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Teaching Multiplication Using Vedic Mathematics Approach

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Abstract

The Vedas are the most ancient knowledge reservoir of Hindu philosophy. Bharati Krishna Tirtha Ji developed Vedic mathematics after eight years of intensive study of the Vedas. He extracted mathematical concepts from the Vedas and developed Vedic mathematics, which consists of sixteen sutras and thirteen sub-sutras. Vedic mathematics is an innovative approach with applications in a wide range of fields such as science, engineering and so on. Though Vedic mathematics has much usefulness in mathematics, the present teaching-learning practices of mathematics are not valuing its importance. The purpose of this research was to investigate the utility of Vedic mathematics techniques in the mathematics classroom. Action research was carried out in one of the government schools in the Kanchanpur District to conduct this study. This study focused on teaching multiplication to fourth-grade children by utilizing the *Nikhilam* and *Ekadhikena Purvena* sutras. It was found that incorporating the Vedic approach improved pupils' mathematical performance, enabling them to solve problems faster. The implementation of Vedic techniques empowered and motivated students towards learning mathematics. In addition to that, Vedic mathematics' simple and straightforward approaches helped students in solving problems quickly. This study concluded that pedagogical strategies of Vedic mathematics can be a useful and beneficial strategy for teaching mathematics at the school level.

Keywords: Vedic mathematics, student engagement, action cycle, sutras and sub-sutras, mathematical anxiety

Introduction

The Veda is one of the most ancient texts of Eastern philosophy. The word "Veda" refers to the warehouse of all knowledge (Itawadiya et al., 2013). In Eastern philosophy, it is believed that Vedas consist of all types of knowledge required for human livelihood (Priya & Kumar, 2021). The Rigveda, Samaveda, Yajurveda and Atharvaveda are the four main volumes of the Vedas. The Veda is regarded as the most ancient scripture of Eastern philosophy, encompassing religious and ritual poetry as well as ritual formulae (Witzel, 2003). Along with different forms of knowledge, the Vedas also contain mathematical ideas and principles. Mathematics extracted from Vedas is termed as Vedic Mathematics. Bharati Krishna Tirtha Ji was the first person who popularized Vedic mathematics. From 1911 to 1918 A.D., he studied the Vedas and invented Vedic mathematics, which consists of 16 sutras and 13 sub-sutras. Later in 1965, a book titled "Vedic Mathematics" was published (Tirthaji, 1965). "Vedic Mathematics" is now recognized as a distinct and important branch of mathematics. Vedic mathematics is an ancient system of mathematics based on sixteen sutras and thirteen sub-sutras (Kumar & Charishma, 2012). Fast calculation is a key feature of Vedic mathematics (Itawadiya et al., 2013). The sutras and sub-sutras work like shortcuts, and with their assistance, any form of mathematical computation can be performed in a relatively short period of time without the use of a calculator. Each sutra has some sort of connection to the others, demonstrating that the sutras and sub-sutras are interrelated (Shylashree et al., 2012).

The researcher (first author), as a mathematics teacher, observed that most of the mathematics laws and principles taught in schools and colleges are influenced by Western culture. There is a lack of cultural contextualization in Nepalese mathematics classrooms (Luitel & Taylor, 2007). In mathematics courses, problems tend to have lengthy solutions with a lot of steps. School mathematics highly emphasizes procedural knowledge rather than conceptual knowledge. In Nepalese mathematics classrooms, the pedagogy places greater emphasis on memorizing formulae and following steps and procedures, rather than motivating students to be creative, ask questions and think critically (Manandhar et al., 2022). Hiebert et al. (2005) also argued that if students memorize procedures only, this may lead to less motivation for students to learn mathematics.

The researcher's experience indicates that students used to spend their maximum time on calculations while solving problems. As students focus more on calculations rather than trying to understand the concepts, it leads to preventing meaningful learning of mathematics. Mathematics learning can be more effective if calculations can be simplified, requiring fewer steps, and allowing students to allocate time for conceptual understanding. Apart from that, mathematics anxiety is

another serious issue among Nepalese students. Mathematical anxiety is a state of tension and fear related to solving mathematical problems (Wang et al., 2014). As per the teaching experience of researchers, one of the reasons behind students' fear in mathematics is due to lengthy steps and calculations. Farooq and Shah (2008) also discussed that a positive attitude toward mathematics leads to better performance by students in the subject. Vandecandelaere et al. (2012) mentioned that students who used to enjoy doing mathematics tend to be more motivated in their learning.

