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Uncovering mathematical traditions: Comparing Vedic and modern teaching approaches

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Abstract
This article seeks to explore the rich history of mathematics education and the evolution of teaching and learning practices in mathematics. The Vedic approach is shown to be more holistic and intuitive, emphasizing the interconnectedness of mathematical concepts, while the modern approach prioritizes technical proficiency and algorithmic problem-solving. Through a comparative analysis of the Vedic era and modern approaches, an insight into the evolution of mathematics education and new ways to enhance the teaching and learning of this critical subject can be known.

Keyword: Vedic mathematics, Vedic era, sutras, pedagogical

1. Introduction
Mathematics is one of the world's most fundamental and widely used subjects. It has been a cornerstone of human progress, contributing to advancements in fields such as science, engineering, economics, and many others. The evolution of mathematics has been shaped by various cultures and traditions, with each era adding its own unique perspective and contributions to the subject. One such time frame, where Mathematics was given an immense importance is the Vedic era, which is often regarded as a golden age of Mathematics [1]. During this period, many mathematical concepts were first discovered and developed, including the decimal system, algebra, and geometry. The Vedic texts, including the Vedas and the Sulba Sutras, provide invaluable insights into the mathematics of this era and the teaching and learning practices that were applied inorder to solve the mathematics problems in lesser time with boosting the confidence of the learner [2].
In Vedic era, Mathematics was regarded as the root of every subject. This very thing has also been emphasized in one of the slokas, i.e.:

यथा सिखा मयुरनांम नागाणां मणयो यथा।
तदवद वेदाङ्गःशास्त्राणां गणितं मुर्धनि स्थितम्।।

Which means that as " sikha" of peacocks and " mani" of Naagas lie within the supremost position, the Mathematics Education also lie within the supremost position. There is no any object in the world, whose root is Mathematics [3].
Today, we live in an era where technology has transformed the way we teach and learn mathematics. Modern teaching approaches utilize tools such as online resources, interactive software, and virtual simulations to enhance the learning experience.

[1] Joseph, G. G. (2000). The crest of the peacock: Non-European roots of mathematics. Princeton University Press.
[2] Acharya, E.R. (2015) Mathematics Hundred Years Before and Now. History Research, 3, 41-47.https://doi.org/10.11648/j.history.20150303.11
[3] Acharya Shri BasudevShastri (2076), Vedic Gyan Bigyan

As such, there is a growing interest in understanding the similarities and differences between the teaching and learning practices of the Vedic era and modern times.

2. Main Results

The Vedic era in ancient eastern civilization was a period of significant innovation and discovery in the field of mathematics, with many mathematical concepts and methods developed during this time which are still in use today. One area of particular interest is the teaching and learning practices of Vedic mathematics, which have many similarities to modern approaches with the underlying differences as well. These similarities and differences and their influence within modern teaching practices are mentioned below.

2.1 Similarities between teaching and learning practices in the Vedic Era and Modern Era

1. Emphasis on Problem-solving and Critical thinking

One of the key similarities between Vedic and modern teaching practices is the emphasis on problem-solving and critical thinking. Both approaches prioritize understanding the underlying principles and concepts of mathematics, rather than simply memorizing formulas and procedures. The Vedic mathematicians developed many methods for solving complex problems using simple techniques, which encouraged students to approach problems with a creative and flexible mindset. With the help of it's sixteen sutras and thirteen sub sutras, it simplifies the complex Mathematical Operation.

One very interesting method is the "Vertical and Crosswise sutra" also called as " Urdhva Tiryagbhyam" which is a shortcut method for multiplying two-digit numbers. The method involves breaking down the two-digit numbers into their constituent parts and multiplying them accordingly.

For example, if we want to multiply 23 and 47, we can break down 23 into 20 + 3 and 47 into 40 + 7. We then multiply the crosswise terms (20 x 7 and 3 x 40) and add them together to get 560. Finally, we add the vertical terms (20 x 40 and 3 x 7) to get 920, giving us a final answer of 1081.

This approach to teaching and learning is supported by research, which shows that problem-solving and critical thinking are important for developing mathematical proficiency [4]. Similarly, modern mathematics education also encourages students to think critically about problems and to develop their own problem-solving strategies. For example, modern mathematics education also teaches shortcut methods for multiplying two-digit numbers, such as the "FOIL" method or the "box method." These methods also involve breaking down the two-digit numbers and multiplying them in parts, with the final answer being the sum of the products.

This shows that emphasis on problem-solving and the use of shortcut methods to solve complex problems is a common feature in both Vedic and modern mathematics.

