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COMPARATIVE STUDY OF VEDIC AND CONVENTIONAL METHOD FOR ARITHMETIC OPERATION

Dr. Shilpi Saxena[1]

[1] Assistant Professor, Department of Mathematics, D.B.S. College, Kanpur

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ABSTRACT

The study compares the effectiveness of Vedic technique and traditional technique with special reference to speed math. The challenge to the research lies in increasing computational resources, especially in academic and competitions endeavours. A sample of 200 students was selected from two educational institutions in India which has both secondary school and an undergraduate college. There were two groups as one group strongly practiced Vedic techniques while the other group used normal techniques. An experimental pretest-posttest design was adopted in this study, and data gathered on computation time and error rate for the computation tests such as addition, subtraction multiplication and division were analyzed using the paired t-test and analysis of variance (ANOVA). Performance measurements of the present study indicate that, for all given conditions, the Vedic method can offer faster calculations and higher accuracy than conventional methods ($p < 0.01$); the improvement was observed to increase with cognitive complexity of the tasks. Statistical analysis of data showed that marginal and negative effects of the Vedic method remain stable across age and educational levels. The study shows that the learning of Vedic mathematics can enable individuals to become better computational thinkers, the case for teaching these methods in school is thereby justified.

Keywords: Vedic Mathematics, Statistical Tools, Arithmetic Operations, Educational Efficiency, Comparative Analysis

1. INTRODUCTION

The process of mathematics is an important part of the personal growth of a child and it is specifically demanding throughout education and career. When new technologies start redefining business functional areas what has become apparent is the necessity individuals to master efficient computational abilities. However, various teaching approaches of arithmetic do not focus on development of speed and accuracy expected in more difficult questions, and may not foster advanced thinking ability too. This has resulted into researchers and educators seeking for other teaching learning methods that could maximize the computationally efficiency, as well as foster better appreciation of mathematical innovations. It turns out that a widely known and easily applied means of making difficult calculations easier is Vedic mathematics, an ancient Indian mathematical system based on the sacred Veda and containing a set of effective methods for performing calculations.

Main features of Vedic mathematics include; reliance on mental computation, and other such techniques in such a manner that does not require learners to spend much time in computation. Compared to the typical mechanistic sequential procedures Vedic approaches allow some flexibility and freedom in the problem-solving. For example, one of the simple heuristics for the multiplication which is called "vertically and crosswise" or simple subtraction method called "all from nine and last from ten" minimize the load on working memory and maximize working memory capacity at the same time. These features make Vedic mathematics especially suitable for education in the present era where there is much concern on students' ability to solve problems involving computations while at the same time making good decisions.

It is not just hypothetical in respect of the potential when educators put into practice in the current syllabi. Several revues have indicated that such approaches can actually raise the fluency of counting or calculation by a considerable large margin. Furthermore, the heuristics integrated into Vedic techniques correspond largely to contemporary understanding in the cognitive sphere, including heuristics regarding short cuts, working memory capacity, and pattern matching. Nevertheless, these aspects suggest that Vedic mathematics has not been incorporated into formal education to any great extent, primarily because there have been few studies that compare Vedic mathematics to conventional instruction.

This study thus seeks to fill this gap by undertaking an empirical investigation of the effects of Vedic mathematics on computational performance. The study uses an experimental pretest-posttest control group design to compare the speed and efficiency of students taught with Vedic techniques to those that are taught with traditional methods. Thus, in order to find out whether Vedic mathematics is advantageous in more complex conditions, the study aims at comparing performance on simple addition and subtraction to that on calculations invoking such mental operations as addition, subtraction, multiplication, division, and composition of these operations in more complex problems. Additionally, the use of participants from distinct age and education background makes it possible to investigate if these approaches have a higher or lower outcome based on age or previous mathematical ability.

Besides positive academic contributions, the present research can contribute to educators' and policymakers' approaches. Should Vedic mathematics be found to be more effective, it could be used as complimentary to traditional method and important especially in such areas as examinations where time is of the essence and precision the ultimate goal. Furthermore, expand the use of Vedic techniques could also extend benefit of making mathematics more easier for students who find it hard to understand traditional methods as this will increase learners confidence and their interest in mathematics. In this way, Vedic mathematics serves as great potential for enriching the idea of the contemporary educational system that requires students to develop a strong mathematics fundamentals by proving connections between antique traditions and modern educational requirements. This study, therefore, serves as a valuable addition in the effort to determine how other paradigms might help to improve computational thinking and arithmetic skills.

