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Vedic Mathematics as Instructional Design for Science Classrooms of The Twenty-First Century

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Abstract:
In the twenty-first century, Vedic mathematics has proven itself to be a boon in classroom transactions. It has been seen several times that learners have lost interest in learning mathematics and science. To combat this, scholars have rekindled interest in Vedic Mathematics, which was rediscovered by Swami Tirthaji around the twentieth century with the help of 16 Sutras (Formulae) and 13 sub-sutras. Vedic mathematics makes the learner acquire lifelong learning skills. It is the most natural way of solving mathematical and scientific problems with minimal effort and helps in keeping the learner's mind active. This article provides a brief introduction to the applications of Vedic mathematics strategies in the science classroom as an instructional design. These techniques can be used to enhance the problem-solving skills among learners and reduce the effort of the teaching-learning process in classroom transactions. It helps learners to think analytically through different kinds of mathematical problems. Apart from this it also ensures the acceptability of results during their work and makes the learners satisfied, which results in the enhancement of their confidence level while applying Vedic mathematics strategies. The present paper also emphasizes the importance of Vedic mathematics strategies in today's classroom transactions.

Key Words: Vedic Mathematics, Instructional Designs, Problem-Solving Skills, Science Classrooms, Twenty-first Century, Cognitive Development.

INTRODUCTION

Academicians are very much familiar with the methods and techniques which are adopted by the educational system of India in the Twenty-first century. Examining and expanding the learner's understanding of the relationship between the learning environment and student outcomes is critical.(Bezci & Sungur, 2021). It is more complicated and difficult to understand, sometimes it is also burdensome on the learners, which requires much more effort to learn and understand the overall concepts and also the course consensus reveals what students consider to be the most significant and unimportant aspects of their education. (Ramlo, 2017). Due to this, many learners develop a fear of mathematics which in turn affects their performances in other subjects for very simple reasons like doing calculations and consequently they want to escape themselves from learning situations. Mathematics lost its essence due to its lengthy and uninteresting way of strategies. To overcome some of the above problems related to mathematical calculations, Vedic mathematics is one among the best strategies which can be adopted in classroom transactions. The straightforward, direct, and simple way of calculations can only be possible through the help of Vedic mathematics techniques (Maharaja, 1965). It also provides accuracy to the learners and brings back all the fun and enjoyment while doing mathematical work.

Therefore facilitators have an important role to explore the needs of learners and the learning contents that would help to achieve a higher dimension of critical thinking and cognitive development (Rodrigues, 2012). They must be able to grasp the problem, perceive it from multiple perspectives, and not be fixated on a single solution strategy to solve the mathematical problems (Rahayuningsih et al., 2021). Now, here

comes the need for instructional design for the learners. Instructional designs are considered the process of producing educational materials. Nevertheless, this goes beyond merely producing instructional materials; it also carefully evaluates how students learn and what resources and teaching strategies will enable learners to attain their academic objectives. To achieve educational goals in mathematics and those branches of knowledge consist of mathematical calculations one needs to introduce the concept of Vedic mathematics to make the calculation faster and more interesting. Vedic mathematics helps in the improvement of problem-solving skills among learners because students must receive an education that can keep up with changes and advancements (Ocak et al., 2021).

VEDIC MATHEMATICS SUTRAS

The most important eminence of Indian mathematics was the invention of "Zero" and the inaugurations of the "Decimal notation" without that, there could not be progress of mathematics as a scientific disciplev(Duval, 2000). Similarly Vedic mathematics also refers to an ancient system of calculations that was recently rediscovered by Shri Krishna Tirathji Maharaj. According to him Vedic mathematics is founded of 16 sutras (formulae) and 13 sub-sutras (Devi, 2020; Karani & Prasad, 2016; Maharaja, 1965; Parajuli, 2021).