2. Use of Visualization and hands-on learning activities

Another similarity between Vedic and modern teaching practices is the use of visualization and hands-on learning activities. The Vedic mathematicians were skilled in using visual aids, such as diagrams and patterns, to help students understand mathematical concepts. They also encouraged students to use their hands to manipulate objects, such as counting stones, to aid in learning.

One example of the use of visualization in Vedic mathematics is the "Vedic Square" method, which is used to calculate the squares of numbers. This method involves drawing a square and dividing it into four quadrants, with the original number being placed in the center. The square is then filled with numbers that are calculated based on their position in relation to the original number. This visual aid helps students to understand the relationships between numbers and how the squares of numbers are calculated.

This approach to learning has influenced modern teaching practices, with many educators utilizing visual aids and hands-on learning activities to help students understand mathematical concepts, where, modern teaching practices often utilize visual aids and hands-on learning activities to help students understand mathematical concepts [5].

For example, in geometry, students are encouraged to use manipulatives such as rulers, compasses, and protractors to construct and explore geometric shapes. This hands-on approach helps students to understand the properties of geometric shapes and how they relate to one another. Another example of the use of visualization in modern mathematics is the use of graphs and charts to represent mathematical data. For instance, students may use a line graph to visualize the relationship between two variables, or a bar chart to represent frequency data. By using visual aids, students can more easily interpret and analyze mathematical data.

In both Vedic and modern mathematics education, the use of visualization and hands-on learning activities is recognized as an effective way to engage learners and enhance understanding of mathematical concepts. These kinds of methods make Mathematics an interesting subject to learn and generate an interest within the students in such a subject which most of the people find boring [6].

3. Collaboration and Group Work

Collaboration and group work are also key similarities between Vedic and modern teaching practices. In both approaches, students are encouraged to work together and collaborate on mathematical problems to enhance their understanding and develop important social skills. The Vedic mathematicians often worked together in groups, sharing knowledge and techniques to solve complex problems. One example of collaboration in Vedic mathematics is the "Ekadhikena Purvena" method, which involves adding one number to another to obtain a third number. This method is often taught in pairs, with one student providing the first number and the other student providing the second number. The students then work together to obtain the final answer using the "Ekadhikena Purvena" method.

Similarly, modern mathematics education often includes group work and collaborative learning activities, which help students develop communication and teamwork skills, as well as deepening their understanding of mathematical concepts. For instance, students may work in pairs or small groups to solve mathematical problems, discuss mathematical concepts, and provide feedback to one another. By working together, students can share their ideas and approaches, learn from one

[4] Baroody, A. J., & Wilkins, J. L. (1999). The development of informal counting, number, and arithmetic skills and concepts. In J. V. Copley (Ed.), Mathematics in the early years (pp. 47-75). Reston, VA: National Council of Teachers of Mathematics.

[5] Clements, D. H., & Sarama, J. (2003). Strip mining for gold: Research and policy in educational technology–a response to "fools gold". AACE Journal, 11(1), 7-75.

[6] Das, S. (n.d.) The History & Future of Vedic Maths. http://hinduism.about.com/od/vedicmaths/a/vedicmath_history_future.html

another, and develop important communication and problem-solving skills. Another example of collaboration in modern mathematics education is the use of project-based learning activities. In these activities, students work in groups to complete a project that involves applying mathematical concepts to a real-world problem. For example, students may work together to design and construct a bridge using geometric principles, or use statistical analysis to study a social issue such as poverty or inequality.

In both Vedic and modern mathematics education, collaboration and group work are seen as effective ways to enhance learning and develop important social and cognitive skills. By working together, students can build confidence, deepen their understanding of mathematical concepts, and develop the teamwork and communication skills that are essential for success in the modern world.

4. Emphasis upon the importance of practice and repetition

Finally, both Vedic and modern teaching practices emphasize the importance of practice and repetition in learning mathematics. Both approaches recognize that practice is essential for developing mathematical skills and building fluency in mathematical operations.The Vedic mathematicians believed that mastery of mathematical concepts could only be achieved through consistent practice, with students encouraged to repeat techniques and methods until they were able to perform them with ease.

In Vedic mathematics, one example of the emphasis on practice and repetition is the "Nikhilam Sutra" method for multiplication. This method involves breaking down a larger number into smaller numbers, multiplying each number individually, and then adding the products together to obtain the final answer. This method requires a great deal of practice and repetition to master, as students must memorize and apply various multiplication tables and techniques.

Similarly, modern mathematics education often includes regular practice and homework assignments, with students encouraged to work through problems until they are confident in their understanding [7]. Another example of the emphasis on practice and repetition in modern mathematics education is the use of drill and practice software, which allows students to practice mathematical skills and operations at their own pace. By engaging in repetitive practice, students can build their confidence and fluency in mathematical operations, and develop the skills needed to tackle more complex mathematical problems.