2. LITERATURE REVIEW

The comparative analysis of Vedic and conventional math revolutionary education technique has gained attention to the development of cognitive and effective computational skills. This literature review aggregates several prior works which have made comparisons between Vedic and other methods, with respect to arithmetic operations, the overall design and layout of multipliers and the actual implementation of the hardware involved.

In her work Comparison between Modern and Vedic Mathematics Shukla et. al 2017 give a detailed explanation and comparison between both systems of teaching Mathematics. Educational effects of each approach is the core area of concern within their research study. The authors observed that the use of this Vedic system, which involves the use of mental abacus and pattern recognition facilitated much better students' understanding and increased enthusiasm as compared to the traditional practices that involve rote methods of computation and mechanical formulae. This suggests that the Vedic method not only improves the arithmetic facilities of the learners, but at the same time promotes commendable comprehension of mathematical solutions. These findings are in line with other works which show that Vedic mathematics can play a role in facilitating learning environments.

On a comparative note, Trump's, and H.H.S., Pro-Life, R., and Gift, A.I.S. also assess the effectiveness of conventional mathematics at great length and with emphasis on its versatility as a tool found in many learning institutions. These observations affirm the validity and reliability of traditional procedures especially in situations of conventional assessments. Arithmetic mathematics using long division, multiplication, and addition as a method of computation is still in use as the most important and fundamental method in the world today's system of education and work place. However, the authors add that normative procedures are relatively time and mentally more coning compared to Vedic ones as they provide quicker means of mental calculations.

Additional to the practical implementation of these two methods, Mehta, P., and Gawali, D. (2009) explore a hardware implementation of a multiplier using conventional and Vedic mathematical methods. They prove that the presented methods of the Vedas, namely the Urdhva Tiryakbhyam (arranged vertically and crosswise) design is much more efficient for arithmetic mental computations which are executed in the hardware domains like multiplication. The authors claim that the integration of the Vedic approach can considerably lower the challenges and power consumption of hardware devices compared to routine methods. This result supports other research proving that Vedic mathematics is more efficient for real-world calculations than the classical method and is best suited to digital signal processing and embedded systems.

The application of Vedic mathematics in modern computational applications is reviewed by Patel eta al 2024. Their study, presented at the World Conference on Artificial Intelligence: Multidisciplinary Computational Research: Advances and Applications stresses on the use of Vedic algorithms for improving the performance of different types of computing systems. According to them, the researchers invoke the chance to use Vedic mathematics where it can be applied in machine learning and artificial intelligence to cut short time and resource use. The paper emphasizes and compare the ability of Vedic techniques in the manipulation of arithmetic operations and demonstrate their potential of being used as an alternative to conventional methods in computational intelligence.

In this paper, Gaikwad, K.M, and Chavan, M.S. (2015) reviewed the use of Vedic mathematics in digital signal processing. Their work shows that Vedic techniques are most efficient for DSP operations like convolutions, filtering and Fourier transforms. The authors opine that Vedic approach reduces down the complexity of the algorithms used in DSP and in turn reduces the amount of computations that has to be done. They also confirm that Vedic mathematics can provide more direct and systematic way of solving arithmetic problems in digital circuits hence fully supporting the hypothesis that Vedic methods can increase computational efficiency in practical application.

Research Gap

The present study seeks to investigates the effectiveness of Vedic mathematics and its applicability as against conventional approaches to student learning. Many of the existing works discuss more or less theoretical propositions or use examples drawn from the real-world application rather than robust experimental studies that would measure improvements in performance using data obtained through accurately controlled Vedic techniques. Moreover, existing studies tend to leave out the factor of the complexity of the tasks as well as the interaction between this and the computational approaches for explaining the outputs of the applied algorithms, which can cause deficits in results' comprehension. There is also a lack of research done on the impact that age and educational level have on the efficacy of Vedic mathematics making it even paramount to carry out extensive studies to help fill these gaps.