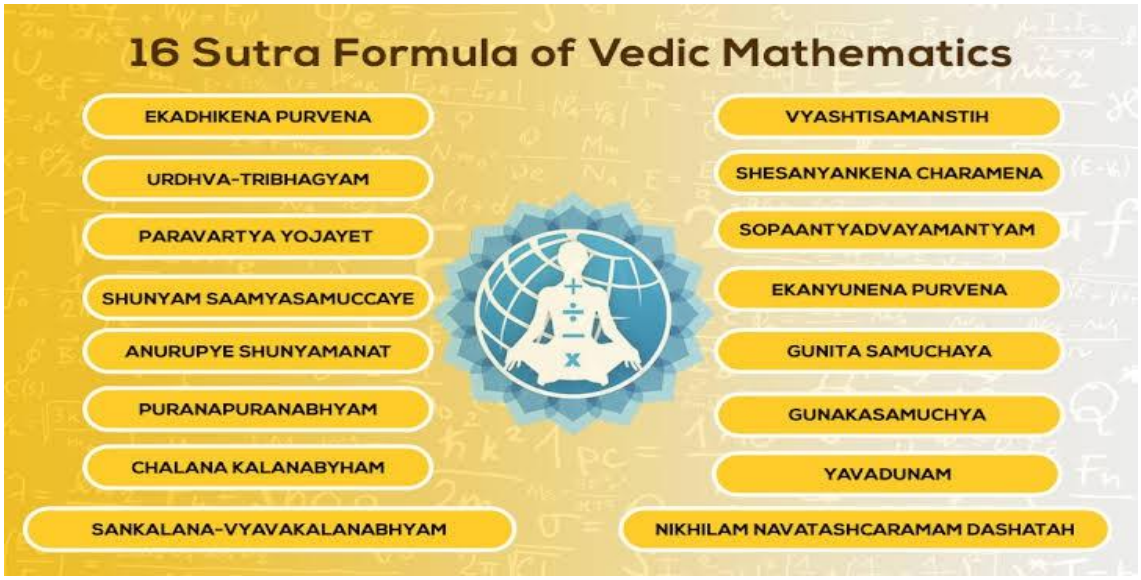

Figure 1: Sutras (formulae) of Vedic Mathematics

(**Source:** https://bharatideology.com/wp-content/uploads/2023/07/vedic-maths-sutra.jpeg)

Many of the new methods were developed which are based on the needs of mathematical calculation in the Twenty-first century. In a similar way, Vedic mathematics is also a new and distinctive method based on effortless rules. It allows mathematical problems to be solved effectively with less effort. The method adopted by Vedic mathematics is totally different and outstanding from the conventional methods of solving mathematical problems. Learners can cultivate their interest in other subjects through the knowledge of Vedic mathematics as it has fun while solving problems.

The sutra of Vedic mathematics such as "Ekadhikena Purvena" can be used to find out the square and multiplication of two numbers. "Nikhilam Navatascaramam Dasatha" can be used to evaluate the problems related to subtraction and multiplications also. "Urdhvatiryakbhyam" can be used for multiplications for decimal and binary system. "Praravartya Yojayet" can be used for solving divisions. Similarly, different types of linear equations can be evaluated with "Sunyam Samyasamuccaye", "Anurupye Sunyamanya" and "Sankalana Vyakalanabhym". "Purana Puranabhyam" can be used for finding out the roots of cubic equation, factorizations and bi-quadratic equations. Problems related to differential calculus and roots of bi-quadratic equations can be solved by using "Chalana Kalanabhyam".

"Yaavadunam" for square of numbers, "Vyastisamansthi" for probability and ratio, "Sesanyankena Charmena" can be used to convert faction into decimal and division, "Sopaantyadvayamantyam" and "Ekanyunena Purvena" can be used in a special case of multiplication like multiply by 12 and 9 to any number respectively. "Gunak Samuccayah" can be used to find out the roots of quadratic equation while "Gunit Samuccayah" is used to check the equations and quadratic equations.

