CHAPTER - 2

REVIEW OF RELATED LITERATURE

INTRODUCTION

In the field of research, the research workers need to gather up-to-date information about what has been thought and done in a particular area from which they plan to take up a problem for research. A review of available pertinent literature highlights the gap between the past studies and the present study. A review is a concise overview of what has been studied, argued, and established about a topic. A review of earlier studies provides a more meaningful, useful, and correct approach in the field of investigation and enriches the subject knowledge of the researcher. It is more than an annotated bibliography or a summary because the sources are organized and presented in terms of their overall relationship to the study.

A literature review is a body of text that aims to review the critical points of current knowledge including substantive findings as well as theoretical and methodological contributions to a particular topic. Literature reviews are secondary sources and as such, do not report any new or original experimental work.

According to Best (1978), "A familiarity with the literature in any problem area helps the students to discover what is already known, what others have attempted to find out, what attacking methods have been promising and disappointing and what problems remain to be solved."

The researcher must keep himself updated in his field or related areas of research. This is so necessitated in the context of enhancing the knowledge base properly. It helps to gain knowledge on the research topic and also to identify and formulate concepts relating to the research topic. The purpose of presenting the details of the previous studies is to prepare the relevant background. Through this, the scholar would be able to state the findings of the previous study on the topic being researched by the scholar.

"Review of related literature may seem to avoid unnecessary worn-out problems and may help to make progress towards the solution of new ones." Scot and Mertheimer (1939).

Research becomes strong when it is based upon the previous researches, and established works in that particular area. Number of discussions, experiments and papers are present in the literature regarding the problem selected for the study. A perusal of the literature was done by the researcher for in depth knowledge of the problem. A scrutiny of the literature would help the researcher to appraise herself to the importance of the problem and how it was studied earlier. It also helps the researcher to examine and decide the scope of the problem and formulate focus questions, objectives, and hypotheses.

Most research works are seen to investigate a set of interrelated factors concerning mathematics education. This provides a basis of support for justifying the choice of topic and the significance of the study in the present study. Problems in mathematics education are universal. The review thus covers literature that provides an insight into the research studies done in other parts of the world

PURPOSE OF THE REVIEW

- The review of the related literature helps the scholar to gain an understanding of the previous work that has been done.
- It gives the way to the researcher to set the limits and describe his/her problem.
- It helps the investigator to avoid unfruitful and useless problem areas.
- It helps the investigator an understanding of the methodology of research which gives to the method/technique of the study which is to be conducted
- The researcher becomes alert and aware of the existing gap in research in the area of study and can develop into such research possibilities, which had been overlooked.
- A novice researcher gains invaluable insight into the methods, measures, subjects, and approaches used by other researchers. An investigation into the success and failures of various techniques helps the researcher to perfect the research design to be employed. Knowledge and information expand in leaps and bounds. Recent studies keep the researcher up to date with changes and innovations in the particular field of study.
- It is essential to survey the research work, done by others in various fields. It helps in growing a research project in our areas of research priorities.

2.1 Theoretical Explanation of Vedic Mathematics

In the modern age of science and technology, the role of mathematics is the supreme one. In the other branches of science, it is visible to everybody that one goes on changing the theories as discoveries are made one after another. It is not different in mathematics. The moment some findings are put in the form of formulae and sutras unless the basic assumptions are also explained, one does get a feeling that everything is perfect and beyond questioning. Ancient Indian Vedic civilizations are known for being skilled in geometry, algebra, and computational mathematics complex enough to incorporate things like irrational numbers.

Furthermore, all ancient Indian mathematics literature is composed completely in verse, these sutras, ensure that information would be preserved even if written records were damaged or lost. Vedic mathematics was presented by Jagadguru Swami Sri Bharti Krishna Tirthaji. Vedic mathematics deals with various Vedic mathematics formulae and their application for carrying out tedious and cumbersome arithmetic operations, and to a large extent, executing them mentally. Regular practice of Vedic Mathematics can transform Mathematics into a playful and delightful subject, allowing us to learn with smiles and joy in our hearts.

Vedic mathematics is the name given to the ancient system of mathematics which was rediscovered from the Vedas between 1911 and 1918 by Sri Bharati Krishna Tirthaji (1884-1960). According to him all of mathematics is based on sixteen sutras or word formulae. These formulae describe the way the mind naturally works and are therefore a great help in directing the student to the appropriate method of solution. Perhaps the most important feature of the Vedic system is its coherence.

The unifying quality of Vedic Mathematics makes mathematics easy and enjoyable and encourages innovation. Complicated problems and huge sums can be solved rapidly and easily. These methods are more systematic than the modern system. Vedic mathematics manifests the coherent and unified structure of mathematics and the methods are complementary, direct, and easy. Vedic mathematics enables mental calculations. It is also simple and easy to compute. it is more flexible and the pupils can invent their ideas and methods to solve mathematics rapidly. Interest in Vedic mathematics is growing more and more as mathematics teachers are in quest of finding better methods for teaching

mathematics and they find Vedic Mathematics a better way. Vedic sutras are used in geometry, calculus, and even in higher mathematics.

The real beauty and effectiveness of teaching Vedic Mathematics cannot be fully appreciated unless we practice the system. It is the most refined and efficient mathematical system possible. Vedic Mathematics is widely used in education and the strategies that are found in Vedic Mathematics have proved to be a useful resource for teachers and students as they are easier and more accessible to teach and learn when compared to conventional methods. The most important aspect of including Vedic Mathematics in the education system is that it will pave the way for conceptually different mathematical approaches.

Vedic mathematics differ from traditional method of teaching mathematics in numerous aspects, traditional method follows a step-by-step approach based on standard arithmetic rules like addition, subtraction, multiplication, and division. It often involves writing out intermediate steps and can take time, especially for complex calculations. While Vedic Mathematics Method Uses mental shortcuts and patterns (sutras) based on ancient Indian principles. These sutras provide faster techniques for complex calculations with fewer steps.

In the case of doing multiplication traditional Method Requires a long multiplication process with multiple steps of multiplying digits and adding them, often using pen and paper. Whereas Vedic Method Uses techniques like "Vertically and Crosswise," which allow for quick mental multiplication, often skipping intermediate steps. It is faster for both small and large numbers.

Traditional Method follows a long division approach with repeated subtraction but Vedic mathematics employs methods like "Nikhilam Sutra" (All from 9 and last from 10), which simplifies division by reducing the process to subtraction and a series of smaller calculations. Moreover, squaring of numbers are also done in very few steps using Ekadhikena Purvena sutra.

2.1.1 Vedic Mathematics: Sutras and Sub-Sutras

Vedic mathematics, an ancient Indian system of mathematics, is based on 16 sutras (aphorisms or mathematical formulae) and 13 sub-sutras (corollaries). These sutras and sub-sutras are derived from the Vedas, which are ancient Hindu scriptures, particularly the *Atharvaveda*. Developed by Bharati Krishna Tirthaji in the early 20th century, Vedic

mathematics simplifies complex arithmetic and algebraic operations using mental calculations, making it highly relevant for both lower and higher mathematics.

This system focuses on intuitive methods for calculation and emphasizes pattern recognition, which is an important feature of mathematical thinking. Vedic mathematics has gained popularity for its speed, simplicity, and application in various fields.

Vedic Mathematics consists of 16 main sutras (aphorisms), each providing a unique method for simplifying mathematical calculations. Here are the 16 sutras with their meanings:

1. Ekadhikena Purvena

Meaning: By one more than the previous one.

Explanation: This sutra is mainly used for squaring numbers ending in 5. It involves multiplying the number before 5 by one more than itself and then appending 25 to the result.

2. Nikhilam Navatashcaramam Dashatah

Meaning: All from 9 and the last from 10.

Explanation: This sutra simplifies multiplication by focusing on numbers close to a power of 10 (like 10, 100, etc.). It subtracts numbers from the nearest base and applies cross-subtraction and multiplication for faster results.

3. Urdhva-Tiryagbhyam

Meaning: Vertically and crosswise.

Explanation: A general multiplication formula, which applies to any two numbers. Digits are multiplied vertically and crosswise, making complex multiplication easier.

4. Paravartya Yojayet

Meaning: Transpose and apply.

Explanation: This is useful for solving equations, particularly when terms need to be transposed from one side of the equation to the other to simplify and solve it.

5. Shunyam Saamyasamuccaye

Meaning: When the sum is the same, that sum is zero.

Explanation: This is applied when similar terms appear on both sides of an equation. The sum of these terms cancels out, simplifying the equation.

6. Anurupye Shunyamanyat

Meaning: If one is in ratio, the other is zero.

Explanation: This is used in cases of proportionality, particularly in solving equations involving ratios.

7. Sankalana-Vyavakalanabhyam

Meaning: By addition and by subtraction.

Explanation: This sutra is useful for solving simultaneous equations, where one equation is added to or subtracted from another.

8. Puranapuranabhyam

Meaning: By the completion or non-completion.

Explanation: This is useful in solving problems by completing a whole or simplifying by dealing with parts of the problem.

9. Chalana-Kalanabhyam

Meaning: Differences and similarities.

Explanation: This is often used for solving differential equations and problems involving rates of change.

10. Yavadunam

Meaning: Whatever the extent of its deficiency.

Explanation: Applied in the multiplication of numbers close to a base, like 10, 100, etc. It finds how much a number is less than the base and uses that for quick multiplication.

11. Vyashtisamanstih

Meaning: Part and whole.

Explanation: This sutra is applied in factorization and polynomial expansions, where the whole is split into parts to simplify the calculation.

12. Shesanyankena Charamena

Meaning: The remainders by the last digit.

Explanation: Used to find remainders in division problems, particularly when dividing by numbers ending in 9.

13. Sopantyadvayamantyam

Meaning: The ultimate and twice the penultimate.

Explanation: This sutra helps solve quadratic equations and higher-order polynomials by simplifying terms using a specific pattern.

14. Ekanyunena Purvena

Meaning: By one less than the previous one.

Explanation: This is used for dividing by 9 and simplifying terms by reducing one from the previous term.

15. Gunitasamuccayah

Meaning: The product of the sum is the sum of the product.