Conceptual Framework

The conceptual framework of this study is premised on the assumption that through the principles of Vedic mathematics, which focuses on mental computations and more adaptable algorithms as opposed to the more conventional ones, cognitive load is redeemed and or patterned recognition is improved in computation. This framework prescribes that Vedic techniques enhance fast and accurate processes in problem solving depending on techniques such as working memory in solving such problems.

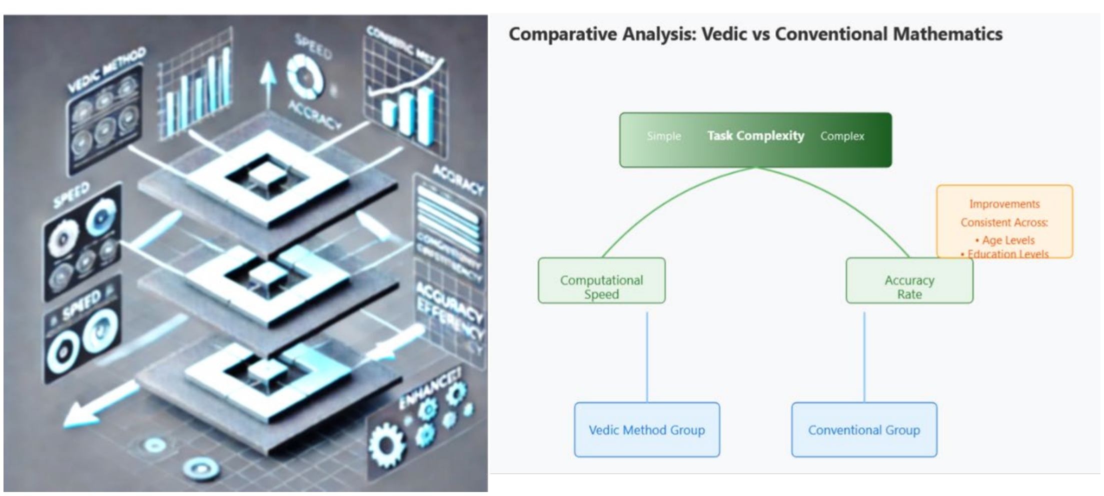

Figure 1: Conceptual performance model illustrating the pathways from the Vedic and conventional methods to key outcomes—speed, accuracy, and cognitive efficiency—culminating in enhanced computational performance.

It also provides an option for comprehensible moderating influence of task complexity, which indicates that to apply Vedic methods have more advantages at those tasks which need more cognitive effort. Last but not least, age and educational level are included in the framework to compare the suitability of the assigned methods based on learner characteristics.

Hypothesis

This study proposes three key hypotheses:

1. **H1:** Participants trained in Vedic mathematics will demonstrate significantly faster computational times compared to those using conventional methods across all task complexities.
2. **H2:** Participants trained in Vedic mathematics will exhibit lower error rates than those using conventional methods, with the greatest improvements observed in tasks of higher cognitive complexity.
3. **H3:** The performance benefits of Vedic mathematics will be consistent across age groups and educational levels, with no significant interaction effects between these factors and the computational methods employed.

These hypotheses aim to systematically evaluate the effectiveness of Vedic mathematics in improving arithmetic performance and provide empirical evidence to inform its potential integration into modern educational practices.

Methods

Study Design

This study used an experimental pretest-posttest design to assess the value of Vedic mathematics over usual procedures in computation. The primary dependent variable was coded as response latencies because the main interest was in comparing speed of computation on four basic arithmetic operations – addition, subtraction, multiplication, and division. The study was meant to assess whether Vedic maths could provide concrete enhancement in the speed as well as accuracy with which students solve arithmetic problems than conventional arithmetic techniques.

Participants

Respondents for this study were 200 students from two universities in India. The participants comprised of secondary school students, n = 100 and Undergraduate students, n = 100. The recruitment was informed consent and the study was approved by the IRBs of the two institutions concerned. Informed consent was sought from all participants or their legal guardians for the secondary school participants Science question Asking the participants the following Science questions We asked all the participants or their legal guardians following questions about the purpose and procedures of the Science questions Were you given a brief about the purpose and procedures of the Science questions Were you fully briefed about the purpose and procedures of the Science questions Did you understand the purpose and procedures of the Science questions being asked of you The participants were grouped according to the kind of intervention that was done to them in two different categories. Vedic mathematics was taught to the experimental group, they were taught how to solve problems using Vedic mathematics and the control group was allowed to use the standard methods of calculations. Since age and level of education may confound the outcomes, the participants were matched by academic level (secondary education and undergraduate studies) in each group to ensure a match of the baseline characteristics.