VEDIC MATHEMATICS IN CLASSROOMS

A scientific classroom promotes learning through observation, experimentation, and inquiry, fostering curiosity, critical thinking, and problem-solving abilities among learners (Buck, 2019). Contemporary educational approaches, as emphasized in NEP (2020), advocate interdisciplinary integration, particularly blending STEM with the humanities and arts, to enhance creativity, innovation, and higher-order thinking skills. In this context, Vedic mathematics often described as the "knowledge of many arts" supports the development of these competencies by integrating diverse cognitive skills and improving learning outcomes.

The shift to remote learning during the 2020 pandemic posed significant challenges, requiring teachers to adapt pedagogical strategies and instructional processes (Barlovits et al., 2021). Integrating Vedic mathematics into the curriculum can enhance engagement and effectiveness in both physical and virtual science classrooms by strengthening learners' critical thinking and problem-solving abilities.
Furthermore, Vedic mathematics simplifies mathematical understanding through efficient and flexible techniques, enabling quick and accurate mental calculations across various domains (Joshi, 2017). It not only supports performance in competitive examinations but also sustains learner engagement and confidence through continuous self-verification of results. Thus, its integration into the education system can address diverse learning challenges and contribute to more effective and engaging pedagogy, supported by ongoing teacher professional development (Njiku et al., 2021).

NEED AND SIGNIFICANCE OF VEDIC MATHEMATICS

The pursuits of mathematical knowledge in India dates back over three millennia to the Vedic era (Dani, 2012). In the contemporary context, Vedic mathematics is emerging as a significant approach with potential applications in advanced technological domains such as robotics, machine learning, and artificial intelligence. These fields rely heavily on precise and efficient mathematical computations, including calculations of distance, time, speed, and trigonometric relationships that guide functions like obstacle avoidance and object manipulation in robotics.

Vedic mathematics facilitates faster and more accurate computations, thereby supporting such applications in both robotics and architectural design (Dharmannavar & Dharmambal, 2015). Furthermore, existing research highlights its potential to enhance programming efficiency, suggesting that it may contribute to future advancements in artificial intelligence and related technological fields.
Vedic mathematics offers high computational speed and reduced hardware complexity, making it effective for cryptographic and signal processing applications (Bhaskar et al., 2012). It improves performance in FIR filter design by reducing execution time compared to conventional methods (Dharmannavar & Dharmambal, 2015). Its potential extends to areas such as steganography, image processing, network security, and financial analysis. In the educational context, Vedic mathematics enhances teaching–learning processes and supports the development of efficient computational skills. It can also be applied in FFT, IFFT, and advanced filter designs like LMS for improved results (Ammade et al., 2020).

Mathematical skills assist learners to know how to rationale and think analytically through a problem. While applying Vedic mathematics, learners can use versatility in solving problems and at the same time, it helps them to decide the best method in solving problems. As Karani & Prasad (2016) has suggested that Vedic mathematics improves speed of basic mathematical operations which enhances the

concentrations and logical thinking of a learners. In addition to this, Parajuli (2020) also addressed the importance of using techniques of Vedic mathematics, especially for calculating square roots of a number either of perfect or imperfect square roots. In both cases it will take less time than the conventional method. The applications of Vedic mathematics in algebra stand convenient for better results in examinations and save lots of time and efforts in solving the problems (Devi, 2020). In support of this Michael O. J. Thomas (2020), found in his study of explorations of Vedic mathematics with regards to the expansions of binomials and factorization of quadratic expressions and found that the performance of students were significantly better and suggested that it could be rather be recommended as a useful adjunct, a complementary method.

Today's era of education is fastest growing and ever evolving epoch. There is competition in each and every sector of education and for jobs also and in all different type of competitive examinations (Joshi, 2017). The ability to solve reasoning with high speed and more accuracy becomes the decisive factor for one's success in various fields. This can be made possible only through techniques of Vedic mathematics while solving problems related to mathematical calculations. The Vedic mathematics system boosts calculation power and equips learners with one-line solutions for every problem which accelerates calculations more than 10 to 15 times faster.