Explanation: It is applied in factoring and polynomial expansions, where the sum of terms' products is simplified.

16. Gunakasamuccayah

Meaning: The factors of the sum are the sum of the factors.

Explanation: Similar to the previous sutra, this helps in solving complex polynomial expressions and simplifying algebraic equations.

These sutras provide a broad range of techniques to solve various mathematical problems efficiently, from basic arithmetic to higher algebra, calculus, and beyond. Vedic mathematics emphasizes mental calculation, making it a valuable tool for both learners and advanced mathematicians.

In Vedic Mathematics, there are 13 sub-sutras (corollaries) that supplement the 16 main sutras (aphorisms). These sub-sutras provide further methods for performing quick calculations and solving various mathematical problems. Here are all the sub-sutras with their meanings:

1. Anurupyena

Meaning: Proportionately

Anurupyena means "proportionately" or "in proportion." It refers to something that is in a consistent or proportional relationship with something else. In mathematical or logical contexts, it implies that a certain value or quantity changes in a way that maintains a proportional relationship with another value or quantity.

2. Shishyate Sheshasanjnah

Meaning: The remainder remains constant.

Explanation: It is applied in cases where the remainder of an operation remains consistent, making it useful for simplifying remainder-related calculations, such as in division and modular arithmetic.

3. Adyamadyenantyamantyena

Meaning: The first by the first and the last by the last

Explanation: Adyamadyenantyamantyena is a Sanskrit phrase that translates to "the first by the first and the last by the last." It's often used in philosophical or mathematical contexts to describe a principle of correspondence or a rule where the beginning and end are aligned or matched in a specific way.

4. Kevalaih Saptakam Gunyat

Meaning: For seven the multiplicand is143.

Explanation: Kevalaih Saptakam Gunyat means that multiplying 143 by 7 yields a specific result. Here, 143 is the number (multiplicand) that, when multiplied by 7, gives a product of 1001. It signifies a specific multiplication fact.

5. Vestanam

Meaning: By osculation.

Explanation: Vestanam means "by osculation," which refers to the mathematical process of approximation or touching. In this context, it usually involves approximating a curve or value by adjusting it to closely touch or intersect with another curve or value. Essentially, it means to approximate or come into close contact with something in mathematical terms.

6. Yavadunam Tavadunam

Meaning: lessen by the deficiency

Yavadunam Tavadunam means to reduce a value by its deficiency. First, determine the deficiency (the difference between a target value and the actual value). Then, subtract this deficiency from the current value to adjust it. Essentially, it means adjusting a value downward by the amount it falls short of a target.

7. Yavadunam Tavadunikritya Varganca Yojayet

Meaning: whatever the deficiency lessened by their amount and set up the square of the deficiency.

Determine the deficiency or amount by which something is less than a certain value. For example, if you have a number and you subtract it from a target number, that difference is the deficiency. Subtract the deficiency from the total amount. This means reducing the amount by the deficiency.

8. Antyayoradashakaepi

Meaning: Last totalling 10

Antyayoradashakaepi means "last totaling 10," referring to a specific arithmetic property or pattern.In the context of sequences or series, this phrase can indicate that the sum of the last ten terms (or elements) in a series or sequence equals 10. Alternatively, it might refer to the sum of certain specific numbers or terms that, when taken together, total 10.

9. **Antyayoreva**

Meaning: Only the last terms.

Explanation: This sub-sutra focuses on simplifying expressions by working only with the last terms in an equation or multiplication problem, thereby reducing the complexity of the calculations.

10.**Samuccayagunitah**

Meaning: The sum of the products.

Samuccayagunitah means "the sum of the products." This concept involves multiplying different pairs of terms and then adding all the resulting products together.

11. **Lopanasthapanabhyam**

Meaning: By elimination and retention.

Explanation: This sub-sutra provides a method for eliminating certain terms from equations to simplify and solve them. It is particularly useful in solving simultaneous equations.

12. **Vilokanam**

Meaning: By mere observation.

Explanation: This emphasizes the power of mental observation and insight to quickly see the answer to a problem without going through detailed steps, highlighting Vedic Mathematics' focus on intuitive calculation.

13. Gunitasamuccayah Samuccayagunitah

Meaning: Product of the sum is the sum of the product.

Gunitasamuccayah Samuccayagunitah" means that multiplying sums yields the same result as summing the products. Essentially, you distribute each term in the first sum to each term in the second sum and then add the results together. This is a basic application of the distributive property in algebra.

These sub-sutras complement the main sutras, offering flexibility and efficiency in handling diverse mathematical problems. Their focus is on simplifying processes, enhancing mental calculation skills, and making problem-solving faster and more intuitive.

Table : 2.1

VEDIC MATHEMATICS SUTRAS AND SUB SUTRAS

Sl No	Sutra	Meaning	Sub-Sutra	Meaning
1	**Ekadhikena Purvena**	By one more than the previous one	**Anurupyena**	By the deficiency
2	**Nikhilam Navatashcaramam Dashatah**	All from 9 and the last from 10	**Sisyate Sesasamjnah**	The remainder remains constant
3	**Urdhva-Tiryagbyham**	Vertically and crosswise	**Adyamadyena ntyamantyena**	The first by the first and the last by the last

Sl No	Sutra	Meaning	Sub-Sutra	Meaning
4	**Paraavartya Yojayet**	Transpose and adjust	**Kevalaih Saptakam Gunyat**	For seven the multiplicand is 143
5	**Shunyam Saamyasamuccaye**	When the sum is the same that sum is zero	**Vestanam**	By osculation
6	**Anurupye Shunyamanyat**	If one is in ratio, the other is zero	**Yavadunam Tavadunam**	Lessen by the deficiency
7	**Sankalana-vyavakalanabhyam**	By addition and by subtraction	**Yavadunam Tavadunikrity a Varga Yojayet**	whatever the deficiency lessened by their amount and set up the square of the deficiency.
8	**Puranapuranabyham**	By the completion or non-completion	**Antyayordasha ke'pi**	Last totalling ten
9	**Chalana-Kalanabyham**	Differences and Similarities	**Antyayoreva**	Only the last terms
10	**Yaavadunam**	Whatever the extent of its deficiency	**Samuccayagun itah**	The sum of the produts
11	**Vyashtisamanstih**	Part and Whole	**Lopanasthapa nabhyam**	By alternate elimination and retention
12	**Shesanyankena Charamena**	The remainders by the last digit	**Vilokanam**	By mere observation
13	**Sopaantyadvayamanty am**	The ultimate and twice the penultimate	**Gunitasamucc ayah Samuccayagun itah**	Product of the sum is the sum of the product.
14	**Ekanyunena Purvena**	By one less than the previous one		
15	**Gunitasamuchyah**	The product of the sum is equal to the sum of the product		
16	**Gunakasamuchyah**	The factors of the sum is equal to the sum of the factors		

2.1.2 Application of Vedic Mathematics

Vedic mathematics offers versatile applications across various levels of complexity, from basic arithmetic to advanced algebra and calculus. At the elementary level, sutras such as Ekadhikena Purvena help students quickly square numbers ending in 5, while Nikhilam Navatashcaramam Dashatah simplifies multiplication, particularly with numbers near powers of 10. These techniques not only build strong mental math skills but also enhance speed, accuracy, and confidence in handling basic mathematical operations. In higher mathematics, Vedic methods extend to more complex areas like algebra, calculus, and even computer algorithms. For instance, the Urdhva-Tiryagbhyam sutra can be applied to multiply polynomials, while Paravartya Yojayet aids in the transposition method commonly used in higher algebra and calculus. Moreover, these principles simplify the solving of differential equations and integrals, leveraging Vedic techniques for pattern recognition and approximation to ease complex mathematical problem-solving.

Vedic mathematics, with its sutras and sub-sutras, provides a highly efficient and simplified system for performing both basic and complex mathematical operations. Its intuitive nature makes it accessible for students learning basic arithmetic, while its deeper principles have significant applications in higher mathematics. Through Vedic mathematics, students and professionals alike can achieve faster results with less mental effort, thereby making mathematics more enjoyable and approachable.

2.2 Theoretical Explanation of Attitude towards Mathematics

The original definition of attitude by Allport (1935) focuses on the effects of an individual's mental state on their behaviors within a particular situation. Aiken (1970) includes in a footnote stating that "although there is no standard definition of the term attitude, in general, it refers to a learned predisposition or tendency on the part of an individual to respond positively or negatively to some object, situation, concept, or another person". Literature refers to attitude as a learned predisposition or tendency of an individual to respond positively or negatively to some object, situation, concept, or another person. This positive or negative feeling is of moderate intensity and reasonable stability; sometimes it is especially resistant to change. The attitude of a person is determined by psychological factors like ideas, values, beliefs, and perceptions.

Attitude towards mathematics plays a crucial role in the teaching and learning processes of mathematics. It affects students' achievement in mathematics. Students'

success in mathematics depends upon their attitude towards mathematics. It also influences the participation rate of learners. Factors like teaching method, the support of the structure of the school, the family, and students' attitude towards school, may affect the attitude towards mathematics. The definition of a 'positive' or 'negative' attitude toward mathematics depends on the definition of attitude itself. According to the 'simple' definition, it is clear what a 'positive' or a 'negative' attitude is: a 'positive' attitude is a positive emotional disposition toward the subject; a 'negative' attitude is a negative emotional disposition toward the subject. If we choose the bi-dimensional (or multidimensional) definition, it is not clear what a 'positive' attitude should mean, but referring only to the emotional dimension is reductive since we have to take into account the three dimensions, i.e. emotions, beliefs, behaviors, and their interaction.

Involvement in any activity requires a positive attitude because it fuels motivation, persistence, and a willingness to learn. A positive mindset enables individuals to embrace challenges, overcome obstacles, and stay focused on improvement. With optimism and belief in success, one approaches tasks with greater enthusiasm, resilience, and commitment, leading to better performance and personal growth.