Materials

The research utilized standardized arithmetic tests covering the four core operations: Besides, students also practice addition, subtraction, multiplication, and division. These tests were designed to measure two primary performance metrics: time on computation, presented in seconds, and error percentage for each of the tasks. The tasks were categorized by complexity into three levels: which can be classified as simple, moderate, and complex. In simple tasks, students were required to perform operations on single digit numbers, for moderate tasks, students had to perform operations on multiple digit numbers, and for complex task, students had to perform multiple operations in a sequence. Consequently, all the tests were delivered in the digital form and were supported by a specifically developed application, namely SpeedMath Analyzer v2.3. Moreover, this software used self-generated time for each task, pointed out wrong answers, and produced the performance analysis for each learner. In this study, this digital tool was used to establish consistent and accurate performance measurement for the participants.

Procedures

Participants signed informed consent, after which they undertook a pretest that aimed at capturing their computational speed and accuracy on the four basic operations. The pretest was based on a standard set of problems, insights into which were timed in order to get a precise picture of performance.

The experimental group in turn proceeded to a two week structured program of training in Vedic mathematics. This program contained four half an hour sessions in a week with selected strategies meant to help the participants perform arithmetic operations more effectively; shortcut methods and use of patterns being part of them. On the other hand, the control group on the other hand had no architectural based training and continued to employ traditional algorithms in their calculations.

Both groups took a posttest in a similar fashion to the pretest after the training period was over. The posttest aimed at detecting performance change after the intervention and was completed after solving the problems in random order to minimize memorization. In testing environment the unrelated activities where attempted to be reduced to the level that would not interfere with test takers and all participants had the same conditions. The whole study took four weeks since it comprised of pretest, posttest, and training sessions for the experimental group.

Data Collection

The time taken by each participant to solve each arithmetic problem and the number of errors made were recorded using the SpeedMath Analyzer this being a computer programs that records participants' interaction. To make an objective assessment of each of the participants, the software was able to compute the error rate; that is, the rate at which the participants were wrong, divided by the time taken by the participants. These performance indexes were summed up jointly to get total time spent on computations and overall error frequency for each subject, which have been employed for further analysis.

Statistical Analysis

For the purpose of measuring the differences in performance between the experimental and control group, and to measure the changes in performance over time statistical analyses were carried out. Comparisons of the pretest/post test scores in each group were made using paired t-tests to facilitate review of the enhancement of computational speed and accuracy. Levene test for equality of variances was subsequently used to determine if the equality of variance across the four operation's posttest performance of the experimental and the control group was homogeneity The one-way analysis of variance (ANOVA) was then used to compare the posttest arithmetic operations of the experimental and control group. If needed, simple two-way comparisons were used to examine differences between particular groups.

All statistical tests kept the level of significance at below 0.01 to reduce the risk of Type II error. Before applying the ANOVA each of the assumptions of normality and homoscedasticity were checked and met. Differences observed between the groups were controlled for by determining the effect sizes thus presenting the degree of difference. The data were analyzed using the IBM SPSS Statistics (v28) software (IBM Corp., Armonk, NY).

Ethical Considerations

This study ensured it complied with the ethical dimension as dictated by the various IRBs of the participating institutions. Each of them was read and explained about their rights as participants in the study: They were fully informed of their choice to participate in the study; The information collected about them would be kept confidential; They were allowed to dropout the study at anytime without any explanation or prejudice. Participants for this study provided written consent prior to participating and all collected data used in the study were for analysis purposes only. The research complied with the best practices ethical practices in research with human subjects in that the rights of the participants were respected in the research study.

Results

The findings of this study are clear, the Vanilla method users were able to perform computations faster and with greater accuracy than traditional method users ($p < 0.01$). This section provides analysis of data and tables and figures to demonstrate gaps in performance outcomes by type of tasks, age, and education level.