Parajuli (2020) suggested that the incorporation of Vedic mathematics can make mathematics a favorite subject among students at the primary level. The integration of Vedic mathematics leads to the enhancement of both procedural and conceptual knowledge among students. Vedic mathematics has features of accuracy, exactness, and preciseness, and is less time-consuming; it holds the potential for meaningful teaching and learning of mathematics.

Vedic Mathematics

Vedic Mathematics assumes that Vedic sutras are based on the natural principles governing the human mind (Fernandes & Borkar, 2013). Bharati Tirtha Krishna Ji pioneered Vedic Mathematics by writing a book entitled "Vedic Mathematics." This book comprises thirteen sutras and sixteen sub-sutras developed by Tirtha Ji through intensive study of the Vedas. Shastri et al. (2017) noted that Vedic Mathematics simplifies many mathematical calculations. Essentially, the sutras of Vedic mathematics function as rapid techniques that facilitate calculations in a very short time, with some calculations even possible to be performed mentally. The sutras and sub-sutras provided in the book "Vedic Mathematics" are the major highlights of Vedic mathematics.

Vedic mathematics can serve as an alternative tool for conducting calculations (Kandasamy & Smarandache, 2006). Fernandes and Borkar (2013) explained that Vedic mathematics reduces calculations to their simplest form because Vedic sutras were designed in a manner that aligns with the way the human mind operates. Beyond teaching mathematics, Vedic mathematics finds applications in various branches of engineering, such as computing and digital processing. A comparative study conducted by Vyas (2019) demonstrated that a student's performance in mathematics can be enhanced through the use of Vedic mathematics in comparison to conventional teaching techniques. The Vedic mathematics sutras and sub-sutras are listed below:

Table 1

Name and Meaning of Sutras of Vedic Mathematics

S.N.	Name of Sutras	Meaning
Sutra 1	Ekadhikina Purvena	By one more than the previous one
Sutra 2	Nikhilam Navatashcaramam Dashatah	All from 9 and the last from 10
Sutra 3	Urdhva-Tiryagbyham	Vertically and crosswise
Sutra 4	Paraavartya Yogayet	Transpose and adjust
Sutra 5	Shunyam Saamyasamuccaye	When the sum is the same that sum is zero
Sutra 6	Anurupyena-Sunyamanyat	If one is in the ratio, the other is zero
Sutra 7	Sopaantyaadvayamantyam	The ultimate and twice the penultimate
Sutra 8	Ekanyunena Purvena	By one less than previous one
Sutra 9	Sankalana-Vyavakalanabhyam	By addition and by subtraction
Sutra 10	Puranapuranabyham	By the completion or non-completion
Sutra 11	Chalana-Kalanabyham	Difference and similarities
Sutra 12	Yaavadunam	Whatever the extent of its deficiency
Sutra 13	Gunitasamuchyah	The product of the sum is equal to the sum of the product
Sutra 14	Vyashtisamanstih	Part and whole
Sutra 15	Shesanyankena Charamena	The remainder by the last digit
Sutra 16	Gunakasamuchyah	The factors of the sum are equal to the sum of the factors

Source: (Tirthaji, 1965)

Table 2

Name and Meaning of Sub-sutras of Vedic Mathematics

S.N.	Name of Sub-sutras	Meaning
Sub-sutra 1	Anurupyena	Proportionately
Sub-sutra 2	Adyamdyenantya-mantyena	First by first and last by last
Sub-sutra 3	Sisyate Sesasamjnah	Remainder remains constant

Sub-sutra 4	Vestanam	By Osculation
Sub-sutra 5	Kevalaih Saptakam Gunyat	For 7 the multiplicand is 143
Sub-sutra 6	Samuccayagunitah	The sum of the coefficients in the product
Sub-sutra 7	Lopanasthapanabhyam	By alternate elimination and retention
Sub-sutra 8	Yavadunam Tavadunam	Lessen by deficiency
Sub-sutra 9	Yavadunam Tavadunam Varganca Yojayet	Whatever the deficiency, lessen by that amount and set up the square of the deficiency
Sub-sutra 10	Antyayordasake	Last totaling 10
Sub-sutra 11	Antyayoreva	Only the last term
Sub-sutra 12	Vilokanam	By observation
Sub-sutra 13	Gunitasmuccayah Samuccayagunitah	The product of the sum is the sum of the products

Source: (Tirthaji, 1965)

The magical formulas of Vedic mathematics may help students solve real-world problems. This action research aimed to explore how Vedic mathematics could be useful and helpful in teaching mathematics at the primary level.

