

An Empirical Study on Role of Vedic Mathematics in Improving the Speed of Basic Mathematical Operations

K. Krishna Prasad

Srinivas Institute of Management Studies,
Pandeshwar, Mangalore - 575 001, INDIA

ABSTRACT

Vedic Mathematics is an Indian ancient system of mathematical calculations or operations techniques developed in the year of 1957 with 16-word formulae and some sub-formulae. In competitive examinations, students find difficult to solve the aptitude questions effectively with very less or small time durations. Even though students are able to understand the problem, they are not able to speedup calculation process. In this paper some basic mathematical calculations, multiplication, square root, cube root and subtraction of fractional decimal numbers are distributed to a group of 25 students, whom are competitive examination writing students and told to solve questions without and with using Vedic methods techniques. The time taken to complete the calculations are taken in terms of minutes before and after adopting Vedic method's techniques and are analyzed using paired t-test. This paper could able to find that Vedic method significantly improves the speed of calculations while performing some basic mathematical operations. Wish this paper could play an active and supportive role in actual research of Vedic mathematics and techniques to improve the speed of calculations especially while writing any competitive examinations.

Keywords: Vedic Mathematics, T-test, Quantitative aptitude.

I. Introduction:

Vedic mathematics is the name given to Indian ancient system of mathematics, or set of some precise rules with which any arithmetic, algebraic, geometry or trigonometry problems can be easily solved. The system is based on 16 Vedic sutras, which are set of word formulae describing steps or logic involved while solving whole range of mathematical problems, which are considered as very difficult or cumbersome in traditional method. Vedic mathematics was initially rediscovered from Indian scriptures between the years 1911 to

1918 and fully developed in 1957 by Jagadguru Sri Bharathi Krishna Thirthaji Maharaja, a scholar of Sanskrit, Mathematics and philosophy [1-2].

The students who faces competitive examinations like Bank Probationary officers exam, IBPS exams, FDA, SDA, Bank Clerks examinations in India finds difficulty in order to solve aptitude or reasoning problem questions. The Vedic mathematics has mainly 16 formulas which can solve some basic mathematical operations like, multiplication of 5 digit numbers, multiplication of numbers near to base, square, square root, cube, cube root, calendar problem, subtraction and division. These methods can be considered as shortcut methods and which will dramatically reduce the burden of competitive examinations reasoning problems and also students can able to solve more no of problems with in a short duration of time.

In this paper an empirical study is conducted to know whether a Vedic mathematics technique improves the speed of basic mathematical operations. A set of mathematical questions are distributed to competitive examinations writing students before and after adopting Vedic mathematics techniques. The basic mathematical operations includes square root, cube root, multiplication of 4 digit numbers, multiplication of numbers near to base, subtraction using the rule all from nine and last from ten. The time taken by the students before and after adopting Vedic methods is noted down in terms of minutes. Initially hypothesis is constructed and is evaluated as significant or not with the help of paired t-test. This paper finds that Vedic method significantly improves the speed of calculations while performing some basic mathematical operations.

II. Related research:

There is only few related study on role of Vedic Mathematics in improving speed of basic mathematical operations or calculations are available in literature. The Vedic mathematics system has become popular even outside of India. In 1981, some British mathematician like Kenneth Williams, Andrew Nicholas and Jeremy Pickles shown interest and delivered lectures on it in different places of London by extending the Bharathi Krishna Thirthaji introductory book [3]. The Vedic mathematics techniques help in rapid or fast calculations in some situations. It improves the concentration and logical thinking which are the crucial need in respect of the mathematical training of competitive examination writing students [4-5]. Vedic mathematics techniques are the one of the stream, when attaining proficiency in rapid arithmetic and aptitude or reasoning. The Trachtenberg speed arithmetic, Lester Meyers' arithmetic are some other techniques or methods also helps to improve or increase the proficiency in rapid arithmetic [6-7].

III. Vedic Mathematics Techniques used in this study:

This study considers some Vedic mathematics techniques, which includes ‘Urdhva Tiryakbhyam Sutra’ (Vertical and Crosswise), ‘Nikhilam Navatas’ Charamam Dasatah’ means all from 9 last from 10, cube root of perfect cubing, square root of perfect square, subtraction using the rule all from 9 and last from 10, Multiplication of numbers with a series of 9’s in the multiplier, multiplication of numbers with series of 1’s 9’s in the multiplier and multiplication of numbers with similar digits in the multiplier.