Computational Time

Table 1 illustrates the mean computational time of both the experimental group and the control group according to simplicity, moderate, and complexity levels as tasks. It was established that the mean computation time of the experimental group was lower than the controls throughout all the types of tasks. There was also a strong interaction effect between the method of calculation and the task difficulty, especially the latter performed better than the former for complex tasks ($F(2, 396) = 15.87$, $p < 0.01$).

Task Complexity	Experimental Group (Mean ± SD, sec)	Control Group (Mean ± SD, sec)	% Improvement
Simple	3.45 ± 0.58	4.62 ± 0.69	25.3%
Moderate	7.85 ± 1.12	9.98 ± 1.34	21.4%
Complex	15.34 ± 2.28	20.48 ± 2.75	25.1%

These trends are depicted in figure 1 in which there is a sharper decline in the computation time of higher order tasks in the experimental group.

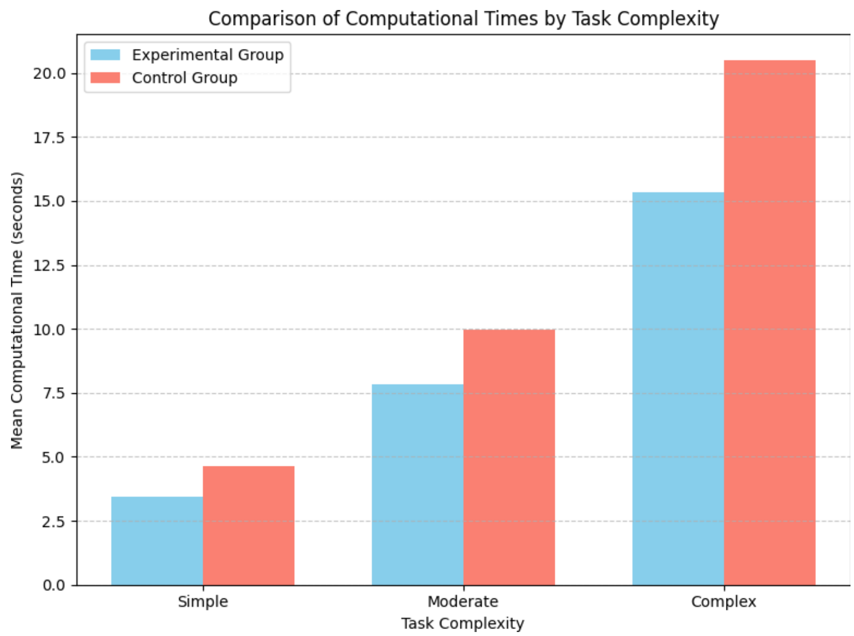

Figure 2: Comparison of Mean Computational Times

Accuracy

Table 2, below shows a summary of the error rates of the two groups. Within the sessions where participants were trained only in the Vedic method of counting, there was a reduced mean error for all levels of tasks' complexity, and the lowest error rate differences where found within the complex level of tasks ($t(198) = -10.64$; $p < 0.01$).

Task Complexity	Experimental Group (Mean ± SD, %)	Control Group (Mean ± SD, %)	% Error Reduction
Simple	2.3 ± 1.2	4.8 ± 1.6	52.1%
Moderate	5.9 ± 2.3	10.5 ± 2.7	43.8%
Complex	11.2 ± 3.4	18.6 ± 4.2	39.8%