The following research questions were used to achieve the objective of this study:

1. How does the Vedic mathematics approach help in teaching multiplication to grade four students?
2. How does the integration of Vedic mathematics lead to motivating students in mathematics learning?

Methods and Procedures

The research used is action research, a method undertaken to improve our current practices. Action research has four key stages: planning, acting, observing, and reflecting (Altrichter et al., 2002). It involves the process of knowledge creation that arises within the context of practice, and researchers work with practitioners. In contrast to social science research, the purpose of action research is to explore the effect of change in generating knowledge (Huang, 2010). The first author conducted the fieldwork, whereas other authors supported the first author in planning, reflecting the manuscript development phase. During this research, we followed the stages outlined below:

Planning: To conduct this action research, much effort was devoted to the planning stage. The researcher has reviewed relevant literature related to Vedic mathematics, like books, journal articles, blogs, and videos for in-depth study. The researcher made an exploratory lesson plan to teach multiplication to grade four students using the Vedic mathematics technique. As the Vedic mathematics was a new concept for students, activities were designed in such a way that students could learn basic concepts of Vedic mathematics first. Basically, two sutras, viz. *Nikhilam* and *Ekadhikena Purvena,* were planned to be used for this study. Classroom activities like group work, problem solving, and class test sheets were designed beforehand. Intended learning outcomes designed for this study were improved accuracy, speed of doing problems, and understanding of the concepts.

Acting: In this stage the researcher performs various activities in the class. In the beginning classes, students were asked to recall the multiplication tables up to 5. Afterward, researcher gave an introduction to Vedic mathematics along with its history and importance. Researcher taught multiplication by both conventional and Vedic methods. After demonstrating a few problems, the researcher used to give practice questions to students. Group activities were also conducted in which each group was provided with a set of questions. Class tests were conducted on a regular basis to assess the students' performance.

Observing: In this stage, the student's engagement, their ability to grasp the technique, and their performance were assessed. Students' excitement level and their participation in question answering were also observed. Researchers also pointed out the rate of error while doing the problems. Students were also given the opportunity to share their experience and feedback regarding the Vedic mathematics technique.

Reflecting: In this stage, students' performances were compared before and after the use of Vedic mathematics. Researchers maintained reflection notes of each class to note down positive points as well as challenges of each class. Researchers used a plan for the next day's class on the basis of reflection.

In this action research Vedic mathematics approach was used as an intervention. Lesson plans were designed by incorporating Vedic mathematics techniques, and researchers taught different types of multiplication problems to grade four students using these techniques. Throughout the class, student performance, interest, and engagement were precisely analyzed and recorded in field notes on a regular basis.

Research Site and Participants

The research site for this action research was one of the Secondary level government schools of Kanchanpur District, Nepal. The participants for this action

research were students of grade IV. There were thirty students in that class.

Data Collection and Analysis

Data is very significant in any research study, so data collection needs to be well-organized and collected properly. In this action research, most of the data is qualitative in nature. Classroom observation was the primary tool for data collection. During classroom observation, we emphasized recording students' performance, their engagement in learning, and their interest in the subject. To manage the data properly, field notes were maintained after each class. After the completion of each class, the researchers used to write reflection notes to reflect on the respective class. After completing two weeks of action research, the field notes and reflection notes of each day were carefully analyzed. Then, themes were generated based on the field notes and reflection notes. The purpose was to develop themes that would help answer the research question or the purpose of the research. We also compared the findings of prior research with our current research findings for the discussion.

Results and Discussion

In this section, the main themes that emerged from the analysis of data were Vedic mathematics for students' engagement, Vedic mathematics for enhancing multiplication skill, Vedic mathematics for enhancing interest in mathematics, and Vedic mathematics for overcoming mathematics anxiety. These themes evolved on the basis of classroom teaching and observation of students' activities. Each theme is discussed and interpreted in the following subsections.

