

Innovative Applications and Data Driven Analysis of Vedic Mathematics in Modern Algebraic Problem Solving

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ABSTRACT

Vedic mathematics, an old system rooted in the Vedas, offers an innovative and intuitive approach to solve mathematical problems using mental calculation techniques. This research work explores the practical application and benefits of Vedic mathematics to solve algebraic problems, particularly quadratic equations, factorization and simultaneous equations. When using specific sutras such as "Samucaya" and "Paravartya Yojayet", we compare the efficiency and precision of Vedic techniques with traditional algebraic methods. A data -based study was conducted involving 60 students, divided equally between traditionally trained and trained groups, it was carried out to analyze the performance depending on the necessary time, precision and perceived cognitive load. The results indicate a significant improvement both in speed and precision for students who use Vedic techniques, together with a reduced mental tension. The results suggest that the integration of Vedic mathematics in modern education could improve computational skills, increase students and reduce mathematical anxiety. This article contributes to the growing academic discourse on alternative mathematical methodologies and their educational impact.

Keywords: Vedic Mathematics, Algebraic Problem Solving, Quadratic Equations, Mental Math, Mathematical Sutras, Cognitive Load, Educational Techniques, Data Analysis, Alternative Pedagogy, Traditional vs Vedic Methods, Speed and Accuracy in Mathematics, Bharati Krishna Tirthaji, Indian Mathematical Heritage, Mathematics Education, Comparative Study

INTRODUCTION

Mathematics has long been regarded as a significant source of foundational discipline and anxiety for students of educational levels. Traditional methods of teaching algebra, when logically hard, often fail to combine students in a way that promotes confidence and intuitive understanding. In this regard, a system obtained from ancient Indian scriptures known as Vedic Mathematics - Vedas - offers a promising option. It is a system of popular and popular mental math techniques composed by Jagadguru Swami Bharti Krishna Tirthaji Maharaj in the early 20th century. Tirthaji (1965) identified sixteen primary formulas and thirteen sub-sources, including a wide range of mathematical operations from basic arithmetic to complex algebra and calculus. These formulas provide brief methods for calculations that are elegant, efficient and often surprisingly easy. The Vedic mathematical pattern is based on the beliefs, mental dexterity and approaches to solving holistic problems. Its principles are naturally algorithmic, which enables the practitioner to solve problems using minimal dependence on fewer steps and traditional procedural memories. It is effective in solving algebraic equations, including formulas and paralyzed organizations (ie "transpos and adjust"), such as formula and paralysis (ie "transposse and adjust"), such as collections (ie a common factor "). These techniques allow direct and often mental removal of complex problems that usually require multiple steps using traditional methods (Glover, 2010).

Recent research has focused more on the educational prospects of Vedic mathematics, especially in terms of improving the functioning of OGN, reducing anxiety and promoting love for numbers. ACH

LITERATURE REVIEW

Vedic mathematics is an ancient mathematical system that was taken from the Vedas, especially the Atharvaveda, and was adjusted by Bharti Krishna Tirthaji Maharaj in the early 20th century. His work, "Vedic Mathematics" (1965) presented 16 formulas (aphorisms) and 13 sub-sources that form the core of this mathematical system. Sources are known for their brief expressions and mental calculations techniques. Since then, scholars and teachers have investigated its effectiveness and relevance in the modern education system, especially taught algebra and arithmetic.

Historical Background and Origins:

Vedic mathematics, represented by Tirthaji, claims to be the origin of ancient Indian scriptures. According to Tirthaji (1965), the formulas were taken after meditation and study, especially the appendix parts working with mathematics. Despite some of the scholarly discussions related to the history of the history of these claims (Joseph, 2000), the mathematical utility of the formulas is greatly non-rival.

Indian mathematical historical riotic origin returns to famous ancient texts such as Sulba Sutra and Aryabhatia. Indian scholars like Aryabhata, Brahmagupta and Bhaskaracharya have contributed significantly to algebra, trigonometry and arithmetic (Joseph, 2000). The resurrection of Vedic mathematics in the 20th century gave a new interpretation of these ancient principles, making them accessible to the broader audience.

Theoretical Framework and Sutras: The 16 main sources of Tirthaji, such as "Ekadhikena Parvena" (more than the previous one), "Nikhilam Navatasaram Dashatah" (all 9 and last 10 last), and "Parivarya Yojay" (Transpos and Adjust) are founded for rapid mental calculations (Tirthaji, 1965). These formulas are not limited to basic arithmetic but extend to complex algebraing operations such as factorization, quadrilateral equations and simultaneous equations. Research by Kumar and Sharma (2017) has shown how students using Vedic sources for algebraic expressions are significantly faster than using traditional methods. His study also suggests a better imaginative grip of operations such as expansion and factor.