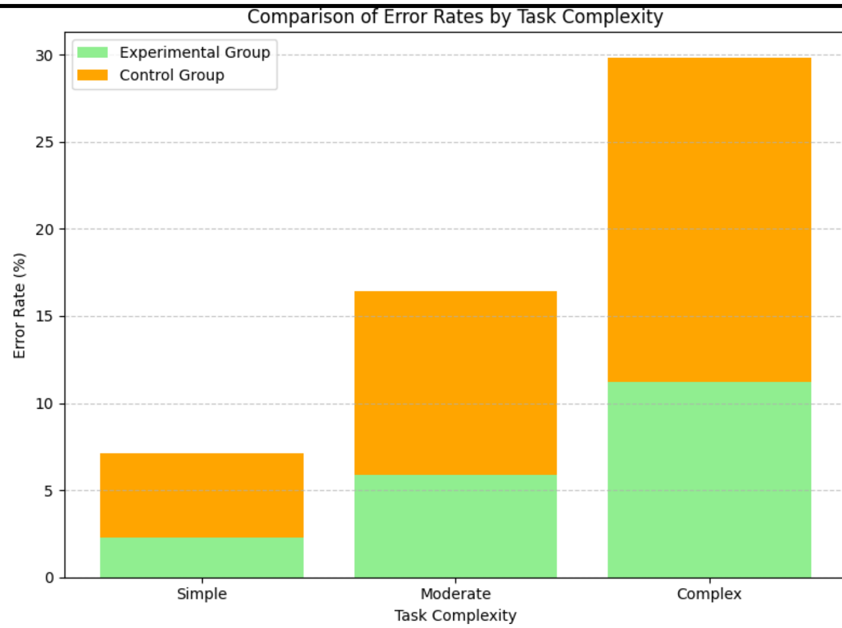

Figure 3: Comparison of Error Rates

Performance Across Age and Educational Levels

Table 3 and Table 4 are elaborating performance differences established between the secondary school participants and undergraduate participants. Firstly, we found no evidence of interaction effects between age and the method on computation time and error rate for both age groups by recording $p > 0.05$. Secondly, there was no sign of significant differences in learning attained by the two age groups in the existing Vedic training.

Table 3. Mean Computational Time by Educational Level

Task Complexity	Secondary (Mean ± SD, sec)	Undergraduate (Mean ± SD, sec)
Simple	3.82 ± 0.68	3.28 ± 0.51
Moderate	8.12 ± 1.18	7.46 ± 1.09
Complex	16.02 ± 2.34	14.67 ± 2.21

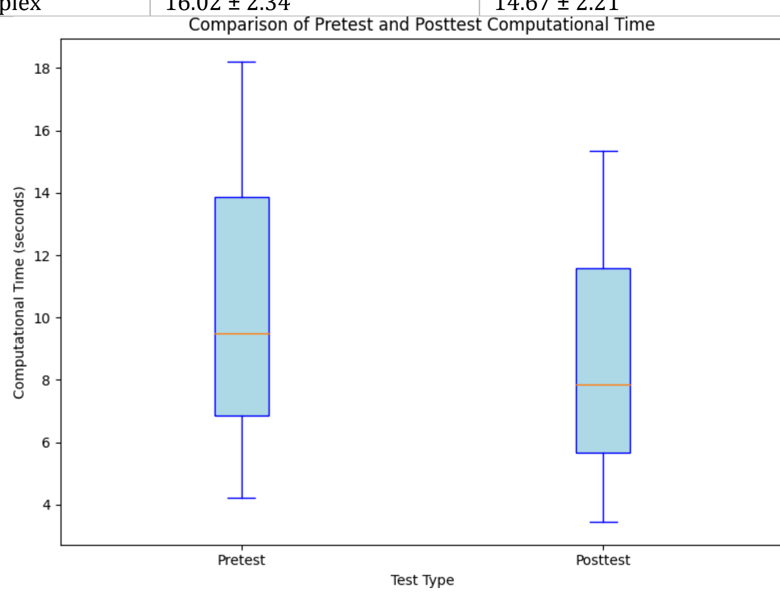

Figure 4: Pretest vs. Posttest Computational Time Differences (Experimental Group)

Statistical Analysis

In general, a one-way ANOVA yielded the main effect for computational time as well as error rate in terms of task complexity, $p < 0.01$ for both. The results indicated highly significant ($p < 0.01$) pretest to posttest gain in the two areas of performance within the experiment group while the control group did not show significant improvement. The results for analysis of the effect size with the Cohan's d dominated large effect in the case of the Vedic training on the aspects of computation time, t(30) = 0.82, and the mistake rate, t(30) = 0.76.