Vedic Mathematics for Students' Engagement

In the first class, the researcher as a teacher started the class by asking students to recall a multiplication table. Almost all students were able to recall multiplication tables up to five; a few were able to recall multiplication tables up to ten, but nobody was able to recall multiplication tables for numbers beyond ten. This indicates that students had difficulty in memorizing the multiplication tables. We all know that multiplication is tedious without memorizing the multiplication table properly. There are high chances of errors in the multiplication of numbers, and errors become more frequent with large numbers in comparison to smaller ones (Domahs et al., 2006). Especially, there are various challenges faced by elementary-level teachers in teaching multiplication (Lo et al., 2008).

While teaching multiplication by the Vedic approach, students were so much more active in the class. When students were asked to solve the questions by the Vedic approach, most of them quickly solved and showed to researcher for checking answers as fast as possible. Interestingly, students were helping their peers in doing

the problems. Some of the students were shown confidence to solve the problem on the whiteboard in front of the class. While teaching, students were attentive and took notes with enthusiasm. After the implementation of Vedic mathematics, student participation as well as engagement was enhanced. This ultimately motivates students towards their learning (Jang et al., 2010). One reason behind the engagement of students after the intervention of Vedic mathematics can be because of its short and easy method of calculations. In some cases, the calculations seemed like magic using the Vedic method.

For example, the square of a number whose last digit is 5 can be found in just a second using the sutra "*Ekadhikena Purvena*" as follows:

$$25^2 = (2 \times 3) | 25 = 625.$$

In such a case, we first write the square of 5 on the right, and the left part is obtained by multiplying the given number by one more than that number.

Figure 1

Student's Multiplying Numbers Whose Last Digit is 5

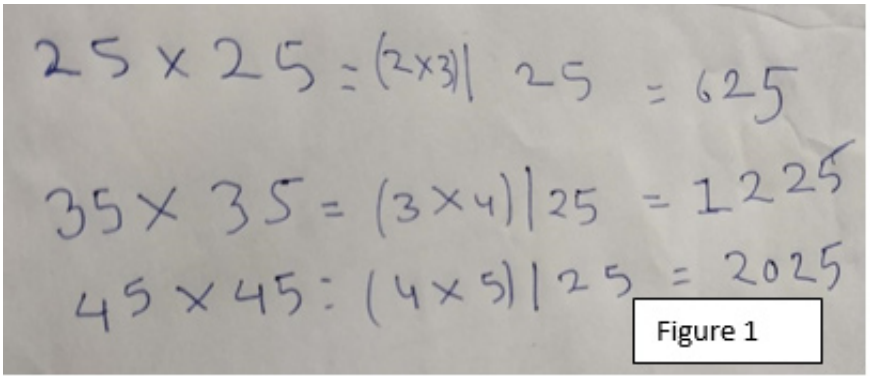


Figure 1 illustrates the work by one of the students, and he has done it correctly. Like him, many others were able to find the squares of numbers whose last digit is 5. After incorporating the Vedic method, students expressed that they loved and enjoyed it. They found this like magic and requested more similar types of problems for practice. They were able to multiply such numbers within a second. In the process of doing multiplication of such numbers, students were found to be engaged. Active engagement leads to enhancing students' motivation and confidence toward learning (Cavanagh, 2011). The researcher's role in the classroom is like a facilitator, in which he offers more opportunities to the students. Students were engaged in problem solving, group work, asking them to solve on a whiteboard, etc. Because of group work, collaboration among students is also enhanced, leading

to meaningful learning. Learning will be effective only when students are actively engaged in the classroom (Wood, 2003).

Rittle-Johnson (2015) mentioned that students generally follow procedures and algorithms, which leads to developing procedural knowledge among the students. As a mathematics teacher, the researcher observed lengthy algorithms and steps in mathematics lead to demotivating students towards learning. In contrast to conventional mathematics, Vedic mathematics provides one-line calculations, and some calculations can be done even mentally. Some of the students replied within a few seconds. When students were asked to multiply 98 and 96, or 105 and 98, and so on, they responded quickly. Once students enjoy practicing Vedic mathematics, they feel comfortable, and their engagement in learning is also enhanced (Shriki & Lavy, 2018).