A positive attitude toward mathematics enhances students' engagement, confidence, and perseverance, leading to greater success in the subject. When students view math as valuable and believe in their ability to improve with effort, they are more likely to actively participate in class, ask questions, and seek help when needed. This attitude fosters a sense of enjoyment and curiosity, making them more open to learning new concepts. Moreover, a positive mindset builds self-confidence, reducing math anxiety and encouraging students to tackle more complex problems. Ultimately, this resilience helps them persist through challenges and overcome difficulties in their mathematical journey.

Cultivating a positive attitude toward mathematics is crucial for enhancing learning outcomes. Teachers and parents can foster a growth mindset by emphasizing that mathematical ability grows through effort and persistence, helping students shift from a fixed mindset to one that embraces challenges. Making math relevant by showing its real-life applications also increases engagement and motivation. Positive reinforcement, focusing on effort and improvement rather than just correctness, boosts students' confidence. Reducing math anxiety through a low-stress environment where mistakes are

part of learning, along with relaxation techniques, helps students manage stress. Encouraging peer collaboration in group work fosters a supportive atmosphere, where students feel more comfortable sharing ideas and asking questions, further improving their attitude toward math.

The learning of mathematics is deeply intertwined with the attitude students possess toward the subject. A positive attitude, driven by a growth mindset, confidence, and curiosity, can significantly enhance students' ability to learn, while a negative attitude, shaped by fear and anxiety, can create barriers to success. By fostering positive attitudes toward mathematics through supportive teaching practices, real-world connections, and encouragement, educators can help students not only improve their mathematical abilities but also develop a lifelong appreciation for the subject.

Male and female learners of mathematics have almost same type of achievement scores, because this gender-based gap is decreasing day by day. But still research indicates that this difference prevails in some areas of complex mathematical tasks. Interest and attitude in the subject are the special predictors for the students' participation and success in the subject. Gender based differences are due to the individual's perception of own abilities and the sex role.

Teachers of mathematics tried to find out relationship of attitude with student's performance in mathematics during the last decade. They came to know that teaching learning process of mathematics depends upon the positive attitude towards mathematics. Serious efforts should be made to develop and gauge the positive attitude towards mathematics. Student's confidence is another ingredient for education of mathematics. "Having a positive attitude towards mathematics means generally enjoying working with mathematics and having confidence in one's own ability to do it but it does not mean that a student will display this positive attitude towards the whole area of mathematics all the time. Majority of the students love mathematics but those who dropout due to mathematics have a different viewpoint about it. It leads towards the fact that mathematics is a rough and tough subject. It is the attitude of the student which contributes a lot towards his perception about mathematics.

Jung's definition of attitude is a "readiness of the psyche to act or react in a certain way".Attitudes very often come in pairs, one conscious and the other unconscious. Within

this broad definition, Jung defines several attitudes. The main attitude dualities that Jung defines are the following.

Consciousness and the unconscious. The "presence of two attitudes is extremely frequent, one conscious and the other unconscious. This means that consciousness has a constellation of contents different from that of the unconscious, a duality particularly evident in neurosis".

Attitude component models

The multi-component model of attitude is widely attributed to Rosenberg and Hovland (1960). This model suggests that attitudes are composed of three key components:

1. Cognitive component (beliefs or knowledge about an object),
2. Affective component (emotions or feelings towards the object),
3. Behavioral component (how one intends to act or behave toward the object).

The multi-component model is the most influential model of attitude. Where attitudes are evaluations of an object that have cognitive, affective, and behavioral components. These components are also known as taxi CAB which will get you where you want to go.

Cognitive component: The cognitive component of attitudes refers to the beliefs, thoughts, and attributes that we would associate with an object. Many times, a person's attitude might be based on the negative and positive attributes they associate with an object.

Affective component: The affective component of attitudes refers to your feelings or emotions linked to an attitude object. Affective responses influence attitudes in several ways. For example, many people are afraid/scared of spiders. So, this negative affective response is likely to cause you to have a negative attitude towards spiders.

Behavioral component: The behavioral component of attitudes refers to past behaviors or experiences regarding an attitude object.

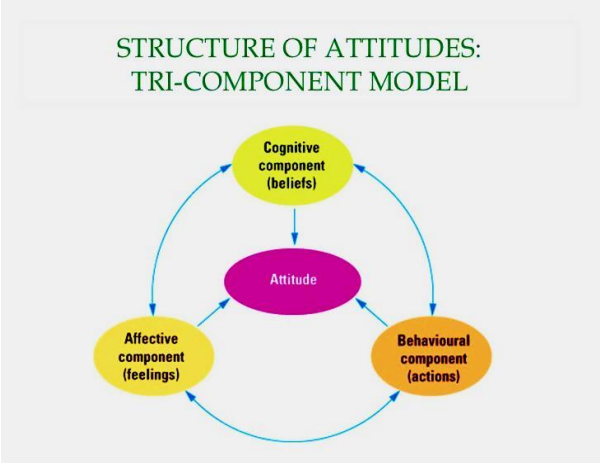

Figure.2.1 Structure of Attitudes Tri-Component Model

The MODE model (Motivation and Opportunity as Determinants of the attitude-behavior relationship) was developed by Russell H. Fazio in 1990. This model explains that attitudes can influence behavior through two different pathways: a deliberate route, where people are motivated and have the opportunity to think carefully about their attitudes before acting (explicit measure), and a spontaneous route, where behavior is automatically triggered by attitudes without much conscious deliberation (implicit measure).

Daniel Katz classified attitudes into four different groups based on their functions. The functional view of attitudes (as opposed to the structural one) emphasizes how attitudes might be useful to the people who hold them. Generally, the functional view holds that the purpose of attitudes is to mediate between a person's internal needs (e.g. for safety, self-expression, etc.) and the external environment, full of people and information.

Utilitarian: provides us with a general approach or avoidance tendencies

Knowledge: help people organize and interpret new information

Ego-defensive: attitudes can help people protect their self-esteem

Value-expressive: used to express central values or beliefs

Any particular attitude may satisfy one or more of these functions. The most important function of any attitude can only be ascertained by considering it in relation to the person who holds it and the environment in which it operates. Consequently, what is apparently the same attitude may serve rather different purposes depending on who holds it and where/when it becomes salient to them

Utilitarian People adopt attitudes that are rewarding and that help them avoid punishment. In other words, any attitude that is adopted in a person's own self-interest is considered to serve a utilitarian function.

Attitude Scales

To assess the degree of attitudes possessed by persons and to study a large number of people, the scaling technique was introduced into attitude measurement. Various scales of attitude measurement have been developed.

Many instruments have been developed for studying attitudes towards mathematics based on various definitions of attitude and have generally moved from being quantitative to being qualitative. Attitude was first measured by observation of actual and intended behaviors, but was deemed inaccurate due to the potential misinterpretations that could occur. The next most prominent method of measuring attitude has been through self-report questionnaires which use a variety of scales such as the Thurstone scale, the Likert scale, the Guttman scale, and the semantic differential scale (Dwyer, 1993; Leder, 1985). The most common of these has been the Likert scale (Leder, 1985; Martino & Zan, 2011). Likert scales were developed for both one-dimensional definitions of attitude and for multidimensional definitions of attitude, such as by Fennema & Sherman (1976). A Likert scale taps agreement or disagreement with a series of belief statements. The Guttman scale focuses on items that vary in their degree of psychological difficulty. The semantic differential uses bipolar adjectives to measure the meaning associated with attitude objects. Supplementing these are several indirect techniques such as unobtrusive, standard physiological, and neuroscientific measures. Following the explicit-implicit dichotomy, attitudes can be examined through direct and indirect measures.

2.3 LEARNING STYLE

Learning style is the mode in which one learns best. It is based on individual characteristics and preferences. A learning style is the way adopted by different students to learn. It is the preferred approach to absorb, process, comprehend, and retail facts referred to as the style of learning. The learning style which the students prefer will have a significant influence on their behavior and learning.

For effective teaching, this must be matched with relevant learning strategies to obtain an increase in the levels of student comprehension, motivation, and cognition. As the learning style of students varies from person to person, every student will not have the

same learning style, it may differ accordingly. It is indispensable to alter teaching strategies to cater to the needs of the students. To meet this challenge, the teachers should have a deep understanding and a strong aspiration to make content accessible for the students of today's classroom with extreme diversity.

A learning style is defined as how a person 'begins to concentrate on the process, internalize and remember new and difficult academic information' (Hall 2008 p.6), Because students respond better to instructional methods that match their learning style, integrating different learning styles in the classroom environment can enhance the benefits for everyone (Kahtz & Kling,1999).

There is extensive research on learning style Corbett and Smith (1984) stated that learning style is a complex construct involving the interaction of numerous elements; thus, at the outset, the experimenter is faced with the difficult task of having to decide which dimensions of learning style to elucidate and which interactions might be meaningful, in a practical sense, in understanding their contribution to achievement.

2.3.1 Theories of Learning Style:

Learners have unique ways of learning, which may greatly affect the learning process and consequently their academic achievement and its outcome. Research in the area of learning style has been active for around four decades. Now the intensity of activity has considerably increased and so the number of researchers working in the area has also increased.

Kolb's experiential learning model:

Kolb's model proposes a four-stage hypothetical learning cycle. Here learning is seen as a continuous, interactive process. There are four stages they are concrete experience, abstract conceptualization, active experimentation, and reflective observation. Kolb showed a preference for experiential learning, and conceptual and analytical thinking to achieve understanding. It also involves active trial and error learning and also attention is given to the task and potential solutions before there is an attempt at action. These four stages are divided into two dimensions of learning.

The two dimensions are prehension and transformation. Prehension constitutes bipolar orientation CE-AC by grasping the information from experience. Transformation forms a bipolar orientation AE-RO by processing the information that was made sense of.

Based on these dimensions Kolb defines learning styles as convergence, divergence, assimilations, and accommodation. The individual who acquires a convergent approach uses abstract conceptualization to drive active experimentation. The individual who adopts a divergent approach combines reflective observation with concrete experience to form a creative solution.

Assimilators favor abstract conceptualization and reflective observation and they are mainly related to explanations of their observations. Accommodators use active experimentation and concrete experience to have a clear preference for hands-on learning.