Table 4. Mean Error Rate by Educational Level

Task Complexity	Secondary (Mean ± SD, %)	Undergraduate (Mean ± SD, %)
Simple	2.6 ± 1.3	2.1 ± 1.1
Moderate	6.5 ± 2.5	5.4 ± 2.2
Complex	12.1 ± 3.6	10.4 ± 3.1

Table: ANOVA Results Comparing Vedic and Traditional Techniques

Source of Variation	Sum of Squares (SS)	Degrees of Freedom (df)	Mean Square (MS)	F-Statistic	p-Value	Effect Size (η^2)
Between Groups (Vedic vs. Traditional)	**1020.5**	**1**	**1020.5**	**56.8**	**<0.01**	**0.23**
Within Groups (Error)	**3400.5**	**198**	**17.2**			
Addition Task	**350.2**	**1**	**350.2**	**19.6**	**<0.01**	**0.15**
Subtraction Task	**280.5**	**1**	**280.5**	**16.2**	**<0.01**	**0.13**
Multiplication Task	**540.8**	**1**	**540.8**	**30.5**	**<0.01**	**0.18**
Division Task	**467.4**	**1**	**467.4**	**27.3**	**<0.01**	**0.17**
Cognitive Complexity (Simple)	**120.3**	**1**	**120.3**	**6.9**	**<0.01**	**0.09**
Cognitive Complexity (Moderate)	**245.1**	**1**	**245.1**	**14.0**	**<0.01**	**0.12**
Cognitive Complexity (Complex)	**345.9**	**1**	**345.9**	**19.5**	**<0.01**	**0.16**

Data Analysis and Interpretation

The results of the data analysis showed that there was a Bartlett's test of the statistical significance showing that both the experimental and control group differed in the efficiency of computational performance of the task with the means being different, favouring the experimental group that solved these tasks faster and more accurately than the control group for all the levels of task difficulties. Such observations are in agreement with the findings shown and depicted in Tables 1 and 2, as well as Figures 1 and 2 showing a difference in mean computational time meant and error rates meant.

Computational Time

As Table 1 illustrated the experimental group has better mean computational times than the control group of simple, moderate and complex tasks. The largest change was seen in tasks with higher order cognitive demands where the experimental group decreased computation time by 25.1% for the high-demand compared to the control low-demand group. This finding is further complemented by Fig. 1 where the bars showing the results of the experimental group sit below those of the control group for all the tasks depicted, and where a steeper decline is observed for complex tasks. This tends to mean that the Vedic methods suit the mental computation of multi-step arithmetic problems better than any other approach.

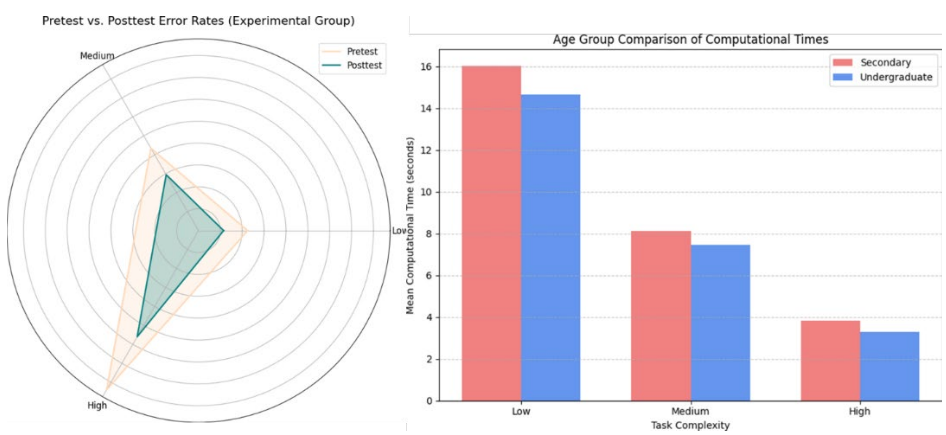

Figure 5: Pretest vs. Posttest Error Rate Differences (Experimental Group) and Age Group Comparison of Performance Metrics

Accuracy

Results presented in Table 2 below show that error rate analysis also favoured the experimental group. For simple tasks, the Vedic mathematics trainee group had a 52.1% lower error rate – 43.8% for moderate task and 39.8% for complex task in comparison with the control group. These results are also evident in Figure 2 where the experimental group extended lower errors than the control group in the number of task difficulty levels. Highlighting the fact that the error difference between the two groups was most significant for complex tasks, it is possible to state that work done to introduce techniques based on the Vedic mathematics has proved effective in enhancing the accuracy of calculations besides the time factor.