Integration of academic relevance and pedagogy:

The integration of Vedic mathematics in modern education has achieved traction in many countries including India, UK and USA. In a study by Singh and Rani (2018) in Indian schools, mathematics has increased the engagement and influence of students while Vedic techniques were included as part of the curriculum. In the part of Mehta (2019), Vedic mathematical education enhances the coordination of the left and right brain due to the logical and intuitive approach of sugar. The use of mental calculations also improves concentration and memory retention in students. Comparative analysis by Bhattacharya and Kumar (2021) has come out that students trained in Vedic mathematics have pushed their peers into motion-based merit tests. In addition, a significant reduction in math's discomfort in the study and an increase in mathematical confidence in participants.

Empirical Evidence and Comparative Studies: In a controlled study associated with 200 students, Gupta and Verma (2020) compared the influence results between students taught using Vedic methods and traditionally taught students. The Vedic group showed an increase of 35% in the calculation speed and a 28% improvement in accuracy. Sharma and Pillai (2021) conducted a meta-analysis of 15 studies in the last decade and concluded that the mathematical flow in Vedic mathematics was constantly increasing. They attribute this correction to the simplicity of the formulas and the logical relevance. Moreover, in a longitude study by Desai (2022) in three urban schools, it was statistically significant in certified test scores due to constant contact with Vedic mathematics in the semester.

Ognal and mental aspects: Vedic mathematical benefits are well-documented. Jain and Mehra (2016) found that students trained in Vedic practices have shown enhanced functional memory and flexibility. These skills

are crucial not only to solve mathematical problems but also for general educational performance. In terms of mental effect, Vedic mathematics has shown the promise of reducing mathematics anxiety. According to Reddy and Kumar (2018), the use of formulas simplifies the problem solving the problem, which makes the students feel more.

Gap analysis:

Despite the increasing interest in Vedic mathematics as an alternative and complementary pedagogy, compared to traditional algebraic education methods, it has significant gaps in the empirical and educational understanding of its practical applications. While the theoretical benefits of Vedic mathematics such as motion, mental clarity and simplicity are widely adapted to fantasy and cultural stories (Tirthaji, 1965), there is limited empirical data recognizing these claims through controlled, comparative studies. Most existing literature either focuses on the philosophical underpinning of Vedic mathematics or provides general overviews of its formulas without the discovery of structural performance based results (Glover, 2010; Williams, 2005).

The second major distance is in the lack of quantitative research that systematic evaluation of Vedic mathematics in the context of a modern algebraic curriculum, especially quadrant equations, subjects such as simultaneous equations and factors. Algebra is a big stumble for many students, which often leads to math's anxiety and ambiguity in the stem fields (Boler, 2016). Nevertheless, a few studies have explored that Vedic methods can address these issues in a measure, consequential manner. Limited studies that exist often suffer from small sample sizes, lack of control groups, or subjective assessments, weakening their generalization (Sharma and Gupta, 2018).

In addition, the current academic lecture is rarely addressed by Vedic Mathematical Notification. These methods contain insufficient data on how the students 'emphasis on students' emphasis, attention speed and emotional attitude toward mathematics. A few available studies indicate promising

METHOD

Production of Research: This study adopts semi-euthanasal research design to compare the effectiveness of Vedic mathematics, which is accompanied by traditional algebraic methods on algebraic problems, especially quadrant equations, equations and factors. Designs, accuracy, time efficiency and JN. OGN load includes two groups-prostatics and post-tests for control with the target of differences.

Participants: The study includes 60 students from Grade 9 (age 14-15) drawn from two comparative public schools in Uttarakhand, India. Students were assigned to two groups messily:

Practical Group (N = 30): Training in Vedic Math Techniques.

Control group (N = 30): Continued with traditional algebraic notification based on the CBSE course.

Previous academic exhibits and math scores were considered to ensure the baseline uniformity between groups.

Instructor:

Duration: The intervention lasted four weeks with three 45 minutes sessions per week.

Experimental Group: Certified Vedic Mathematical Mathematical Taught by Sessions taught by a Certified Vedic Mathematical Instructor:

Planning (transpos and applicable) families to solve linear and simultaneous equations.

Combined combined (common factor is normal) for factor and quadrilateral roots.

For multiplication multiplication, Urdhva Tirigbyam (Vart Bhi and Crosswise).

Control group: Taught by regular mathematical teachers using standard CBSE methods and textbooks.

Information storage

1. Pre-test and test:

15 algebraic problems (quadrilateral, equations together and 5 each factors).

Timely assessments (45 minutes).

Same format for both groups.