Urdhva Tiryakbhyam Sutra (Vertical and Crosswise): This is the general formula which is applicable to all cases of multiplication [3, 8]. The rule of multiplication for 3 digit number (708 x 908) is as follows.

| | | | |
|---------------------------------------------------------------------------|--------------------------------------|-----------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\begin{array}{r} 7 \quad 0 \quad 8 \\ 7 \quad 0 \quad 8 \end{array}$ | <p>Step 1: (8x8)</p> | $\begin{array}{r} 7 \quad 0 \quad 8 \\ 7 \quad 0 \quad 8 \end{array}$ | <p>Step 2: (8x0) + (0x8)</p> |
| $\begin{array}{r} 7 \quad 0 \quad 8 \\ 8 \quad \quad \quad 0 \end{array}$ | <p>Step 3: (7x8) + (8x7) + (0x0)</p> | $\begin{array}{r} 7 \quad 0 \quad 8 \\ 7 \quad 0 \quad 8 \end{array}$ | <p>Step 4: (7x0) + (0x7)</p> |
| $\begin{array}{r} 7 \quad 0 \quad 8 \\ 7 \quad 0 \quad 8 \end{array}$ | <p>Step 5: (7x7)</p> | <p>Final Answer =501264</p> | <p>Step 1: 64 (6 carry) = 4 Step 2: 0+6 = 6 Step 3: 112 (11 carry) = 2 Step 4: 0 + 11 (1 carry)= 1 Step 5: 49 + 1 = 50 Final Answer =501264</p> |

Nikhilam Navatas’ Charamam Dasatah’ (all from 9 last from 10): This formula can be very effectively applied in multiplication of numbers, which are nearer to bases like 10, 100, 1000 i.e., to the powers of 10. The steps are as follows.

1. Find the Base and Difference
2. Number of Digits on the RHS= Number of zeros in the base
3. Multiply the difference on the RHS
4. Put the cross answer on the LHS (subtract the cross val

$$\begin{array}{r} 97\text{----}03 \text{ (base is 100)} \\ 99\text{----}01 \\ \hline 96 \quad 03 \end{array}$$

For example- 97 x 99

Final Answer = 9603

Cube root of perfect cube:

| | |
|----|------|
| 1 | 1 |
| 2 | 8 |
| 3 | 27 |
| 4 | 64 |
| 5 | 125 |
| 6 | 216 |
| 7 | 343 |
| 8 | 512 |
| 9 | 729 |
| 10 | 1000 |

Note that all cube roots end with same number as their corresponding cubes except 3 & 7 and 8 & 2 which end with each other

The method can be explained with an example, Find the cube root of 287496

Step 1: We shall represent the number as

$$287 \mid 496 \text{ (3 digit on RHS, immaterial even though there is no digit is on LHS)}$$

Step 2: Cube root ends with 6, thus answer at this stage is ___6

Step 3: To find the left hand of answer we take number which lies left of the slash is 287

Step 4: Find the two perfect cubes between which the number 287 lies in the number line

$$(216 < 287 < 343) \text{ viz. between } 6 \text{ \& } 7$$

Step 5: Out of the above 2 numbers, take smallest one viz. 6 we write answer as 66

Thus 66 is cube root of 287496

Subtraction using the rule all from 9 and last from 10: For example subtract 459. 64 from 100000.

| |
|-----------|
| 100000.00 |
| 459.64 |
| ----- |
| 99540.36 |

Start from Left & subtract all from 9 and the last from 10

Compare last digit of the square and square Root

| | |
|---|--------|
| 1 | 1 or 9 |
| 4 | 2 or 8 |
| 9 | 3 or 7 |
| 6 | 4 or 6 |
| 5 | 5 |

Square root of perfect square:

| | |
|----|-----|
| 1 | 1 |
| 2 | 4 |
| 3 | 9 |
| 4 | 16 |
| 5 | 25 |
| 6 | 36 |
| 7 | 49 |
| 8 | 64 |
| 9 | 81 |
| 10 | 100 |

Find the square root of 7744.

Step 1: The number 7744 ends with 4. Therefore square root ends with ___2 or ___8.

Step 2: Take complete Number 7744

Step 3: 7744 lies between 6400 (which is square of 80) and 8100 (which is square of 90)

Step 4: From Step 2 we know that square root ends with 2 or 8. Of all the numbers between 80 & 90 (81, 82, 83, 84, 85, 86, 87, 88, 89). Thus out of 82 & 89 one is the correct answer

Step 5: Observe the Number (7744) is either closer to 6400 or 8400. It is closer to 8400. So Answer is 88.