Vedic Mathematics for Enhancing Multiplication Skill

Mathematical calculations are essential components in mathematics. Basic arithmetic operations—addition, subtraction, multiplication, and division—are fundamental concepts in elementary mathematics. In this action research, we focused on multiplication operations. In the conventional way of performing the multiplication of numbers, it consists of many steps, making it difficult for students. Parajuli (2020) demonstrated basic mathematical operations like addition, subtraction, multiplication, and division can be executed quickly through the Vedic method. During this action research, the researcher observed that students completed the multiplication tasks very quickly when Vedic mathematics techniques were incorporated. The Vedic method is more effective in comparison to conventional methods for doing the multiplication task (Chauhan & Ali, 2021). During this study, students were able to do multiplication tasks very quickly, which is in line with Joshi (2017), who argued that Vedic mathematics aids in achieving accurate and faster mathematical calculations.

Classroom observation showed that students were highly motivated and encouraged in doing the problems by Vedic mathematics techniques. This also signifies that the Vedic approach is more effective than the conventional one in terms of students' achievement in mathematics (Shukla et al., 2017). Chauhan (2021) also supports that sutras of Vedic mathematics are useful for performing mathematical calculations with high accuracy in a short time.

For example, by using the *Ekadhikena Purvena* sutra anyone can find the square of the numbers whose last digit is 5. Like the square of 75 as $75^2 = (7 \times 8) | 25 = 5625$. This can be done in just a second. But it can take a long time by conventional method.

Similarly, the sutra *Nikhilam Navatascaramam Dastah* (''All from 9 and last from 10'') can be useful to multiply the numbers which are near the base (base 10, 100, 1000, etc).

When the two numbers are near base 10 or powers of 10, their multiplication can be found easily by using this sutra. Figure 2 illustrates one of the examples.

Figure 2

Vedic Method to multiply 92 and 95 using Nikhilam Sutra

92	− 8
× 95	− 5
87	| 40

Figure 3

Pupil Applying the Nikhilam Sutra to Multiply the Numbers which are Near the Base 100.

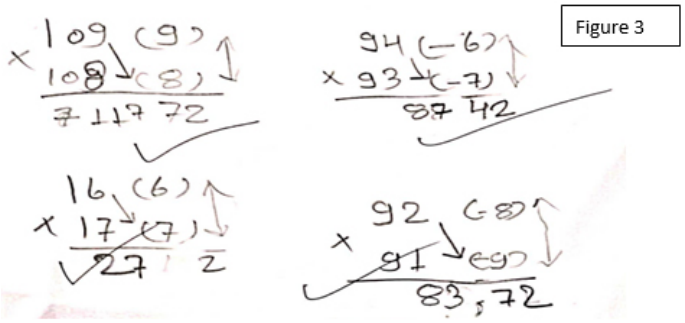
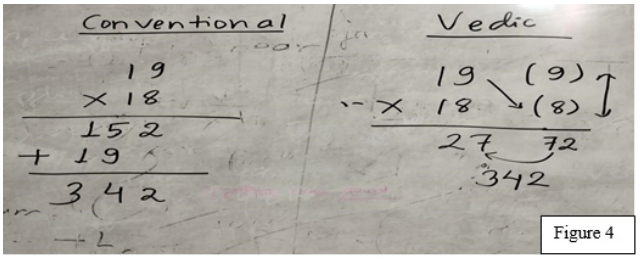


Figure 3 shows one of the students' works in which he incorporated the *Nikhilam* sutra to do the multiplication. He has done the problems correctly and was done so quickly. Most of the other students have also done the above questions correctly in a very short time. This clearly indicates Vedic mathematics has the potential of speedy calculations, as Prasad (2016) mentioned Vedic mathematics enhanced the speed of basic mathematical calculations.

Figure 4

Teachers Demonstration of Multiplication of Two Numbers both by Conventional and Vedic Methods



The example in Figure 4, shows the multiplication of 19 and 18 by both Vedic and conventional methods. When the teacher demonstrated the comparison of two methods, students responded they liked the Vedic technique as it consists of fewer steps and can be done quickly. Students responded that the Vedic method is an easy method to do the multiplication.

