups:

- **Group A:** Control Group (n=30): Received instruction using standard curriculum-aligned mathematical methods, including conventional algorithms and step-wise computation strategies.
- **Group B:** Experimental Group (n=30): Underwent a four-week structured intervention in Vedic Mathematics, focusing on core sutras relevant to basic arithmetic and mental calculations.

The instructional intervention for Group B was integrated into regular math periods and delivered by a trained educator proficient in both conventional and Vedic methodologies.

### 4. INSTRUMENTS AND PROCEDURE

To assess the impact of the intervention, students in both groups completed identical pre-tests and post-tests, designed to measure three key performance indicators:

- Calculation Speed (measured as the average time taken per problem)
- Accuracy (total number of correct responses)
- Error Rate (percentage of incorrect responses)

The test items covered operations in multiplication, division, and mental arithmetic, selected based on their alignment with both conventional and Vedic approaches.

The intervention for the experimental group consisted of 12 structured instructional sessions over four weeks (three sessions per week, each 45 minutes long). The sessions introduced and practiced foundational Vedic sutras including:

- Nikhilam Navatashcaramam Dashatah (for complements and subtraction)
- Urdhva-Tiryagbhyam (for multiplication)
- Ekadhikena Purvena (for squaring numbers ending in 5)

Sessions included demonstration, guided practice, peer collaboration, and independent problem-solving, with an emphasis on mental strategies and pattern recognition. The control group continued regular mathematics instruction based on CBSE curriculum norms.

### 5. DATA ANALYSIS

The collected data were subjected to descriptive and inferential statistical analysis using SPSS software:

- Descriptive statistics (mean, standard deviation) were computed to summarize performance trends.
- Independent samples t-tests were applied to compare the pre-test and post-test scores between the control and experimental groups to determine statistical significance.
- The effect size of the intervention was calculated using Cohen's d, allowing for interpretation of the practical significance of observed differences.

In addition, the internal consistency and reliability of the test instrument were validated through Cronbach's alpha, yielding a coefficient of 0.82, indicating high reliability.

## 6. RESULTS AND ANALYSIS

### 1) Quantitative Findings

The results from the pre-test and post-test assessments reveal notable differences in performance between the control and experimental groups across all measured parameters: calculation speed, accuracy, and error rate.

Metric	Group A (Control)	Group B (Experimental)
Average Time (sec/problem)	14.2	9.3
Accuracy (%)	78.6	92.3
Error Rate (%)	21.4	7.7
Cohen's d (Effect Size)	–	0.85 ( <i>Large effect</i> )

An independent samples t-test confirmed that the performance differences between the two groups were statistically significant ( $p < 0.01$ ). Students in the experimental group, who were trained in Vedic Mathematics techniques, completed arithmetic tasks 30–40% faster than their peers in the control group and exhibited an error reduction of over 60%.

The calculated Cohen's d of 0.85 indicates a large effect size, highlighting a strong practical significance of the intervention. These results suggest that Vedic methods significantly enhance both the efficiency and accuracy of arithmetic computation among high school students.

### 2) Qualitative Observations

In addition to the quantitative outcomes, several behavioral and cognitive shifts were observed among students in the experimental group during the intervention phase:

- **Increased Confidence and Engagement:** Students in Group B displayed noticeably higher levels of self-assurance when solving mathematical problems. Many were more willing to approach complex questions independently and exhibited greater enthusiasm during class activities.
- **Enhanced Pattern Recognition and Mental Agility:** Learners demonstrated improved ability to identify number patterns, employ mental shortcuts, and perform mental calculations with minimal reliance on pen and paper. These gains were particularly evident among visual and spatial learners, who responded well to the diagrammatic and symmetrical nature of Vedic techniques.
- **Improved Attitude Toward Mathematics:** Informal feedback and classroom interactions indicated a positive shift in attitudes toward mathematics, with students expressing greater enjoyment and reduced anxiety related to calculation tasks.

These qualitative findings align with prior research by Raina (2013) and Singh (2018), which also report improved student motivation, computational fluency, and engagement following exposure to Vedic Mathematics. The consistency of these outcomes across contexts reinforces the potential of Vedic methods as an effective pedagogical supplement in mathematics education.

## 7. PEDAGOGICAL IMPLICATIONS

The findings from this study suggest that Vedic Mathematics holds significant promise as a pedagogical enhancement within modern mathematics education, particularly at the foundational and middle-grade levels. Its integration can support diverse learning needs and enrich the teaching-learning process in the following key areas:

### 1) Benefits of Curricular Integration

Integrating Vedic Mathematics into formal school curricula offers multiple educational advantages:

- **Enhancement of Number Sense and Flexibility:** Vedic methods promote deeper numerical intuition by encouraging flexible thinking and pattern recognition.
- **Complementary Mental Strategies:** These techniques can serve as effective supplements to standard algorithmic approaches, offering students alternative pathways to problem-solving.
- **Improved Motivation and Reduced Math Anxiety:** The intuitive and engaging nature of Vedic methods fosters positive emotional responses to mathematics, especially among students who find conventional approaches challenging or intimidating.