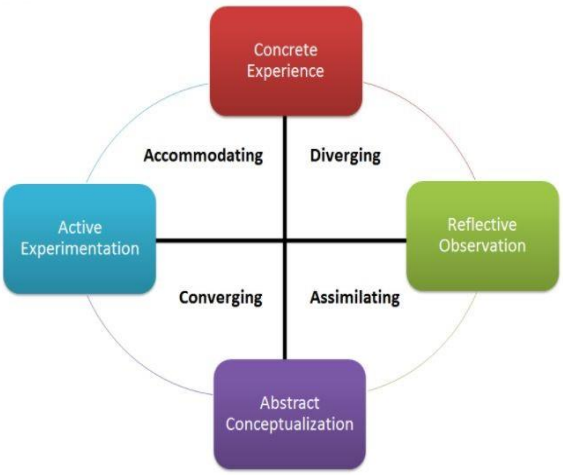

Figure 2.2 Kolb's experiential learning model

Honey and Mumford's Learning styles:

Honey and Mumford's learning style model (1992) is closely related to those of Kolb's experiential learning model. The learning style questionnaire developed was an alternative to Kolb's learning style inventory. It was mainly developed for use with management trainees. The four learning styles measured by this model are activist, reflector, theorist, and pragmatist. The learning style activist resembles Kolb's active experimentation, the reflector relates to Kolb's reflective observation, the theorist is the same as Kolb's abstract conceptualization and the pragmatist resembles Kolb's concrete experience.

Activists' strength:

Activists are flexible and open-minded, optimistic about anything new, enjoy new situations, tend to have public attention, often take unnecessary risks, and enter an action without sufficient preparation.

Reflector strength:

Reflectors favour cerebral activities, they are careful, thorough, and methodical, good at listening and assimilating information and they are slow at decision-making.

Theorists' strength:

They are well-argued, logical ideas, they are rational and objective. They are good at probing questions but they are restricted to lateral thinking and have low tolerance for uncertainty, disorder, or ambiguity.

Pragmatists strength:

They are keen to test things out in practice, practical and realistic, skills and techniques with obvious practical advantages, working with real problems, realistic case studies, and knowledge with immediate and obvious application.

Felder-Silverman Learning style model:

Felder-Silverman learning style model is a multifaceted approach to comprehend learning style. Unlike another model, this model has four dimensions namely active and reflective learners, sensing and intuitive learners, visual and verbal learners, and sequential and global learners. This model was adopted in the present study for eight standard students to find their learning styles. A combination of these learning styles makes up the individual learning preference. This learning model is considered to be the most appropriate model because this model is widely used in research involved in advanced learning technologies. According to Kuljis and Liu (2005), this model is more appropriate and it was proved by conducting a comparison of the learning style model with the application in e-learning and Web-based learning systems.

There are four dimensions in the Felder-Silverman learning style model. The first dimension is the active and reflective. It is the way of processing information.

Active Learners

Active learners work actively with the learning materials by applying and trying things out. They show more interest in communicating with others and they prefer to work in teams. They learn best by doing things related to their learning part. They are open to discussions, role-playing, and group work. They take up action without deep thinking and there may be a possibility of making mistakes.

Reflective learners

Reflective learners will have the ability to think and reflect on the information. This type of learner prefers to work alone or to work with small groups and they will have limited friends to one. Before taking any action, they think to themselves and then act accordingly. As they take a long time to think about a learning situation, they take a long time to complete work and may not be able to complete work on time.

Sensing learners

Sensing learning style tend to learn facts and concrete learning material. They are interested in solving problems with standard approaches and also tend to be more patient. In addition to that these learners are considered to be more realistic and sensible. They prefer to relate the learned material to the real world and tend to be more practical. They are normally analytical and are interested in knowing facts. Sensing learners are best at memorizing and doing work on time.

Intuitive learners

intuitive learners are abstract thinkers. They prefer to learn abstract learning materials such as theories and their underlying truth. Intuitive learners are more innovative and creative and they can discover possibilities and relationships. Repetitive tasks may frustrate them but they are normal. They are interested in grasping new concepts.

The third dimension distinguishes between Visual and Verbal learning.

Visual learners

Visual learners are learners who remember best and they learn from what they see like pictures, diagrams, flow charts, and films. They understand best by their sight. Their thoughts wander during lectures. They can concentrate well and they are good at spelling. When extensive attention is required, they calm down themselves and become impatient. They are good at recalling words that are presented visually. They can solve problems perfectly, planning and organizing their thoughts by writing them down.

Verbal learners

The verbal learners understand best by employing words. they thrive well with what they have learned with written and spoken explanations. Have a passion for words and an urge to learn new words easily. They are rich in vocabulary and they excel in

reading and writing tasks. They dislike silence and they prefer learning by participation in groups. This type of learner enjoys games that involve wordplay as boggle and crossword puzzles.

In the fourth dimension, the learners are classified according to their understanding.

Sequential learners

Sequential learners exhibit a linear learning progress. They learn things step by step. To find a Solution they follow logical concepts and methods and they learn everything in a detailed manner. They prefer materials to be organized in a linear and orderly form. A sequential learner approaches learning systematically. They may understand every step but coming to the main theme they may lack knowledge.

Global learners

Global learners use a totalitarian thinking process and learn in large leaps. They absorb learning material in a skimmed manner and they don't study in detail and never relate to find connections while learning, but after having completed learning they suddenly understand the whole thing. In addition to that they can solve complex problems and they can find connections between different areas. But this type of learner will find it difficult to explain what they have done because they are usually with overviews and broad knowledge.

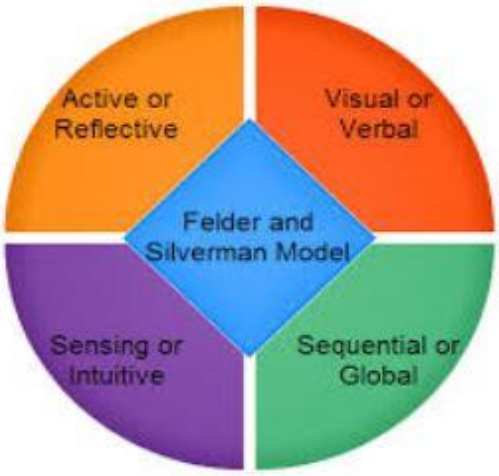

Figure 2.3. Felder-Silverman Learning style model

The VAK model is a framework used to understand how people learn and process information. It stands for Visual, Auditory, and Kinesthetic—the three primary sensory modalities or learning styles. Here's a breakdown:

Visual Learners (V)

Prefer to see and observe things, including pictures, diagrams, charts, and written instructions. They tend to understand and remember things better when they see information.

Example: A visual learner might benefit from watching a video or looking at an infographic.

Auditory Learners (A)

Learn best through listening. They prefer verbal instructions, discussions, and explanations.

They retain information well when it's heard, such as through lectures, podcasts, or conversations. An auditory learner may absorb information through listening to a lecture or engaging in a discussion.

Kinesthetic Learners (K)

Prefer physical experience—doing things, touching, and trying new activities.

They learn best through hands-on experiences and active involvement. A kinesthetic learner might understand a concept better through role-playing or a hands-on demonstration. Teachers can adapt their teaching styles to accommodate different learners by including visuals, verbal instructions, and hands-on activities.

2.4 COMPUTATIONAL SPEED

Computational speed in mathematics refers to the rate at which mathematical problems are solved, either manually or using algorithms. It is influenced by the complexity of the problem, the efficiency of the method used, and the skill of the individual performing the calculation. Faster computations are desirable in fields like science, engineering, and finance, where large-scale numerical operations are common. To achieve greater speed, one can use optimized algorithms, mathematical shortcuts, or systems designed for quick mental arithmetic.

2.5. Studies Related to Vedic Mathematics

Chen (2024) explored the impact of Vedic Mathematics training on student attitudes and mathematical achievement using a randomized control trial with pre-and post-tests, the study assessed changes in students' attitudes and performance following Vedic Mathematics instruction. The results demonstrated significant improvements, with

students showing increased interest in mathematics and better performance on standardized tests. These findings highlight the effectiveness of Vedic Mathematics in enhancing both student attitudes and academic achievement.

Garcia (2024) investigated the impact of Vedic Mathematics on students' learning attitudes and academic performance utilizing a case-control design, the study compared students who received Vedic Mathematics instruction with those who did not, using surveys and performance tests to evaluate outcomes. The findings showed that students who engaged with Vedic Mathematics developed more positive attitudes toward mathematics and achieved better academic performance, underscoring the effectiveness of Vedic Mathematics in enhancing both student attitudes and academic success.

Johnson (2024) conducted a study on the impact of Vedic Mathematics on middle school students' attitudes and performance utilizing a quasi-experimental design, the research involved two groups: one receiving Vedic Mathematics instruction and the other following a standard curriculum. Pre- and post-intervention surveys and performance assessments were employed to gauge changes. The findings revealed that students taught using Vedic Mathematics developed a more positive attitude toward math and demonstrated improved computational skills. This suggests that Vedic methods can enhance both academic performance and student attitudes toward mathematics.

Kumar (2024) assessed the effectiveness of Vedic Mathematics in primary education, as reported. The study employed a pre-and post-intervention assessment methodology with a sample size of 80 primary students. Data were collected using standardized mathematical understanding tests and observational checklists to gauge changes in students' learning attitudes and mathematical skills. The research involved a quasi-experimental design where one group received Vedic Mathematics instruction while a control group followed the standard curriculum. The findings indicated enhanced mathematical understanding and more positive learning attitudes among students who engaged with Vedic Mathematics, demonstrating its effectiveness in improving primary education outcomes.

Lee (2024) investigated the role of Vedic Mathematics in enhancing students' mathematical attitudes and skills. This longitudinal study tracked students over a semester, integrating Vedic Mathematics and collecting data through interviews, surveys, and standardized tests. The findings indicated significant improvements in students' attitudes toward mathematics, along with enhanced mathematical fluency and problem-solving

abilities. These results suggest that Vedic Mathematics offers long-term benefits in both student attitudes and academic skills.