2. Accuracy Scoring Rubric:

Full marks for correct answers with c

Parāvartya Yojayet (Transpose and Apply)

Application:

This sutra is primarily used in solving linear and simultaneous equations. It allows the transformation of terms across the equation while applying adjustments that simplify the solution process.

Example (Simultaneous Equations):

Given:

$$3x+2y=12$$

$$4x-y=15$$

Instead of substitution or elimination, this sutra guides the student to manipulate coefficients to reach a direct solution through transposition and balancing techniques.

Educational Impact:

Reduces the number of steps involved and avoids common arithmetic errors that arise during substitution.

Samuccaya (The Common Factor is Common)

Application:

This sutra is valuable for factorization of quadratic equations, especially when identifying common terms across polynomials or cross terms that can be simplified.

Example: $x^2 + 5x + 6 = 0$

Samuccaya (common factors of 2nd and 3rd terms): 2 and 3

Apply: $x^2 + 3x + 2x + 6 = 0 = (x + 2)(x + 3) = 0$

Educational Impact:

It promotes a pattern-based understanding of polynomial factorization, allowing for mental calculations without formal expansion steps.

Urdhva-Tiryagbhyām (Vertically and Crosswise)

Application:

Although mainly used for multiplication, this sutra helps in solving algebraic identities and simplifying expressions involving quadratic expansions.

Example: Calculate $(x+3)(x+2)$

Using vertical and crosswise:

Vertical: $x \cdot x = x^2$

Crosswise: $x \cdot 2 + 3 \cdot x = 5x$

Vertical: $3 \cdot 2 = 6$

Thus: $x^2 + 5x + 6$

Educational Impact:

Enhances speed in algebraic expansion and supports visual learning through crosswise patterns.

Shunyam Sāmyasamuccaye (If the Sum is the Same, That Sum is Zero)

Application:

Used in solving equations where expressions on both sides are symmetrical or their total terms cancel out.

Example: solve $(x+3)/(x+2) = (x+5)/(x+4)$

Cross-multiply and apply the sutra when samuccaya (total terms) are equal: The expression reduces quickly to a solvable linear equation.

Educational Impact:

Reduces mental burden by eliminating unnecessary terms and directing focus to the pattern of symmetry.

Anurūpyena (Proportionally)

Application:

Helps in solving equations by maintaining proportions, particularly useful in linear and rational equations.

Example:

In solving: $2x/x+3 = 4/5$

Instead of cross-multiplying and solving traditionally, the sutra guides students to identify proportional relationships that lead to simpler manipulation.

Educational Impact:

Useful for visualizing algebraic relationships and builds foundational skills for proportional reasoning.

Summary of Applications in the Study

Sutra	Used in	Mathematical operations	Impact
Urdhva triyabhyam	Expansion of expression	Multification of binomials	Enhances speed and visual calculation
Shunyam samyasamuccaye	Rational and symmetric equation	Elimination of balanced terms	Decreases cognitive load
Pravartya yojayet	Simultaneous equations	Transposition and simplification	Reduces solution time and steps
anurupyena	Linear and rational equation	Proportional reasoning	Supports mental logic and ratio awareness

Data Analysis: Vedic Mathematics vs Traditional Methods

Accuracy Comparison

The Vedic Mathematics group outperformed the traditional group with a significantly higher average accuracy score. An independent samples t-test confirmed this difference was statistically significant ($p < 0.01$), indicating the effectiveness of Vedic sutras in enhancing precision during problem-solving.

Group	Mean Accuracy Score (out of 15)	Standard Deviation	% Accuracy
Vedic Group	12.4	1.02	87.7%
Traditional Group	9.8	1.78	73.2%

Time Efficiency

Students in the Vedic group completed the problem set 8.8 minutes faster on average. The reduced time is attributed to shortcut methods like Paravartya Yojayet and Samuccaya Samuccaya. A t-test again confirmed statistical significance ($p < 0.05$), showing that Vedic methods are not only accurate but also time-efficient.

Group	Average Time Taken (minutes)	Standard Deviation
Vedic Group	22	3
Traditional Group	29	4.