Multiplication of numbers with a series of 9's in the multiplier: Multiply 6554 by 9999

| |
|----------|
| 6554 |
| 9999 |
| ----- |
| 65533446 |

Subtract 1 from 6554 and put it on left side of the answer

Subtract each of the Digits (6553) from nine i.e.. 9-6, 9-5, 9-5, 9-3

Multiplication of numbers with series of 1's in the multiplier: Multiply 21432 by 1111

| | |
|----------------------------------------------|--------|
| We write down 2 in the unit place as it is 2 | -----2 |
| Add (2+3) = 5 | -----5 |
| Add (2+3+4)= 9 | -----9 |
| Add (2+3+4+1)=10 1 carry | -----0 |
| Add (3+4+1+2) + 1carry =11 1 carry | -----1 |
| Add (4+1+2) + 1 carry = 8 | -----8 |
| Add (1+2) = 3 | -----3 |
| Write down 2 as it is = 2 | -----2 |

Final Answer is = **23810952**

Multiplication of numbers with similar digits in the multiplier: multiply 444 by 333

444 x 3 x 111
444 x 3 = 1332 x 111

We write down 2 in the unit place as it is 2 -----2
 Add (2+3) = 5 -----5
 Add (2+3+3) = 8 -----8
 Add (3+3+1) = 7 -----7
 Add (1+3) = 4 -----4
 Write down 1 as it is = 1 -----1
 Final Answer is = **147852**

IV. Objective and Methodology of the study:

- The main objective is to know whether a Vedic mathematics technique improves the speed of the basic mathematical operations.
- The sub objective is to find the decreased time difference in terms of minutes before and after adopting Vedic mathematics techniques while solving some basic mathematical operations.

This study is based on primary and secondary data sources. The primary data is collected from students of BANK PO, BANK clerks and IBPS competitive examinations writing students. These students belong to one of the competitive examinations training centre at Mangalore City in Karnataka State of India. The qualitative data collection instrument chosen is the secondary data and focus group interactions. Secondary data sources are newspaper, journals, magazines, web links and related research papers. Based on focus group interaction a hypothesis is developed and to test the hypotheses paired t-test is used.

The population or sample size is 25 are collected from one of the competitive examinations training centre at Mangalore City in Karnataka State of India. A set of mathematical questions are distributed to respondents, which includes basic mathematical operations, square root, cube root, multiplication of 4 digit numbers, multiplication of numbers near to base, subtraction using the rule all from nine and last from ten. The time taken by the students before and after adopting Vedic methods is noted down in terms of minutes. A hypothesis is developed and tested its significance using paired t-test.

V. Hypothesis and Paired t-Test:

The scores of 25 persons are listed using Table-1. Table-1 includes serial number, time taken for completion of mathematical operations before and after adopting Vedic mathematics techniques in minutes, their difference and difference square.

Table 1: Paired T-test table for before and After Adopting Vedic Mathematics Techniques

| Sr. No. | Before adopting Vedic mathematics techniques (x) | After adopting Vedic mathematics techniques (y) | Difference (d=x-y) | d ² |
|--------------|--------------------------------------------------|-------------------------------------------------|--------------------|----------------|
| 1 | 10 | 7 | 3 | 9 |
| 2 | 10 | 6 | 4 | 16 |
| 3 | 15 | 8 | 7 | 49 |
| 4 | 15 | 7 | 8 | 64 |
| 5 | 18 | 15 | 3 | 9 |
| 6 | 15 | 12 | 3 | 9 |
| 7 | 12 | 9 | 3 | 9 |
| 8 | 18 | 13 | 5 | 25 |
| 9 | 15 | 10 | 5 | 25 |
| 10 | 10 | 7 | 3 | 9 |
| 11 | 10 | 6 | 4 | 16 |
| 12 | 13 | 9 | 4 | 16 |
| 13 | 18 | 12 | 6 | 36 |
| 14 | 9 | 7 | 2 | 4 |
| 15 | 19 | 17 | 2 | 4 |
| 16 | 13 | 9 | 4 | 16 |
| 17 | 8 | 6 | 2 | 4 |
| 18 | 15 | 9 | 6 | 36 |
| 19 | 10 | 8 | 2 | 4 |
| 20 | 14 | 12 | 2 | 4 |
| 21 | 15 | 13 | 2 | 4 |
| 22 | 8 | 7 | 1 | 1 |
| 23 | 11 | 9 | 2 | 4 |
| 24 | 15 | 12 | 3 | 9 |
| 25 | 15 | 11 | 4 | 16 |
| Total | | | 90 | 398 |

Null Hypothesis (H₀): $\mu_x = \mu_y$, Mean score before and after adopting Vedic mathematics techniques are same. In other words, there is no significant difference between before and after adopting Vedic mathematics techniques while solving some basic mathematical problems.