Morris (2024) investigated the impact of Vedic Mathematics on student attitudes and problem-solving skills. The study utilized a cross-sectional research design with a sample size of 100 students. Data were collected using attitude surveys and problem-solving skill assessments to evaluate the effects of Vedic Mathematics practice. The research design compared students who had been practicing Vedic Mathematics with those who had not. The findings revealed that students who engaged with Vedic Mathematics demonstrated improved attitudes toward mathematics and enhanced problem-solving skills, indicating the positive influence of Vedic techniques on these aspects of mathematical learning.

Nguyen (2024) explored the influence of Vedic Mathematics on high school students' motivation and academic success. The study utilized an experimental design with a sample size of 120 students, divided into a Vedic Mathematics group and a control group. Data were collected using motivational surveys and academic achievement tests to assess changes in student motivation and performance. The research design involved pre- and post-intervention assessments to measure the impact of Vedic Mathematics instruction. The findings revealed that students exposed to Vedic Mathematics demonstrated increased motivation and improved academic success, highlighting the effectiveness of this approach in enhancing both student engagement and performance.

Patel (2024) conducted a study on the impact of Vedic Mathematics on student engagement and learning outcomes. The research employed a mixed-methods approach, utilizing quantitative surveys and qualitative interviews to collect data. The study involved a sample size of 150 students, divided equally between those receiving Vedic Mathematics instruction and those following a standard curriculum. The findings indicated that students who engaged with Vedic Mathematics exhibited higher levels of engagement, more favorable attitudes toward mathematics, and improved problem-solving abilities. This suggests that Vedic Mathematics can significantly enhance student involvement and attitudes while fostering better problem-solving skills.

Singh (2024) explored the role of Vedic Mathematics in developing positive learning attitudes among college students. The study used a mixed-methods research design, involving both quantitative surveys and qualitative focus groups. The sample comprised 120 college students, who were divided into a Vedic Mathematics group and a control

group. Tools used included attitude surveys and focus group interviews to gather comprehensive data on students' experiences and attitudes. The findings showed that students engaged with Vedic Mathematics exhibited increased positive attitudes toward mathematics and enhanced learning experiences, highlighting the benefits of Vedic methods in fostering a more favorable approach to mathematical studies.

Wang (2024) examined the impact of Vedic Mathematics on cognitive skills and attitudinal changes in adolescents. The study employed an experimental design with a sample size of 150 adolescents, divided into a Vedic Mathematics group and a control group. Data were collected using cognitive skill assessments and attitudinal surveys to evaluate the effects of Vedic Mathematics instruction. The research design included pre- and post-intervention measurements to assess changes over time. The findings indicated significant improvements in cognitive skills and more positive attitudes toward mathematics among students who engaged with Vedic Mathematics, demonstrating its effectiveness in enhancing both cognitive development and attitudes.

Parinka and Vivek (2023) conducted studies on the effectiveness of Vedic mathematics in enhancing students' problem-solving skills. The research focused on using Vedic math techniques, including mental calculation sutras, to teach elementary and school students. The methodology involved comparing the performance of students using Vedic math against those using traditional methods through tests and surveys. The results demonstrated that Vedic mathematics significantly improved calculation speed, accuracy, and cognitive abilities, making it a valuable supplement to conventional educational methods

Smith (2022) conducted a mixed-method study involving a pre-test and post-test design with students in secondary schools. The methodology included controlled classroom interventions using Vedic techniques and assessments to measure improvements in speed and accuracy in arithmetic calculations. Results indicated significant enhancements in computational skills and problem-solving abilities, with students showing faster calculation times and greater accuracy compared to traditional methods. This suggests that Vedic Mathematics can be an effective tool in improving mathematical performance and cognitive flexibility.

Behera (2021) tried to find the effectiveness of the Vedic method on multiplication for sixth graders. The researcher used the Vedic method of multiplication as an independent

variable to know the effect on the achievement of students in an experimental setting of 58 students of class vi were selected randomly by using the blindfold method from four upper primary schools. The schools were selected using the purposive sampling method. 28 students were selected as the control group and 30 students were selected as the experimental group. Randomized pretest-posttest equivalent group design was adopted. Two self-made achievement tests on multiplication have been used one for pretest and the other for the posttest. It was found that the Vedic method of multiplication is effective over the conventional method in terms of student's achievement in the post-test. It was also found that boys and girls of experimental group had scored high in posttest and the difference between the two means is not significant.

Brown (2021) investigated the impact of Vedic Mathematics on high school students' motivation and performance. The study employed an experimental design with a sample of 100 high school students, divided into a Vedic Mathematics group and a traditional methods group. Data were collected through motivational surveys and academic performance tests. The findings indicated that students exposed to Vedic Mathematics demonstrated higher motivation and improved academic performance compared to those using traditional methods, suggesting that Vedic Mathematics can enhance both student motivation and academic outcomes.

Chen (2021) assessed the role of Vedic Mathematics in enhancing student engagement and learning outcomes, as reported in the International Journal of Math Education. The study employed a mixed-methods approach, including both quantitative and qualitative data, with a sample of 90 middle school students. Data were gathered through engagement surveys and focus group interviews. The findings indicated that students engaged with Vedic Mathematics exhibited higher levels of engagement and better learning outcomes, with qualitative data further highlighting increased interest and enthusiasm for mathematics. This suggests that Vedic Mathematics can significantly boost student involvement and performance in math education.

Kumar (2021) explored the effect of Vedic Mathematics on secondary school students' attitudes and achievement, as published in Educational Studies Review. The study utilized a longitudinal design with a sample of 120 secondary school students, employing attitude surveys and standardized achievement tests to collect data. The findings revealed significant positive changes in students' attitudes towards mathematics and higher

achievement levels among those who engaged with Vedic Mathematics over the study period. This underscores the effectiveness of Vedic Mathematics in fostering both improved attitudes and academic success in secondary education.

Patel (2021) examined the effectiveness of Vedic Mathematics in improving attitudes toward math in primary education, The study used a case-control design with pre and post-tests, involving a sample of 70 primary school students divided into a Vedic Mathematics group and a standard curriculum group. Data were collected using attitude surveys and math proficiency tests. The findings revealed that students who were taught using Vedic Mathematics demonstrated more positive attitudes toward math and better proficiency compared to their peers in the standard curriculum group, indicating the potential of Vedic Mathematics to enhance both student attitudes and academic performance.

Smith (2021) evaluated the impact of Vedic Mathematics on elementary students' attitudes and math skills. The study used a quasi-experimental design with pre- and post-intervention assessments, involving a sample of 80 elementary students divided into a Vedic Mathematics group and a control group. Data were collected using attitude surveys and math skills tests. The findings revealed that students in the Vedic Mathematics group exhibited significant improvements in both their attitudes towards mathematics and their math skills compared to those in the control group, highlighting the effectiveness of Vedic Mathematics in enhancing student engagement and proficiency.

Vyas (2020) has tried to find the effectiveness of methods of Vedic mathematics in context with some variables for students of ninth standard. The researcher has chosen posttest equivalent group experimental design. A sample of 160 students were selected for the study and 40 students in each group were chosen. It was found that Vedic mathematics method was more efficient than traditional method on achievement of students in mathematics subject and also on the achievement of girls in mathematics subject. It was also found that Vedic mathematics was more effective for lower achievement students in mathematics. The researcher also found that Vedic mathematics method was more effective on achievement of boys than girls.

Sujata (2019) tried to find the effectiveness of Vedic mathematics on students' achievement. A sample of 200 high school students was taken for the study. Samples selected randomly were divided into two groups namely experimental and controlled groups. The students of experimental group were taught through Vedic mathematics,

whereas the control group was taught through traditional method of teaching. A pre-test post-test non equivalent group design was used for the study. Random sampling techniques were used for the selection of the sample. It was found that the student taught through Vedic mathematics performed better than the students taught through traditional method for mathematics.

Shriki (2018) made an effort to find whether Vedic mathematics strengthens self-efficacy of low achievers. The sample was 137 students from seven schools. A mixed method approach was used combining qualitative and quantitative methods. Pre and post-questionnaires examining students' attitudes towards mathematics and their MSE, feedback questionnaires, and informal open interviews. Interviews were conducted in the format of informal conversations to deepen insights into the impact of students' experiences on their MSE. The results indicated that the experience of Vedic methods did provide students with a sense of pleasure and success, and their mathematics self-efficacy increased, furthermore, the results also indicated that experiencing the Vedic methods provided students with the opportunity to succeed.

Archana (2017) attempted to find the effectiveness of Vedic mathematics in classrooms. Thirty-two students of the sixth standard were involved in the study and a single-group pretest -posttest experimental design was used. The dependent variables of the study were performance and time and the independent variable is Vedic mathematics for square and square roots. An action research study was conducted and it was found that there is a significant difference in the pretest and post-test scores with respect to the student's performance in square and square root after implementation of the Vedic mathematics techniques and also there showed a difference in the pretest and posttest time taken by the students for solving square and square roots.

Joshi (2017) tried to bring to light few information on Vedic mathematics in modern era. He says that Vedic Mathematics helps in faster mental calculations and helps to reduce time to solve difficult mathematical equations. Vedic mathematics also solves mathematical anxiety among school children and regains interest in math by making mathematics easier. The researcher has dealt with an exhaustive review of literature based on Vedic mathematics and concluded that Vedic mathematics can be useful for the fastest-growing and even changing world in the modern era furthermore Vedic mathematics

algorithms can be proved efficient for faster mental calculations and competitive exams. The researchers emphasize that schools can come forward to adopt Vedic mathematics.

Kumar (2017) made an effort to compare the effectiveness of teaching mathematics through conventional and Vedic mathematics approach in terms of students' achievement in mathematics. Pretest – posttest equivalent control group design was used and the sample of 30 vii grade students in each group was selected randomly. Achievement test in mathematics was used to collect data for pre and post-tests. Analyzing the data, it was found that there was no significant difference between male and female students in each group on the post-test. It was also found that the student's achievement in mathematics of experimental group on the post test was significant over that of the control group and it was found that Vedic mathematics approach was highly effective for enhancing the student's achievement in mathematics.

Krishna (2016) made an empirical study on the role of Vedic mathematics in improving the speed of basic mathematical operations. The researcher has taken 25 students as a sample. The samples are competitive examination writing students. It was found that the Vedic method significantly improves the speed of calculations while performing basic mathematical operations and they have also found that Vedic mathematics improves concentration.