Even in the classroom, students fear Mathematics and science involving numerical and want to avoid it because of their inefficiency in performing long multiplication, division, or conversions, as well as solving sums based on squares and cube roots. Students frequently miss out on full marks in science due to careless errors in long calculations. Furthermore, pupils are unable to finish their assignments during examinations (Katgeri, 2017). Vedic mathematics can solve mathematical apprehension among school children and retrieve interest in mathematics and other subjects by making mathematical problems easier to solve. Vedic mathematics also enhances the confidence and satisfaction level of students towards learning.

VEDIC MATHEMATICS AS AN INSTRUCTIONAL DESIGN FOR SCIENCE CLASSROOMS

Instructional design can also be termed as an Instructional System Design (ISD) in which the instructional materials are practice with the systematic order. It is firstly designed, developed and deliver in the classroom settings during teaching and learning processes (Indulska & Recker, 2010). Science is a systematic process of accumulating and organizing knowledge about the universe in the form of testable explanations and predictions (Wilson, 1998). Students need attention in their classroom transactions to understand the concept and grasp the content for their future use. For more scientific attention, there is the need to change the instructional design strategies from conventional methods to creative and innovative methods towards science classroom (Klijn & Koppenjan, 2006). Nonetheless it is completely conceivable for captivating and eye-opening design which emerges from an unusual and even a little insane method (Gaver, 2014). This method will be the integration of Vedic mathematics into school, as the Vedic system has some outstanding characteristics which can be definitely used to find the solutions of different kinds of problems (Singh et al., 2017) in science classroom related to their textbooks. The current trends in science learning is the integration of several disciplines with the science curriculum to enhance the interdisciplinary approach of learning among students (Winarno et al., 2020). Integrated science attempts to blend concepts, perspectives, and methodologies from diverse scientific disciplines in order to comprehend scientific occurrences in everyday life (Winarno et al., 2020). The integration of Vedic mathematics strategies with the science discipline makes the subject more interesting and easier to handle not only for the high achievers' students but also for the low achievers' students. It will reduces the burden of calculations and enhance the problem solving skills with less time consumption (Parajuli, 2019) among the science students in their classroom. This can be justified by using an example of science numerical problem.

Question
Find the moment of force of 24N about an axis of rotation at distance of 26m from the force.
Solution
Moment of force = force × perpendicular distance of force from the point of rotation
Moment of force = F × ⊥distance
Moment of force = 24N × 26m

Calculation using Traditional method	**Calculation using Vedic mathematics**
2 4 **× 2 6** **1 4 4** **4 8 ×** **6 2 4**	**2 4** **× 2 6** **6 2 4**

There are several sutras which were used in multiplications but among them Urdhvatiryakbhyam is the most easy and flexible in nature. It can be applied in every type of multiplication, especially for two digits multiplication. It is also called as "Vertically and crosswise". Other than this, there is separate strategy for multiplication such as multiplication of 5, 25, 50, 125, 11 etc. but here only vertically and crosswise is elaborated.
The steps involved the calculation of two-digit numbers.
Let us assume that the two-digit number is in the form of (PQ) × (RS), then

Step1: Multiply Q×S
Step2: (P×S) + (Q×R)
Step3: (P×S)
Example: multiply 24×26

Step3

2 4
2 6
(2×2)
4

Step 2

2 4
2 6
(4×2) + (2×6)
8 + 12

Step 1

2 4
2 6
(4×6)
24

24 × 26= (2×2) / (4×2) + (2×6) / (4×6)
= 4 / 20 / 24
= 624
With the help of above examples, it can be assumed that Vedic mathematics makes the calculations simpler and easier for the learners as compared to traditional methods. For better clarification we can see the interrelationship of Vedic mathematics with other branches of science as discussed below with examples.