Alternative Hypothesis (H₁): $\mu_x \neq \mu_y$, (Two tailed)

H_1 : There is a significant difference between before and after adopting Vedic mathematics techniques while solving some basic mathematical problems.

Test statistic. Under H_0 , the test statistics is

$$t = \frac{d}{s/\sqrt{n}} \sim t_{n-1} = t_4$$

$$d = \frac{\sum d}{n} = \frac{90}{25} = 3.6$$

$$s^2 = \frac{1}{n-1} \sum d^2 - \frac{(\sum d)^2}{n} = \frac{1}{24} \cdot 398 - \frac{8100}{25} = 3.0833333$$

$$|t| = \frac{d}{s/\sqrt{n}} = \frac{3.6}{\sqrt{3.0833333/25}} = 10.25090635$$

The tabulated value of t for 24 degree of freedom (d.f.) and at 5% significance level is ($t_{0.025}$) = 2.064. Since calculated value of t (10.25090635) is greater than tabulated t, it is significant at 5% level of significance. Hence null hypothesis is rejected and alternative hypothesis is accepted.

If we consider, one tailed t-test (right tailed), $\mu_x > \mu_y$, there is a significant decrease in time before and after adopting Vedic mathematics techniques while solving some basic mathematical problems. The tabulated value of t for 24 degree of freedom (d.f.) and at 5% significance level is ($t_{0.05}$) = 2.064. Since calculated value of t (10.25090635) is greater than tabulated t, it is significant at 5% level of significance.

From both the alternative hypothesis we can conclude that Vedic mathematics techniques improve the speed of calculations while solving some basic mathematical problems.

RQ: Whether Vedic mathematics improves speed of basic mathematical operations?

About 98% respondents out of 25 members agree that Vedic mathematics improves the calculation speed. Where as only 2% replied no improvement in speed.

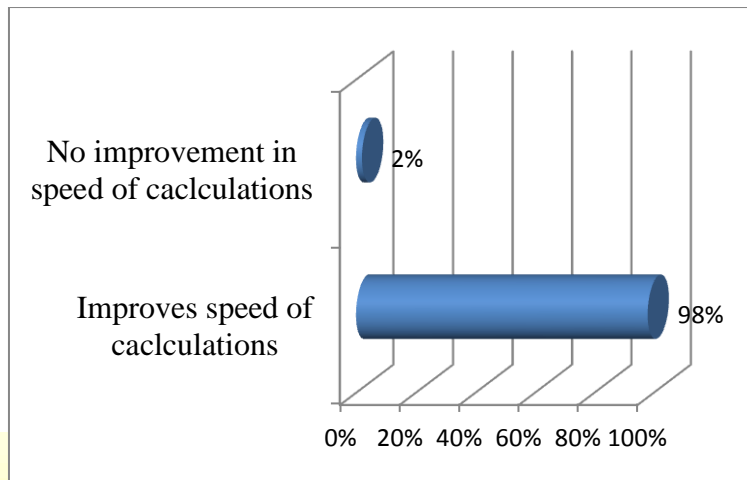


Figure 3: Graph showing the percentage of speed improvement and no improvement using Vedic mathematics techniques

RQ: Whether Vedic mathematics improves concentration?

About 84% respondents out of 25 members agree that Vedic mathematics improves the concentration. Where as only 16% replied that Vedic mathematics does not improves concentration power.