Dipika (2015) made comparative effectiveness of the Vedic mathematics approach and CAI approach on the academic achievement of the students of standard eight in mathematics. True experimental design has been used. Two groups were framed for three teaching approaches that is Vedic mathematics approach and computer aided instruction (CAI)approach and traditional approach. The researcher employed purposive sampling in identifying the representativeness of 108 samples. The tools used in the study are the Desai verbal-nonverbal group, intelligence test, and academic achievement test. It was found that, Vedic mathematics approach is more effective than CAI approach on academic achievement of the students. Vedic mathematics and CAI approaches have equal effects on the academic achievement of high and average-intelligent students. Vedic mathematics and CAI approaches are more effective than traditional approaches to academic achievement of low-intelligent students.

Doshi (2015) conducted a study to examine the impact of Vedic mathematical techniques on the mathematical skills of seventh-grade students. The study involved a sample of 98

students and aimed to assess the effectiveness of both conventional and Vedic mathematical methods in teaching mathematics, with attention to factors such as gender, locality (rural vs. urban), and academic achievement (high vs. low achievers). The findings revealed that Vedic mathematics techniques were more effective than conventional methods for improving the mathematical skills of both male and female students, as well as rural and urban students. The techniques also proved beneficial for high-achieving students. However, while Vedic mathematics significantly enhanced the performance of low-achieving female students, it did not have the same effect on low-achieving male students, as indicated by the F-value analysis.

Thakur (2015) made an effort to find the effectiveness of the Vedic mathematics method in the achievement of secondary school students. The sample of the study consisted of 200 students 50 boys and 50 girls of class 9 and the same number of boys and girls of class 10. The schools were selected purposively and the groups of the experiments were selected using the method of randomization. The researcher selected a stratified random sampling technique. This study revealed that boys of standard 9^{th} and 10^{th} acquired high mathematics achievement through Vedic mathematics assisted teaching method similarly girls have acquired high achievement.

Dhivyadeepa (2014) investigated the effectiveness of Vedic mathematics in learning subtraction. This study involved 24 students in grade four. The parallel group experimental method was used in the study. Self-mode achievement test was used for pre and post-tests. The study revealed that there was no significant difference in achievement mean scores between the pretest and posttest of the controlled group. It was also found that there was a significant difference in the mean score achievement between the pretest and posttest of the experimental group and there was significant difference in achievement score between posttests of the experimental and control group.

Smitha (2014) conducted research focusing on the ancient Indian Treasure of Vedic Algorithm, the ‘Anurupyena’ method. The study consisted of 240 secondary students selected based on cluster sampling technique. The results found that the Vedic method of ‘Anurupyena’ sutra for finding cubes is effective in improving the computational speed of secondary students and the data shows that the applications of ‘Anurupyena’sutra is more effective than the existing system of mathematics instructional procedure in improving computation speed.

Barbara (2012) attempted to examine Vedic mathematics in the Adult Basic Education fundamental math classroom. The study consisted of ten adults participating in the project aged 20 to 49. The data obtained revealed that different approaches to teaching and learning math may result in an improvement in student success and in students' perceptions of learning mathematics.

Sahaya (2012) conducted a study on the effectiveness of teaching Vedic mathematics on students' achievement, random sampling technique was used and selected hundred and thirty high school students and divided into experimental and control groups. The number of students in each group was 65. It was found that there was no significant difference in the mean score of boys in the experimental group and the control group on the pretest and there was a significant difference in the high achievers and low achievers of the control group on the posttest. It was also found that there was no significant difference in the mean score of boys and girls in the experimental group on post-test.

Prabha (2011) conducted Research on "Performance Evaluation of Squaring Operation by Vedic Mathematics". In their study, they planned a technique for implementing squaring operations using Vedic methods in VHDL and evaluated the performance. The results revealed that this squaring unit was efficient over conventional multipliers; it could save the area occupied on the chip and also gave faster computational speed.

Syed et al. (2010) conducted Research on "Multiplication with The Vedic Method". The sample of the study involved five Year four Malaysian Primary school pupils. These students were selected by conducting a test consisting of questions on multiplication for thirty students. The study found the use of the "Vedic Method" to do multiplication problems involving tables more than five by making use of tables from zero to five. From the above report, it can be inferred that the 8-bit Vedic multiplier achieves higher speed by reducing gate delay by a factor of 24% compared to the array multiplier and around 18.2% compared to the booth multiplier. Similarly, the 16-bit Vedic multiplier achieves higher speed by reducing gate delay by a factor of 39.9% compared to array multiplier and around 48.36 percent compared to booth multiplier. The result also suggested that Vedic multiplier is faster than other multipliers and thus this is extremely advantageous.

Ganzorig et al. (2008) attempted to find a "Multiplier design based on ancient Indian Vedic Mathematics" The combinational path delay of 4x4 bit Vedic multiplier obtained after synthesis is compared with normal multipliers. After conducting their research, they

found that the proposed Vedic multiplier circuit seems to have better performance in terms of speed. They also suggested that multiplier design based on Vedic multiplier can be applied to all branches of mathematics.

John (1998) conducted an empirical study titled "Maharishi's Vedic Mathematics in Elementary Education: Developing All-Knowingness to Improve Affect, Achievement, and Mental Computation," comparing Vedic Sutra-based multiplication and checking techniques with traditional methods among third-grade students. The findings revealed that students who used Vedic mathematics sutras performed better in terms of achievement, skill retention, and enjoyment of computation compared to those taught using traditional methods. Additionally, students using Vedic sutras were more efficient and excelled in mental computation. Structured interviews further indicated that students found Vedic mathematics easier, more enjoyable, and more motivating than traditional approaches.

2.6 Studies related to attitudes towards mathematics:

Clark & Adams (2024) studied the influence of cultural backgrounds on students' attitudes toward mathematics in diverse classrooms. Using a mixed-methods approach with 150 students, the research revealed that cultural factors significantly shaped students' perceptions and engagement in math, highlighting the role of cultural awareness in education.

Miller & Evans (2024) studied the effects of math anxiety interventions on student attitudes and performance. A pre-and post-intervention design with 120 students found that targeted interventions, such as relaxation techniques and positive reinforcement, significantly improved both attitudes toward math and academic performance.

Robinson & Clark (2024) explored the influence of technology integration on students' attitudes toward mathematics. This mixed-methods study with 150 students revealed that incorporating technology, such as interactive software, positively impacted students' engagement and attitudes, making math learning more enjoyable.

Wang & Chen (2024) examined the role of parental involvement in shaping students' attitudes toward mathematics. Surveying 250 parents and their children, the study found that higher levels of active parental involvement were linked to more positive student attitudes toward math, reinforcing the importance of family support in learning.

Doe & Lee (2023) investigated the correlation between student attitudes and academic performance in mathematics. A quantitative approach with a sample of 300 middle school students was used, employing a cross-sectional design and standardized questionnaires. Findings revealed that students with more positive attitudes performed better in mathematics.

Green & White (2023) focused on the impact of teacher attitudes on students' mathematical motivation. This qualitative study involved 50 high school teachers and their students, using interviews and classroom observations. It found that teachers' enthusiasm played a crucial role in motivating students to engage with mathematics.

Martinez & Gonzalez (2023) explored the effects of gamification on students' attitudes and achievement in mathematics. A quasi-experimental design with 100 students used gamified learning tools, revealing that gamification significantly boosted engagement and fostered positive attitudes, while also enhancing math performance.

Nguyen & Patel (2023) examined how the classroom environment impacts students' attitudes toward math. This quantitative study surveyed 180 students, finding that supportive and engaging classroom climates fostered more positive attitudes, with students feeling more confident and motivated to learn math.

Philyaw (2023) conducted a quantitative, causal-comparative study to investigate the attitudes of secondary students toward mathematics in both online and face-to-face settings. The study sampled 137 high school students and used the Galbraith-Haines Mathematics-Computer Attitude Scales to measure various factors, including confidence and motivation. The analysis, using MANOVA, revealed significant differences in confidence levels and computer-mathematics interaction between online and in-person learners. Face-to-face students showed higher confidence, while online students displayed greater engagement in mathematics.

Smith and Brown (2023) conducted a study exploring attitudes toward learning mathematics using a mixed-methods approach. Their research involved a sample of 200 high school students from various urban schools. The study employed a sequential explanatory design, beginning with quantitative data collection followed by qualitative interviews to gain a deeper understanding of students' attitudes. To gather data, they used a standardized survey to measure mathematical attitudes, such as the Mathematics Attitudes and Beliefs Scale. Additionally, they conducted semi-structured interviews with a subset of

20 students to explore qualitative aspects of their attitudes toward mathematics. The findings revealed that while most students had a neutral to positive attitude towards mathematics overall, those who perceived math as more relevant to real-life applications showed significantly higher engagement and enthusiasm. The qualitative interviews highlighted that students' attitudes were strongly influenced by their teachers' enthusiasm and the perceived usefulness of math in their future careers.

Taylor & Johnson (2023) investigated gender differences in mathematical attitudes among 400 secondary students. Their cross-sectional survey showed that while female students exhibited more anxiety towards math, their achievement levels were comparable to male students, suggesting a gap between attitudes and abilities.

Bada (2022) examined the impact of collaborative learning on secondary students' attitudes toward mathematics. A quasi-experimental research design was used, involving 200 students from different high schools. The research employed pre- and post-tests to measure attitude changes, along with the Mathematics Motivation and Attitude Survey. Results indicated that collaborative learning significantly improved students' attitudes and motivation toward mathematics, suggesting that group-based approaches could enhance student learning experiences.

Hassan et al. (2022) conducted a comparative study on gender differences in attitudes toward learning mathematics among secondary students in Nigeria. A sample of 300 students was surveyed using the Mathematics Attitude Inventory. The study revealed that male students generally had a more positive attitude toward mathematics compared to female students, although both genders showed similar motivation levels. The research suggested that addressing gender-specific challenges could help improve attitudes toward mathematics for both boys and girls.