VEDIC MATHEMATICS WITH OTHER BRANCHES OF SCIENCE

Mathematics is "science of all science" and "art of all arts". Mathematics plays a crucial role in understanding the content of other subjects. The concept of other subjects can easily be grasped with the better understanding of mathematical tools. Science and mathematics subjects are currently posing a lot of challenges (Ayoub, 2010) for the 21st century learners. Science is somehow meaningless without mathematics, because mathematics can easily counter with the theories of science, its numerical, chemical reactions, and many more. Applications for Vedic mathematics can be used in scientific concepts like work, energy, electricity, thermodynamics, kinetics of chemical reactions etc. The more precise the

concept of mathematics, the more it would help to understand other disciplines and make it more relevant and relatable. It allows learners to communicate in class, but it is mostly teachers who can limit or expand their pupils' abilities to communicate mathematically and scientifically (Ingram et al., 2017). So, use of Vedic mathematics made it valid and relevant to the learners.

a) Vedic Mathematics and Physics: Physics as a branch of science, it is embedded with mathematical calculations. A learner must have rich knowledge of mathematics to tackle the whole concept of physics. Mathematics is used in the calculations of energy, work done, friction etc. Even in the physical laboratory mathematical skills play an important role in the determination of values during experiments and for the calculations of errors in the experiments. All these can be eradicated if the mathematical problem of physics is integrated with Vedic mathematics solutions.

Example: In physics, chapters like Light: Reflection and Refraction, Vedic mathematics techniques can be used to solve numerical related problems in that chapter. In this chapter, the sutras like 'Ekadhikena Purvena' sutras (By one more than the previous one) for some specific types of numerical such as calculation of power of lens and sometimes can also be used for determination of mirror and lens formula. Adaptation of Vedic integrated strategies in physics would enhance the understanding level of numerical and also create interest among learners regarding the subject. Let us take an example of from the chapter of physic Light: Reflection and Refraction.

b) Vedic mathematics and Chemistry: The process of learning chemistry should be implemented by many integrating aspects such as attitude, knowledge and skill. (Pendidikan & Dan, 2006). Mathematics is also used for the calculations of molecular weight of compounds, the ratio of constituent mixture, empirical formula of compounds, in balancing the equations, in e.m.f (electromotive force) of cell, for the electronic configurations of atoms etc. Mole concepts can only be understood with the help of calculations involved in it even for thermodynamics and chemical kinetics has wider applications of mathematics. Without the knowledge of mathematics, it is almost impossible to determine all the calculations involved in the above theory of chemistry which has been used in day-to-day life. Hence, mathematics maintains the essence of chemistry in life.

Example: While introducing chemistry, the concept of Moles can easily be calculated with Vedic mathematics sutras named as 'Nikhilam' Sutras (All from 9 and the last from 10). It can be also solved with the help of 'Urdhva-Tiryagbhyam' sutras (Vertically and crosswise) which is a general formula applicable to all cases of multiplication. It is found to be very useful in the division of a large number by another large number as it is known that Avogadro's number (6.023×10^{23}) is frequently used in the determination of mole concepts. It makes the whole calculations single lined and provides accuracy to the learners. Let us take an example from the chapter of chemistry Solution.

c) Vedic mathematics and Biology: Mathematics is also highly interrelated with biology. i.e. calculations of weight and height of a human body to provide proper nutrition accordingly. It is also used in the calculations of RBC, WBC and Platelets etc in our blood which helps to diagnose the blood related diseases. All these can only be done with the help of mathematics only. Mathematic applications are also used by Mandel theory for the calculations of F1 and F2 generations in both the sexual and asexual species. Calculations of life span of any living species can be done with the help of mathematics.

While teaching biology, Vedic mathematics can be used in Heredity and Evolution chapter for the calculation of Mendelian ratio and percentage. For this chapter, we can use 'Paravrtya Yojayet' sutras (Transpose and adjust) to make the calculations easier and more enjoyable for the learners. It will surely maximize concentration and self-confidence among the students. It will also create interest among the learners in their subjects concerned. Similarly in biology one can apply Vedic mathematics strategies for the simple calculation of osmosis concentration and rate for exchange.