In both Vedic and modern mathematics education, the emphasis on practice and repetition reflects a recognition that mathematical skills are developed through a process of repetition and mastery. By providing students with ample opportunities to practice and master mathematical concepts and techniques, both approaches aim to build strong mathematical foundations and develop the skills needed for success in the modern world.

Thus, teaching and learning practices in mathematics have evolved significantly from the Vedic era to the modern era. While there are several differences between the two eras, there are also striking similarities. Both eras emphasize the importance of visualization and hands-on learning activities, collaboration and group work, and the importance of practice and repetition in learning mathematics. By recognizing these similarities, educators can develop teaching strategies that are effective in both the Vedic and modern eras.

2.2 Differences between teaching and learning practices in the Vedic Era and Modern Era

Over the centuries, teaching and learning practices in mathematics have evolved significantly. In particular, there are notable differences between the way mathematics was taught and learned during the Vedic era and the way it is taught and learned in modern times. Some of the key differences between teaching and learning practices in the Vedic era and the modern era are:

1. Curriculum and Content

One of the most obvious differences between teaching and learning practices in the Vedic era and the modern era is the curriculum and content. In the Vedic era, mathematics was primarily focused on practical applications, such as calculations related to trade, agriculture, and architecture. The mathematics curriculum of the Vedic era was heavily influenced by the Vedas, which are ancient Hindu texts that contain mathematical concepts and techniques.

In contrast, modern mathematics education is more focused on abstract concepts and theories, such as calculus, geometry, and algebra. The curriculum and content of modern mathematics education is based on a systematic approach to mathematics, with each concept building upon the previous one.

2. Pedagogical Methods

Another key difference between teaching and learning practices in the Vedic era and the modern era is the pedagogical methods used to teach mathematics. In the Vedic era, mathematics was primarily taught through oral instruction and memorization. Students would learn mathematical concepts and techniques by reciting them repeatedly, often under the guidance of a guru or teacher.

In contrast, modern mathematics education emphasizes a more interactive and hands-on approach to learning. Students are encouraged to explore mathematical concepts and techniques through problem-solving, critical thinking, and experimentation. Modern pedagogical methods also include the use of technology, such as interactive whiteboards, online resources, and educational software, to enhance the learning experience.

3. Assessment

The assessment of mathematical knowledge and skills is also a key difference between teaching and learning practices in the Vedic era and the modern era. In the Vedic era, assessment was primarily based on the ability of students to recite mathematical concepts and techniques accurately. This type of assessment was often done orally and was focused on memorization rather than understanding.

In contrast, modern mathematics education emphasizes the assessment of understanding and application. Students are assessed on their ability to apply mathematical concepts and techniques to solve problems and to think critically. Modern assessment methods also include a range of tools and techniques, such as tests, exams, projects, and portfolios, to evaluate student learning.

[7] Fuson, K. C., Smith, S. T., & Lo Cicero, A. M. (1997). Supporting mathematics learning in the early years. In J. V. Copley (Ed.), Mathematics in the early years (pp. 77-98). Reston, VA: National Council of Teachers of Mathematics.

4. Diversity and Inclusion

Finally, there is a notable difference between teaching and learning practices in the Vedic era and the modern era when it comes to diversity and inclusion. In the Vedic era, mathematics education was primarily reserved for upper-caste males, with little to no access for women and lower-caste individuals.

In contrast, modern mathematics education is more inclusive and diverse, with a focus on providing equal opportunities for all students, regardless of their gender, race, ethnicity, or socioeconomic status. Modern mathematics education also emphasizes the importance of cultural diversity and the contributions of mathematicians from different backgrounds and cultures.

Thus, there are significant differences between teaching and learning practices in the Vedic era and the modern era. While the Vedic era emphasized practical applications and oral instruction, modern mathematics education is more focused on abstract concepts and hands-on learning. Moreover, modern mathematics education places a greater emphasis on diversity, inclusion, and the assessment of understanding and application. By understanding these differences, we can develop more effective and inclusive approaches to teaching and learning mathematics in the modern era.

3. Conclusion

There is a significant role of Vedic Era in shaping the Mathematics Education to the form it is today. It is evident that while there are significant differences between the teaching and learning practices of the Vedic era and modern era, there are also many similarities. Both eras emphasize the importance of problem-solving skills, visualization, and hands-on learning activities, collaboration and group work, and practice and repetition in learning mathematics. Understanding these similarities and differences can help us to appreciate the rich history of mathematical traditions and develop more effective teaching and learning strategies for the modern classroom. By reviving some of the valuable techniques and approaches of the Vedic era and incorporating them into modern teaching practices, we can enhance the learning experience for students and deepen their appreciation for the beauty and significance of mathematics.

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