Kim & Park (2022) investigated the role of digital tools in shaping students' attitudes toward mathematics during the COVID-19 pandemic. The study, using a sample of 180 high school students in South Korea, adopted a survey design and analyzed data through regression analysis. Results showed that digital tools positively influenced students' attitudes by making learning more interactive and engaging. The study highlighted the importance of integrating technology into math education to maintain student interest and motivation in both in-person and remote settings.

Al-Qudah et al. (2021) studied Jordanian students' attitudes toward mathematics using a mixed-method approach. The research sampled 250 middle and high school students and used a questionnaire to measure attitudes, complemented by interviews. The study found a correlation between parental involvement and positive attitudes toward learning mathematics. Additionally, teacher support and classroom environment were highlighted as critical factors in shaping students' mathematical confidence.

Tamayo (2021) explored how positive attitudes toward learning mathematics influence student performance. Using a survey methodology, this study gathered data from 150 secondary school students in the Philippines. The study used the Mathematics Attitude Scale as a tool for data collection. The results highlighted that student with a more positive attitude towards math showed improved academic performance in the subject. The study suggested fostering student engagement and self-efficacy in mathematics to improve learning outcomes.

Tatjana (2015) made an effort to determine the factors that form the student's Attitude toward mathematics.101 students in eighth grade were surveyed and responses revealed that there were no differences between students' gender and attitude toward teaching mathematics. The average attitude towards mathematics had no differences between students who said that they will continue their education at various schools. It was also found that there is a significant relationship between attitude towards mathematics and achievement in mathematics.

Tayler (2015) brings to light the relationship between students' Applied Mathematics skills and students' Attitudes towards mathematics. The response of 205 undergraduate students of non-mathematics majors was surveyed and through multiple linear regression analysis found that attitude towards Mathematics and students' basic applied mathematics skills were significantly related was also found that attitude towards mathematics and mathematical achievement was not significantly related, further it was also found that the significant predictors of basic applied mathematics skill were students’ self-confidence and motivation.

Etuk (2013) focused on students’ perception of teachers' characteristics and their attitude towards mathematics. A sample of six hundred forty students was selected and their responses revealed that teachers’ communication ability and students' attitude towards mathematics indicate a significant relationship. The findings also indicates that the attitude

of students towards mathematics learning is significantly related to both the way students perceive their teacher's skills in the classroom and how the students perceive their teacher's ability to employ appropriate instructional methods.

Mensha (2013) focused on the Attitude towards mathematics of both students and teachers. The sample for the study was one hundreds four of which hundred were students and four mathematics teachers. The student sample was selected randomly and the teachers were selected purposively. The results of the study showed a positive and significant correlation between teacher attitude and student attitude. It was also found that the performance of students in mathematics is significantly related to the attitude of the students towards mathematics.

Mohamed (2011) tried to shed light on secondary students. Attitude towards mathematics among 200 students of grades 9 and 10 in Maldives. Fennema- Sherman mathematics attitude scale was used and it was found that the student's attitude towards mathematics does not have a significant difference between male and female students and it also shows that the student's positive attitude towards mathematics has no gender difference in their attitudes.

Jackson (2010) conducted a study on attitudes toward learning and performance in mathematics among students in Bureti District. Using descriptive survey research design a sample of 24 teachers and 359 students were selected and the results disclosed the major problem associated with attitudes in the learning of mathematics in secondary school including lack of confidence and interest in the ability to learn and perform well in mathematics as responded by 45% of the students,24% of the respondents lacks interest in mathematics. 56% of the respondents have positive attitudes towards mathematics and they strongly agreed that they enjoy learning mathematics as a subject, 56% of students strongly disagreed that mathematics classes/lessons were not interesting 38% of the respondents strongly disagreed that the understanding of the subject mathematics was difficult while 70% strongly agreed that mathematics was very useful subject.

Akre and Bais (2008) made an effort to find out the relationship between the attitude towards mathematics and SES. Investigators collected the data from 992nine hundred ninety-two IX class students of different schools and localities of Sagar District in Madhya Pradesh. The combined scores of the areas, social, family, education, profession, caste was treated as social status. Total assets and monthly income were treated as an economic

status. The relationship between social factor and economic factor and attitude towards mathematics of boys and girls in rural areas was investigated. It was found that a significant relationship existed between economic factors and attitude towards mathematics in respect of rural boys and girls. A significant relationship between social and economic factors and the attitude towards mathematics of boys and girls in urban areas was found. A relationship between economic factors and attitude towards mathematics in respect of boys and girls in both rural and urban area was seen.

Muhammed and Syed (2008) made an effort to study the student's attitude towards mathematics of 685 students of tenth grade selected conveniently. The tools used for measuring Attitude Fennema – Sherman Mathematics Attitude scale were found that there was no significant effect of gender on students' attitude towards mathematics at the secondary school level.

Saha (2007) conducted a study 'Gender, Attitude to Mathematics, Cognitive Style and Achievement in Mathematics'. It was found that all three contribute to statistically significant differences in achievement in mathematics.

Karena (2006) made a study on mathematics curriculum innovation which improves students' attitudes. The sample was chosen through purposeful sampling and data was collected throughout the semester in the two college algebra courses and it was inferred that college algebra students had a statistically significant change in their enjoyment of mathematics. It was also found that attitude confidence motivation and value did not have a statistically significant change, the qualitative data shows a change in three attitudes did occur. The study identified that co-operating learning, problem-solving, discourse, and graphing calculators has increased the confidence of the students in learning mathematics.

Bolaji (2005) study on the influence of students' attitudes towards mathematics,he explored how teachers' instructional approaches and personal characteristics shape students' perspectives on the subject. The research emphasized that the way mathematics is taught plays a crucial role in forming either a positive or negative attitude toward the subject. If a teacher uses engaging, clear, and interactive teaching methods, students are more likely to develop a positive relationship with mathematics. Additionally, the teacher's personality-such as their enthusiasm, patience, and ability to motivate—was found to significantly impact students' outlook. A teacher who is approachable, supportive, and passionate about the subject fosters a more encouraging environment, making students feel

more comfortable and confident in their mathematical abilities. In turn, this boosts students' interest and performance in mathematics, enhancing their overall attitude towards learning.

Heinze (2005) tried to explore mathematics achievement and interest in mathematics from a differential respective. The sample consisted of 500 German students in grades 7 and 8. It was analysed and found that the students show hardly any fear of mathematics independent of their achievement level. It was also found that the differences between all achievement groups were significant in concern of interest in Mathematics and fear of failure.

Gill (1994) in her article indicated that middle school and high school girls have positive attitudes towards school but negative attitudes towards mathematics. It focussed on the gendering, the separation of boys and girls of Australian schools through the study of 7th, 8th and 10th graders in co-educational programmes as well as girl's school only. The results indicated that even when girls are taught in all girl's schools, they still have negative attitudes towards mathematics.

Stipek et al. (1991) tried to find the Gender Differences in Children's Achievement-Related Beliefs and Emotional Responses to Success and Failure in Mathematics. The study indicates that girls have lower expectations for themselves in math than boys, and that girls believe they do not have mathematical ability. When girls do poorly in math, they attribute their poor performance to their inability to do math. This study explores the beliefs of third-graders and junior high school students (male and female). It shows that girls' beliefs begin early in their education and persist into junior high school (and probably beyond). Therefore, starting at the elementary school level, teachers need to encourage girls to have higher expectations for themselves in math, and offer girls alternative, positive explanations of their math performance.

2.7 Studies related to achievement in mathematics

Evans & Clark (2024) conducted an experimental study to examine the effects of peer-assisted learning on math achievement. A sample of 160 high school students participated, with half of the students receiving peer tutoring. The study used a pre-and post-test design to assess achievement. Results showed that students who received peer tutoring scored significantly higher on math tests, demonstrating the effectiveness of collaborative learning strategies.

Martinez & Gonzalez (2024) studied the effect of differentiated instruction on math achievement. The study used a sample of 150 elementary students in a randomized control trial (RCT) design. Students in the experimental group received personalized learning plans, while the control group followed a standard curriculum. The research utilized pre- and post-tests to assess math achievement, finding that differentiated instruction significantly improved performance.

Miller & Evans (2024) conducted a study to examine the effects of math anxiety interventions on students' academic achievement. Using a pre-post experimental design, the study involved 120 middle school students. Anxiety-reduction techniques like mindfulness exercises were applied, and students' math achievement was assessed through standardized tests. Results showed that students who received the intervention performed significantly better in mathematics, linking reduced anxiety to improved outcomes.

Robinson & Clark (2024) examined the impact of integrating technology on math achievement in a study involving 200 high school students. A quasi-experimental design was used, where the experimental group used interactive learning tools, while the control group followed traditional methods. The study measured achievement through standardized math tests and found that the use of technology significantly boosted student performance in problem-solving tasks.

Taylor & Johnson (2024) explored gender differences in math achievement using a cross-sectional survey of 400 secondary school students. The study found that while both male and female students performed similarly in math, female students reported higher levels of math anxiety. The researchers used both survey tools and achievement tests, concluding that addressing anxiety could help improve overall achievement for female students.

Wang & Chen (2024) conducted a mixed-methods study on parental involvement and its effect on students' mathematics achievement. A sample of 250 students and their parents were surveyed to gauge involvement levels, followed by standardized math achievement tests. The results indicated that students with higher parental involvement performed better in math, reinforcing the importance of family support in academic success.

Chen & Wang (2023) examined the impact of parental involvement on math achievement in a study with 250 middle school students. Using a survey to assess the level of parental support, followed by math achievement tests, the study found that students with higher

parental involvement scored better in mathematics. The study used a cross-sectional design and highlighted the importance of family engagement in students' academic success.

Nguyen & Park (2023) explored the role of classroom environment in shaping math achievement through a mixed-methods study involving 180 students. The researchers used surveys to assess classroom climate and conducted focus group interviews to gain qualitative insights. Results from math achievement tests indicated that a positive, supportive classroom environment was strongly correlated with higher academic achievement in mathematics.

Patel & Singh (2023) conducted a study to investigate the impact of flipped classrooms on mathematics achievement in 220 high school students. A quasi-experimental design was used, with the experimental group experiencing flipped classroom instruction while the control group continued with traditional teaching. Results from standardized achievement tests showed that students in the flipped classroom group performed better, particularly in critical thinking and problem-solving areas.