Scientific knowledge about mathematics teaching cannot be gained simply by combining results from these fields; rather, it necessitates a specific didactic approach that integrates different aspects into a coherent and comprehensive picture of teaching and learning and then applies it constructively. If research

and development have specific links to practice at their core, and the practice improvement is merged with the field's overall progress, than specific tasks of mathematics education be carried out(Wittmann, 2021).So, on the basis of above discussions it can be said that use of Vedic mathematics strategies into all these, it will become quite simple and easier, to understand, for a learner and also save adequate time with faster and accurate result.

ROLE OF TEACHER

The role of a teacher in a mathematics and science classroom is to facilitate learning by providing instruction, guidance and support to students. This includes creating a positive learning environment, delivering curriculum, assessing students. This encompasses fostering a positive learning environment, delivering the curriculum, assessing student understanding and progress, and differentiating instruction to address diverse learner needs. The teacher should also model critical thinking and inquiry, encouraging students to independently explore mathematical and scientific concepts.

The main aim of mathematics teachers is to fabricate their students to think out of the box and to think critically and analytically. With the assistance of Vedic mathematics techniques, a mathematics teacher can provide their students with better knowledge, understanding and skills which ensure that learners would not only success in the classroom but also become a productive citizen of our society. Some important roles of Vedic mathematics teacher in Twenty-first century are as follows:

1. A Vedic mathematics teacher should have comprehensive mastery over subject matter.
2. They should have always positive attitude towards teaching subjects as it influences the learning process of the learners.
3. They must understand the uniqueness of every individual and guide the learners according to their needs and interest.
4. The method of teaching must be adopted by Vedic mathematics according to the learning capabilities of the learners.
5. They should have good analytical power so that one can easily determine the difficulty of learners and provide them with remedial measures.

CONCLUSION

Vedic mathematics is a system of mathematics that was developed in ancient India and is said to have been passed down through oral tradition. It is based on 16 sutras, or word formulas, that provide a way to solve mathematical problems in a more efficient and faster way. It is an important system of mathematics because it offers an alternative method of solving mathematical problems that are different from the traditional method taught in schools. This can be beneficial for students who struggle with traditional methods, as it may help them to understand mathematical concepts in a different way. Additionally, Vedic mathematics can also be used to perform complex calculations in a shorter amount of time, which can be useful in various fields such as business and engineering as well.

In the modern education system, people are surrounded by scientific and technological changes which have a significant impact on the community as well as on the entire society. In the search for material life, people ignored the ideals of truth and morality. In accordance to achieve mastery over sense, there has been an introduction to Vedic education for enhancing the ideals of truth, the ideal of equality, the ideal of liberty and the ideal of peace and unity. Whether literary or professional the integration of Vedic education with modern education makes the students fit and enhance all-round development in all aspects of life. The principles and objectives of Vedic education have been a better source of encouragement for all educational systems across the world. In this modern period of education, learners obliterate their cultural and moral values towards their society and environment. The adaptation of Vedic education can change the mind of the learners and the characters of society at large. It has capability to change the behavior of learners in positive direction because the ultimate aims of Vedic education were to enhance the personality and development of character(Kamil Arif Kirkiç, 2015).

In the competitive world, Vedic mathematics enhances the mental ability of learners and speeds up their problem-solving skills, and it also consumes time in entrance examinations. Many school have realized the importance of Vedic education in all aspects either it is related to any kind of disciplines or it is related to moral values of human. So many educational institutions merged Vedic education in their curriculum. In the Twenty-first century, Vedic mathematics continues to be a center of attraction for research at global level. It enhances the natural way of working with very little effort, learners get to know lots of things in very short period and this knowledge remnant for longer time. Even scientists from NASA have applied certain principles of Vedic mathematics in realm of artificial intelligence because of its versatility in nature (Joshi, 2017). Vedic mathematics nourishes personality and contributes to all round development of learners which makes it relevant in Twenty-first century. India has also understood the paramount value of Vedic mathematics in modern era. It is supposed to adore Vedas for the uninterrupted humanity. The beauty of Vedic mathematics lies in its invectiveness, which one experiences while applying.

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