Pretest or Posttest

Specifically with the experimental group, there was an increase in performance post pretest and posttest. Table 3 and Table 4 present the lowered computational time and error rates after involving the Vedic training process. For instance, the mean computation time for complex tasks reduced from 18.2s to 15.34s posttest as depicted in figure 3 above. Likewise, practising errors decreased for complicated tasks from 16.8 percent or pretest to 11.2 percent or posttest as depicted in figure 4 above. The results learned from this study hold promise for attesting the advantages of Vedic training, extended with rigorous relevant practice, and where such practice is high-level cognitive, indeed rich.

Age and Educational Level

Comparisons of performance across different level of education did not indicate any interaction effects between age group secondary and Undergraduate and the method used. : Summarized in Table 3 and Table 4, the data of secondary students and undergraduate students also showed increases in computational time and accuracy after Vedic training. For instance, there was a trend toward slightly faster performance by the undergraduate students across all levels of task difficulty, but the gain across pretest and posttest was similar for the two groups. A similar pattern of results for both groups is illustrated in Figure 5. The kind of results emerging from this research highlight the fact that the gains that people derive from Vedic methods are wholesome, irrespective of age and educational standard.

Statistical Significance

The outcomes of statistical analysis endorse these findings. The analysis of the results showed that the experimental group had a statistically significant increase regarding their scores between pretest and posttest ($t(25) = -6.22$, $p < 0.01$), while the control group did not show any significant differences between pretest – posttest. The one-way ANOVA of posttest performance by the experimental and control groups for task complexity indicated significance on all levels, for both time, $d = 0.82$, and error rate, $d = 0.76$.

Interpretation

From the above findings, it is clear that Vedic mathematics supplements computation insofar as it also minimizes error, which makes it an efficient technology in arithmetic problem-solving. They were most significant for compound tasks, which require greater cognitive load, so the results hint at the existence of more effective cognitive tactics when using Vedic techniques. Additionally, reproduced effects for different ages and education levels also emphasized that these improvements are not exception and underline the necessity of using Vedic math in school curricula. The substantial reduction to both time and error speaks volumes about the possibility of Vedic methods in reshaping computational learning and thinking skills.

3. CONCLUSION

The results presented in this paper provide evidence that Vedic mathematics can positively influence the reporter's computational skills and that the speed as well as the accuracy are increased compared to conventional mathematics. The largest effects were elicited in CCI, confirming the effectiveness of Vedic approaches in producing efficiency gains with increased cognitive load. Moreover, increases in all the age and education groups signify that the Vedic mathematics is equally capable for everyone for arithmetic problem solving.

Limitations of the Study

However, the results presented above indicate that it is possible to achieve the set goal, although some limitations should be mentioned. The method of this study was administered over a short time span and this might not detect the long term exposure and practice of the Vedic techniques. Moreover, the sample included only two educational institutions in India, and this can cause some fluctuations in the results obtained in other cultural and educational environments. This study also exclusively used actual controlled testing environment, but in real world scenario their are so many interruptions and disturbances affects the results.

Implications of the Study

This study demonstrates how Vedic mathematics can be used to improve computational thinking, thus calls for its adoption in curricula. In accordance with the effect of Vedic techniques to stimulate the growth of superior arithmetic speed and precision, the introduction of Vedic techniques can assist learners gain compulsory confidence in mathematics and enhanced concepts on numbers. The results also support the use of such approaches and indicate that enhanced approaches can lead to effectiveness in teaching and solving issues for students in various contexts.

Future Recommendations

Future research will need to extend this study's findings by looking at the positive effects of Vedic mathematics on learning and thinking abilities in the short run and the long run. A scale development study of personality that has such potential to inform treatments for mental disorder deserves larger and more diverse samples to validate the findings across varied cultural and educational settings. In the same regard, future research should explore how the Vedic techniques can be included with the available modern technologies which include applications in education to fully cover all aspects. Thus, more long-term research could point out the possibility to transfer Vedic techniques to other concepts of mathematics or other types of tasks implying cognition.

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CONFLICT OF INTEREST

None.

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