Figure 5

Answer sheet of one of the student (P) before using the Vedic mathematics approach

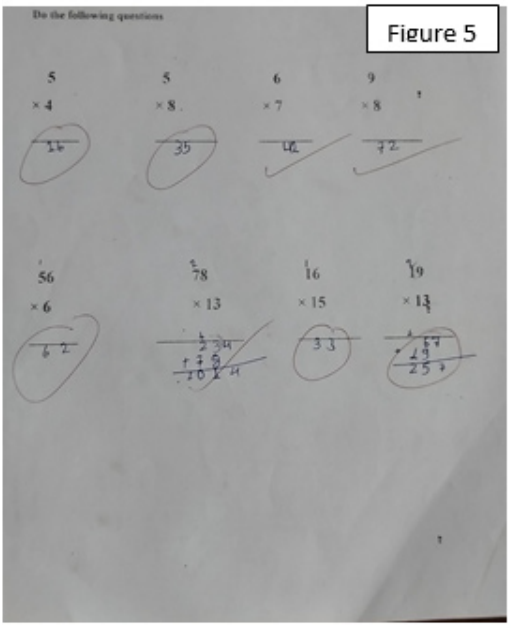
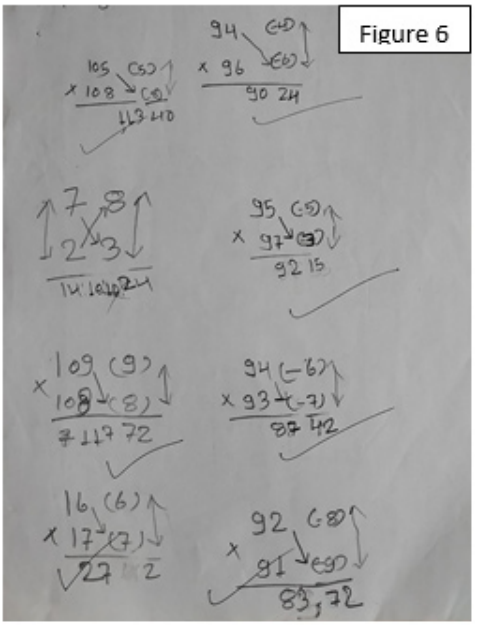


Figure 6

Answer sheet of the same student (P) after being taught by the Vedic approach



Figures 5 and 6 shows the work of one of the students before and after using the Vedic mathematics approach. Figure 5 shows the student's performance without having the knowledge of Vedic mathematics. Actually, Figure 5 reflects the preliminary knowledge of the students, in which we can see several minor mistakes in multiplication. Figure 6, on the other hand, displays the performance of the same student after acquiring the knowledge of Vedic mathematics, showcasing an improvement in the student's multiplication skills. The comparative study of Figures 5 and 6 indicates that the student's performance was enhanced after the incorporation of Vedic mathematics.

Vedic Mathematics for Enhancing Students' Interest in Mathematics

Student's interest is very necessary in teaching learning process for the better

performance. Vedic mathematics includes more enjoyment of math, which leads to increased creativity and confidence among students (William, 2005). One student (A) said that, "*Please assign more questions for homework; I loved practicing Vedic mathematics*." Many others agreed with him; this shows that students loved doing mathematics by the Vedic method. This also reflects they did not feel bored. In the classroom also, students were found to be in a happy mood and becoming confident after using the Vedic approach.

In the context of Nepal, it is a common belief that mathematics is a very difficult subject and not suitable for average students. A National Assessment of Student Achievement, NASA (2018) report also stated that more than half of the students do not have a sense of mathematics. To overcome this issue in teaching mathematics, it is necessary to find a way to enhance students' interest in mathematics. Overcoming students' fear of mathematics needs to be addressed so that students can enjoy mathematics. When multiplication was taught using the Vedic method, students started to love this technique, and their interest towards mathematics gradually found increasing.

Another student (B) asked the teacher, "Sir, can we use the Vedic method for multiplication problems in the examination? I found this method easier than the conventional one." This shows that students prioritize the Vedic method over the conventional method. They found this method easy.

Vedic mathematics is not just a set of tricks; rather, it offers a tool for effective teaching and learning (Shastri et al., 2017). Vedic mathematics enables students to visualize how and why certain methods work. This leads to an increase in students' confidence, and their interest in learning is also enhanced. In general, students used to be familiar with conventional methods, so in the beginning stage, Vedic mathematics also requires some sort of practice. Later on, after understanding the basics of sutras, calculations can be done easily. In this regard, Vedic mathematics is systematic, simplified, unified, and faster in comparison to conventional methods, making the mathematics classroom interesting and enjoyable (Raikhola et al., 2017). This action research just explored teaching multiplication. In teaching other topics of mathematics, this technique can be equally useful.