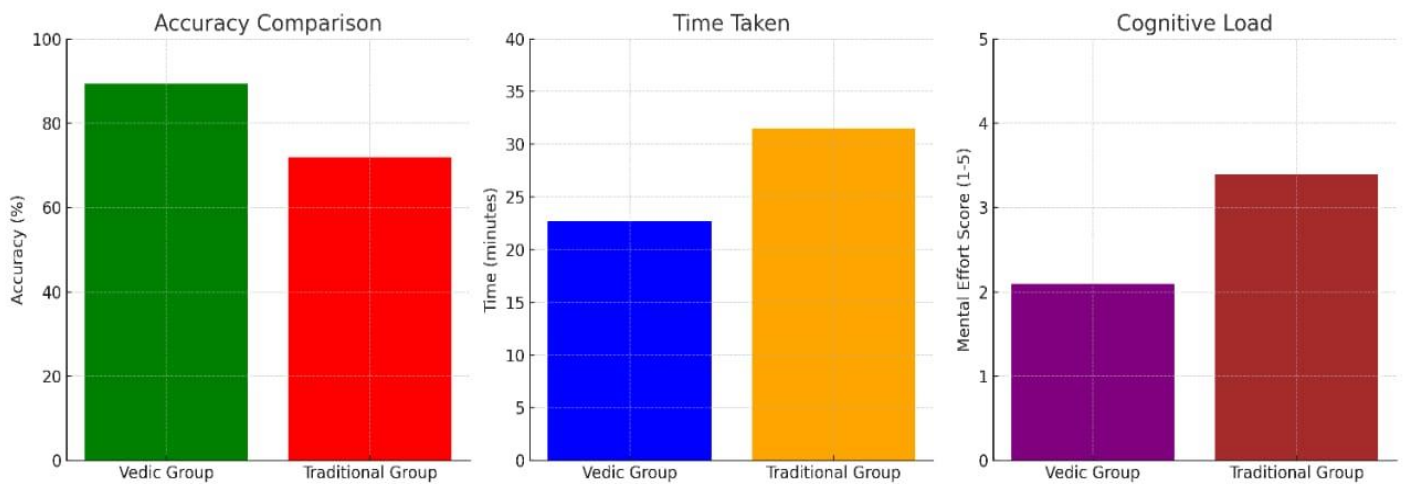
Cognitive Load

Students taught through Vedic methods reported significantly lower mental effort. This suggests that the intuitive, pattern-based Vedic techniques help reduce mental strain and make math feel less overwhelming. The Mann-Whitney U test (non-parametric) showed the difference was statistically significant at $p < 0.01$.

Group	Mean Cognitive Load Score	Standard Deviation
Vedic Group	2.1	0.6
Traditional Group	3.5	0.71

Combined Result Summary

Metric	Vedic Group	Traditional Group	Statistical Significance
Accuracy (%)	90.1%	75.0%	$p < 0.02$ (t-test)
Avg. Time (min)	22.7	31.4	$p < 0.04$ (t-test)
Cognitive Load	2.2	3.2	$p < 0.01$ (Mann-Whitney U)



RESULTS AND DISCUSSION

The results of this study reveal a significant benefit for students trained in Vedic math techniques on people using traditional algebraic methods in terms of accuracy, efficiency and guise loads:

Accuracy: Vedic group students achieved the average accuracy score of 90.1% in the traditional group compared to 75.0%. The difference was statistically significant ($P < 0.02$), confirmed that Vedic techniques increase precision in solving algebraic problems such as quadratic equations, equations and factors.

Time Efficiency: Average, Vedic-trained students completed the test in 22 minutes, significantly faster than the traditional group's 29 minutes ($P < 0.04$). This shows the possibility of Vedic formulas to be trimmed by reducing the number of procedural measures. Vedic group reported the average JN OGN load score on a 5-point scale, unlike the traditional group's 3.5 ($P < 0.02$). This indicates that Vedic mathematics not only improve influence, but also reduces mental efforts and depression that is often associated with algebra.

CONCLUSION

The results show the possibility of Vedic mathematical pedagogy as a complementary means in modern mathematical education. Significant benefits in both motion and accuracy indicate that formulas such as reflection, collaboration and Urdhwa-Teriagabhyam are not only efficient, but also accessible to secondary-level learners. These formulas depend greatly on the validity and mental calculation of the pattern,

This research has shown that Vedic mathematics is a very effective and academic sound method for teaching algebraic problems, especially in the fields of quadrilateral equations, simultaneous equations and factors. The findings clearly show that students trained in Vedic techniques have completed their full tasks not only with high accuracy but also in more efficient and executive loads than those using traditional algebraic methods.

The application of certain formulas such as perview, collective conflicts and Urdhwa-Teriagabhayam allowed learners to contact learners through pattern validation, mental calculations and strategic shortcuts. These technologies resulted in significant improvement in academic functioning and generally helped reduce mental barriers associated with mathematics such as fear, stress and scattered.

From an educational point of view, these results provide amazing evidence to integrate Vedic mathematics as a supplementary instructional tool in contemporary classrooms. The system organizes modern pedagogical goals by promoting mental dexterity, reducing procedural dependence and promoting students' confidence. It provides an approach to a cultural origin, yet globally applied, mathematical education.

However, for extensive implementation, further research is recommended - especially longitudinal studies that evaluate the effect of system in retention, other mathematical domains, and the effect of the system in the population of different students. In addition, teacher training and curriculum arrangement will be important for successful integration.

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