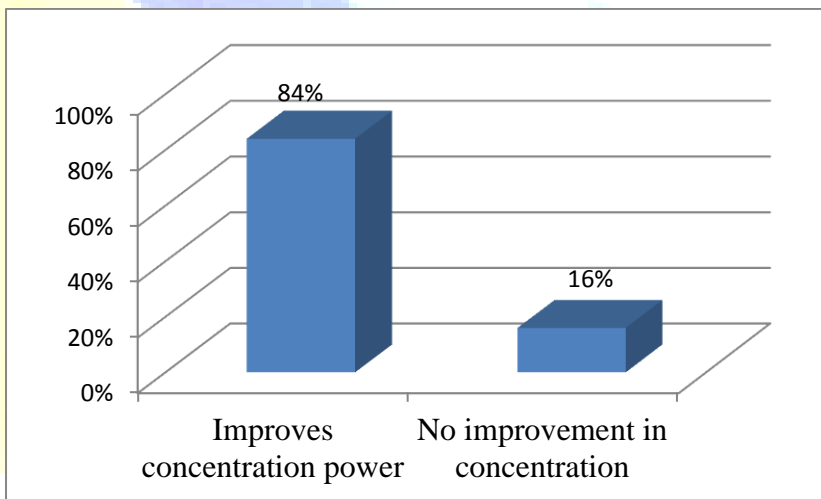


Figure 4: Graph showing the percentage of concentration improvement and no improvement due to Vedic mathematics techniques

RQ: Whether Vedic mathematics improves logical thinking?

About 80% respondents out of 25 members agree that Vedic mathematics improves the logical thinking. Where as only 20% replied no improvement in logical thinking.

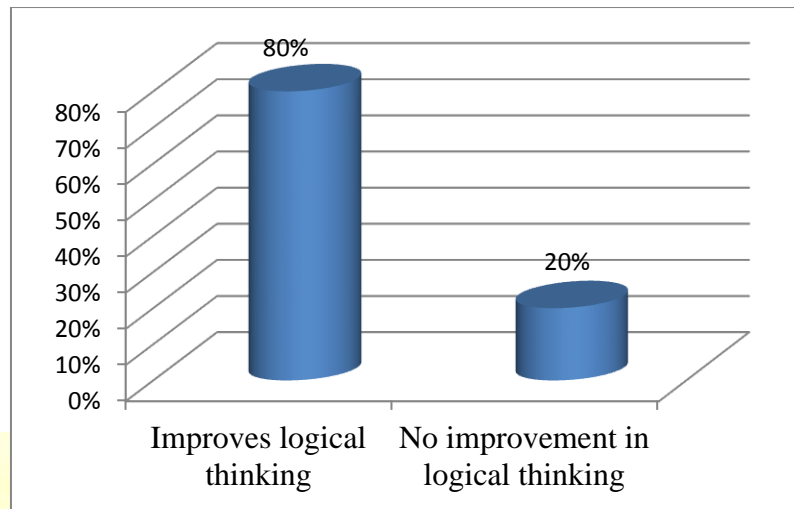


Figure 5: Graph showing the percentage of improvement in logical thinking and no improvement due to Vedic mathematics techniques

RQ: Practice is required for Vedic mathematics Techniques.

All the 100% respondents out of 25 members agree that continuous practice is required in order to familiarize and remember Vedic mathematics techniques.

VI. Limitations and Future Scope of Research:

This study is limited by the following factors:

- The population or sample size is very much limited comprised with only 25 people. The future study requires more samples for higher accuracy.
- The study considered only few mathematical operations. The future study requires more basic mathematical operations.
- The study considered time in terms of minutes. For the accurate result the future study requires more advanced form of time maintenance in terms of even seconds.

VII. Conclusion:

Vedic Mathematics is an ancient Indian mathematics system developed based on 16 formulae and sub formulae which is originally referred in Sanskrit as sutras. In order to become expert in Vedic mathematics techniques a person requires continuous practice and a very good interest. This paper found that Vedic mathematics techniques significantly reduce the time required for completing some basic mathematical calculations. The Vedic mathematics techniques can reduce the burden and overhead of students in competitive examinations while

solving quantitative aptitude and reasoning problems. It is considered as one of the short cut method for solving basic mathematical operations.

In this paper, a set of mathematical operations are considered, which includes square root, cube root, multiplication of 4 digit numbers, multiplication of numbers near to base, subtraction using the rule all from nine and last from ten. The paper statistical proved that Vedic mathematics techniques significantly reduce the time duration while solving some basic mathematical problems. All the respondents found that in worst case at least one minute can be saved, if we adopt Vedic mathematics techniques for solving problems of basic mathematical operations. Null hypothesis is disproved and alternative hypothesis are selected based on paired t-test. Wish this paper could play an active and supportive role in actual research of Vedic mathematics and techniques to improve the speed of calculations especially while writing any competitive examinations.

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