Another student (C) asked the researcher, "Sir, please give us more and more questions like this for classwork." Other students said the same, which also showed they are happy with the Vedic approach. Throughout the process of teaching, we observed enhancement of students' motivation level, upliftment of their confidence, and an increase in the concentration of students. These findings were also in good agreement with Ismail and Sivasubramniam (2010); they mentioned the enhancement

of students' performance due to the implementation of the Vedic mathematics approach.

Vedic Mathematics for Overcoming Mathematical Anxiety

Mathematics anxiety represents learners' negative feelings or reactions to situations involving numbers, mathematical calculations, and other math-related problems. It is the tension in the learners' minds because of math problems. Learners can experience math anxiety in formal classrooms, standardized tests, or real-world math problems (Ashcraft and Moore, 2009). During the process of this action research, in the beginning phase when Vedic mathematics was not introduced, students were found to be very nervous in doing multiplication problems. They used to commit many errors in simple problems like 15×5, 12×6 and so on. When students were not able to solve problems correctly, they lacked confidence. Low confidence in mathematics leads to math anxiety and decreased cognitive skills among students. Math anxiety starts in elementary schools, ultimately leading to poor performance in mathematics (Shastri et al., 2017).

As a mathematics teacher, we witnessed that, while teaching multiplication by conventional method, students need to go through many steps, and there is the chance of committing mistakes. Due to fear of mistakes, the student's interest towards mathematics diminished. Mathematics anxiety deteriorates both the performance and participation of the students (Newstead, 1998). In Nepalese schools, most students avoid mathematics as an elective course. For example, while choosing elective subjects in grade nine, the majority of students used to choose subjects other than mathematics. Similarly, in grades 11 and 12, few students go with the mathematics major. This is due to math anxiety among Nepalese students. Mathematics is considered a difficult subject from the elementary level of school education.

In the initial class of the action research, most students showed fear towards mathematics. Students were passive and unable to enjoy themselves in the classroom at the beginning of the class. The teacher asked a question to the class: "How many of you feel mathematics is a difficult subject?" Out of thirty students, more than twenty students raised their hands. This indicates that the majority of students had difficulty with mathematics. Progressively, after a few days of teaching using the Vedic technique, students started to enjoy mathematics. A few days later, when the students' views were taken, the majority of them responded that they found mathematics a little easier after Vedic mathematics was incorporated.

In the classroom, "Students were doing the task in a happy mood with smiley faces showing passion and enthusiasm." This shows that students did not feel bored

when taught by incorporating the Vedic mathematics technique. One student said, "Sir, can we use Vedic mathematics to do other types of calculations like addition and subtraction? Please teach us the technique for addition and subtraction using Vedic mathematics." This reflects that Vedic mathematics has helped them overcome their fear of mathematics, which motivates them to learn.

In this regard, Shastri et al. (2017) suggested using Vedic mathematics as a tool to improve cognitive skills as well as to reduce mathematics anxiety among students. By the use of Vedic mathematics, it was observed that students can openly ask their doubts to the teachers. When any problem is assigned to them, they quickly get ready to respond. So it is expected that integrating Vedic mathematics in teaching mathematics subjects at the school level can help in overcoming mathematical anxiety among the students.

Conclusion

Vedic mathematics is a revitalizing approach to teaching mathematics, popular for its fast calculation techniques, fewer algorithms, and mental calculations. This action research demonstrates that students' performance in doing multiplication has been enhanced by incorporating the Vedic mathematics approach. Students were able to do multiplication easily and quickly. In addition to that, students' interest in mathematics also found enriched after incorporating Vedic mathematics. Students' responses suggest that Vedic mathematics techniques are an easier method for multiplication as compared to conventional calculation methods. It was found that Vedic mathematics helped engage students in learning and to overcome mathematics anxiety, leading to the active participation of students in the classroom. Apart from teaching multiplication, the Vedic approach can be equally useful in teaching other topics of mathematics. Taking Vedic mathematics as a tool can ultimately help in meaningful teaching and learning of mathematics at all levels of school mathematics.

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