### 2) Inclusive and Differentiated Pedagogy

Vedic Mathematics proves particularly beneficial for students with diverse cognitive styles:

- Students who struggle with abstract algorithms often find Vedic strategies more concrete and relatable.
- Visual learners, in particular, benefit from methods such as the criss-cross multiplication technique, which leverages spatial reasoning and symmetry.
- The approach also encourages active mental engagement, benefiting students with short attention spans or lower academic confidence.

These features align well with inclusive education frameworks and support differentiated instruction practices in mixed-ability classrooms.

### 3) Teacher Preparation and Instructional Resources

Successful implementation of Vedic Mathematics within mainstream education requires systematic teacher support and curriculum development:

- **Curriculum-Aligned Lesson Plans:** Instructional materials must be designed to align with national education standards (e.g., CBSE, NCERT) while embedding Vedic techniques in meaningful contexts.
- **Comprehensive Teacher Training:** Teachers need access to pedagogical training modules that introduce the theoretical foundations, practical applications, and classroom integration strategies of Vedic Mathematics.
- **Multilingual and Accessible Resources:** To maximize reach and inclusivity, materials should be developed in multiple languages and adapted for learners from varied socio-cultural backgrounds.

## 8. LIMITATIONS

While the study provides encouraging evidence on the pedagogical value of Vedic Mathematics, several limitations must be acknowledged to contextualize the findings and inform future research:

- **Limited Sample Size and Duration:** The study was conducted with a relatively small cohort ( $n=60$ ) over a short intervention period (four weeks). Broader generalizations require longitudinal studies across varied educational settings.
- **Debates over Historical Authenticity:** The Vedic origins of the sutras remain contested among historians and mathematicians. Although this does not diminish their pedagogical potential, it raises questions about cultural framing and epistemological positioning.
- **Lack of Formal Proofs for Some Techniques:** Certain Vedic strategies are heuristic in nature and lack formal mathematical proofs as required by traditional academic standards, which may challenge their acceptance in rigorous mathematics curricula.

- **Scope of Applicability:** Vedic methods are highly effective for arithmetic and elementary algebra, but their relevance declines when applied to advanced mathematical domains such as trigonometry, calculus, or abstract algebra.
- **Risk of Over-Reliance and Superficial Learning:** If Vedic methods are used as a replacement rather than a supplement, students may become overly dependent on shortcuts, potentially impeding their conceptual understanding and procedural flexibility.

## 9. CONCLUSION

This study highlights the pedagogical promise of Vedic Mathematics as an effective supplementary tool for enhancing mental computation, calculation speed, and learner engagement in mathematics education. The findings indicate that students trained in Vedic methods demonstrate higher accuracy, reduced error rates, and a more confident approach to arithmetic problem-solving compared to peers taught through conventional methods.

While the benefits are evident, Vedic Mathematics should be viewed as a complementary framework rather than a replacement for standard mathematical instruction. Its value lies in strengthening number sense, promoting intuitive thinking, and diversifying problem-solving strategies, especially in early and middle-grade learning environments.

For successful classroom implementation, careful curricular integration, teacher training, and the development of inclusive and accessible learning materials are essential. Moreover, when positioned thoughtfully, Vedic Mathematics can serve as a bridge between traditional knowledge systems and contemporary cognitive science, enriching the mathematical experiences of students while fostering cultural appreciation and educational innovation.

## 10. RECOMMENDATIONS FOR FUTURE RESEARCH

To build on the promising findings of this study and address its limitations, the following directions are recommended for future research:

- **Longitudinal Impact Studies:** Conduct extended-duration studies to evaluate the retention of skills, long-term conceptual understanding, and the transferability of Vedic techniques to broader mathematical domains.
- **Wider Demographic and Geographic Sampling:** Replicate the study with larger and more diverse student populations, including learners from different regions, socio-economic backgrounds, and educational boards, to enhance generalization.
- **Comparative Analyses with Other Mental Math Systems:** Perform comparative studies that evaluate the relative effectiveness of Vedic Mathematics against other globally recognized mental math systems, such as Abacus, Singapore Math, or Kumon, to better position its utility.
- **Technology-Enhanced Instruction:** Investigate the development and impact of digital learning tools, interactive apps, and gamified platforms that deliver Vedic Mathematics in an engaging and scalable format, especially for remote and under-resourced educational contexts.

## CONFLICT OF INTERESTS

None.

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