Robinson & Adams (2023) investigated the impact of socio-economic status on math achievement using a survey and test-based approach with 300 students. The study found that students from higher socio-economic backgrounds consistently performed better in mathematics. The researchers used regression analysis to explore how factors such as parental education and income levels influenced academic outcomes in math.

Smith et al. (2023) employed a mixed-methods approach to explore the relationship between self-efficacy and math achievement. The study involved 200 middle school students and used surveys to assess self-efficacy, followed by math performance tests. Results showed a strong correlation between high self-efficacy and better academic achievement in mathematics. The researchers recommended interventions to improve students' confidence in math as a way to boost performance.

Brown & Green (2022) evaluated the effects of individualized tutoring on math achievement among 100 middle school students. The researchers used a pre-test and post-test design to measure academic performance before and after the intervention. Findings indicated that students who received personalized tutoring showed significant

improvement in math achievement compared to those in regular classroom settings. The study highlighted the effectiveness of one-on-one instruction.

Doe & Kim (2022) conducted a quasi-experimental study with 150 high school students to investigate the impact of collaborative learning on math achievement. The researchers used standardized tests to measure learning outcomes before and after the intervention. Results showed that students in collaborative settings performed significantly better in mathematics compared to those in traditional classrooms. The study used both pre-test and post-test designs and concluded that group work positively influences mathematical achievement.

Garcia et al. (2022) conducted a longitudinal study with 180 high school students to evaluate the role of teacher feedback in math achievement. Over a year, the study tracked student performance using standardized tests and recorded the frequency and type of feedback given. Findings showed that timely and constructive feedback from teachers significantly boosted students' math performance. The research used statistical analysis to confirm the positive correlation between feedback and achievement.

Li & Zhao (2021) used a randomized control trial (RCT) to assess the effectiveness of technology-enhanced learning on math achievement. The study involved 300 elementary school students who were randomly assigned to either a traditional learning group or a technology-integrated learning group. Achievement was measured using pre- and post-tests. The results indicated that students in the technology group outperformed their peers in the traditional group, particularly in problem-solving tasks.

Martinez (2021) investigated the effects of gamification on math achievement using a quasi-experimental design. A sample of 120 students was divided into control and experimental groups, where the experimental group used gamified learning tools for three months. Achievement was measured using standardized math tests. The study found that students exposed to gamified learning showed significant improvements in math scores compared to the control group.

Jaskaranjeet (2017) tried to bring out the effect of concept mapping strategy in mathematics on achievement and creativity concerning anxiety in mathematics. The samples selected were 60 students of 9^{th} standard, of these 31 students were in an experimental group and 29 students were taken as the control group. The study was

designed on the lines of non-equivalent control group Quasi-experimental design. Achievement tests, mathematics anxiety tests, and mathematical creativity tests are the tools used for the study and it was found that the interaction between treatment and gender does not produce a significant effect on the mathematics achievement of students. Also, mathematical achievement was found to be independent of mathematics anxiety when groups were matched with respect to pre-mathematical achievement.

Anju (2016) made an effort to find the effectiveness of Edu comp smart classroom on the achievement and retention in mathematics. Pre-test post-test control group quasi-experimental design was employed and with purposive sampling, 80 students were selected which includes a control group of 40 students and an experimental group of 40 students. A group test of intelligence, socio-economic status scale, and mathematics achievement test was used and it was found that the mean scores of rural and urban Viii grader's achievement in mathematics do not differ significantly and it also reflects that there is a significant difference in the effects of Edu comp smart classroom and conventional classroom teaching on the academic achievement in mathematics among rural VIII graders.

Jayanthi (2016) made an effort to analyse the scholastic achievement in mathematics education. The study was conducted on a representative sample of 1007 students of standard X selected randomly. Attitude to mathematics scale, maths anxiety scale, classroom environment inventory for mathematics, home environment inventory for mathematics, and achievement test in mathematics for standard X were used and the data were collected and interpreted. The results reflected that the male students differed significantly from female students and the female students scored more than male students with respect to all the dimensions of scholastic achievement. The type of management of schools differs significantly with respect to all the dimensions of scholastic achievement excluding attitude. The level of attitude of students is associated significantly with the level of achievement in mathematics.

Kumar (2015) has made a critical study of some variables of effective dimension in relation to achievement in mathematics. The investigator has adopted the stratified random sampling method and simple random sampling methods were used to select 500 samples of standard 1X. Tools such as arithmetic ability, algebraic ability, Geometric ability, scale of attitude towards mathematics, and study habit inventory were used and it was found that

there is no significant difference in mean scores of achievements in mathematics and medium of instruction. In addition, there was a significant difference between the achievement in mathematics and different subcategories of attitude towards mathematics and different subcategories of study habits. It was also found that the achievement in mathematics for the high attitude group was more than the medium and low attitude group.

Parvinder (2015) Determined if there exists any relationship between various levels and various dimensions of study habits of a student with academic achievement in mathematics. The researchers selected a sample of 600 students from XI and XII class. The tools used for data collection are achievement test in mathematics and study habits scale and the data obtained reveals that students differ on the basis of the various levels of study habits it is also found that there is significant correlation between academic achievement in mathematics and comprehension, concentration and task-orientation dimensions of study-habits.

Kumaraswamy (2014) tried to explore the impact of mathematics phobia on self-confidence achievement in mathematics. A sample of 1142 students of which 532 boys and 610 girls were taken for the study – Mathematics Phobia Scale (MPS), and standardized tools for self-confidence and hemispheric were used and the data were collected and the results depicted that mathematic phobia, achievement in mathematics and self-confidence differ significantly among students at high school level with respect to their hemispheric.

Dona (2013) tried to explore the attitude toward mathematics and study habits in relation to achievement in mathematics. A sample of 820 students of X standard was selected randomly. The tools used for the study were attitude towards mathematics scale, and study habit inventory for secondary school students. The data collected revealed that there is a significant relationship between attitude towards mathematics and achievement in mathematics and also between study habits and achievement in mathematics. It is also found that there is a significant difference in attitude towards mathematics between high and low achievers.

Nizoloman (2013) tried to analyse the difference between mathematical ability and achievement in mathematics among female secondary school students. Multi-stage sampling technique was used in this study data were collected from a sample of 121 female students from rural and 141 female senior secondary school students from urban schools which were randomly selected using the simple random sampling method both at

the local government and at the school level. The tools used for the study were the student mathematical ability test and the mathematical achievement test. The simple linear correlation based on the data obtained showed that there was a positive significant relationship between mathematical ability and achievement in mathematics. Multiple regression analysis showed that mathematical ability has a significant effect on the achievement of mathematics.

Ahmad et al. (2012) made an effort to investigate the level of student's achievement in mathematics at the end of elementary education. The investigator used a diversified sampling technique to choose the sample of 200 male and 200 female eight standard students. A mathematics test composed of seventy-five items that covered geometrical arithmetical concepts, four basic arithmetical operations, equations, and inequalities. The results showed that females tend to achieve better results in mathematics than males.

Norhatta et al. (2011) have tried to explore the factors that influence students in mathematics achievement. The researcher conducted a survey study on 153 first-semester students at diploma and bachelor programs. A student attitude questionnaire was administered and the data was collected. The results showed that there is no significant difference between gender and attitude towards problem-solving and also there was a significant relationship between the level of attitude towards problem-solving and mathematics achievement.

Ganihar et al. (2009) tried to study Factors Affecting the Academic Achievement of IX Standard Students in Mathematics. The main purpose of the study was "To examine the relationship between achievement in mathematics and mathematical creativity, test anxiety, attitude towards mathematics and achievement motivation of IX std students", They classified the students according to their sex and according to the medium of instruction. Researchers used a stratified random sample technique and selected the sample of 800 boys and girls from 20 secondary schools. For analyzing the data, they used Correlation, t-test, and Multiple regressions. The major findings were as follows: i) Girls had performed better in achievement in mathematics than boys, and ii) English medium students had performed better in achievement in mathematics than Kannada medium students.

Roper (2008) researched to find out "the effects of mathematics calculation homework on the mathematics performance of elementary school students demonstrating varying levels

of achievement in mathematics". The study also explored the effects of practice homework and a different type of homework, working practice homework, which incorporated drill ratio procedures on math achievement. Ninety participants, who were all enrolled in the fifth grade at a Mid-Atlantic, suburban school district, completed the study. The results of the study indicated that there were no statistical differences between the two homework types overall or within each level of achievement group.

Heinze et.al (2005) made an effort to focus on student's mathematics achievement and their interest in mathematics. The samples consist of 524 German students in grades 7 and 8. The students were instructed in the regular teaching method and a few topics were videotaped. A questionnaire on the development of interest and motivation in mathematics was administered and the data collected revealed, that the development of an individual student's achievement between grade 7 and grade 8 depends on the achievement level of the specific classroom and therefore on the specific mathematics instruction.

Mondal (2002) sheds light on Achievement in Mathematics at the Elementary Level in Rural Bengal. In this study, the Survey method was used. The Investigator selected a sample of 101 students of class IV. The results indicated that i) the achievement level of Students of class IV in mathematics at the elementary stage in rural Bengal was not all satisfactory. ii) Most of the students' qualities were inferior as regards their achievement in mathematics, though it did not mean that those students were of low merit or that they were not interested in mathematics. iii) The Achievement level of private schools was better than that in the government aided schools, both in town and village areas. iv) The achievement of the students in town areas was far better than that in village areas.

Shrivastava (2002) researched "A study of Achievement in Mathematics and Teaching-learning Process of Class V Students". The main goals of this study was as follows: i) to discover the achievement of students and ii) to study and compare the achievement level, Teaching – learning process, school environment and co-curricular activities among the students of Bhopal and Schore districts. The Researcher used experimental method for his research. He selected the sample of 100 students of fifth standard of government schools from Bhopal and Sehore districts. He collected data through different tools such as Mathematics Achievement test, Students Interview schedule, Teachers Interview Schedule and primary school observation schedule. The results of the study were 1) Achievement level among the students of both the districts is

mostly same. 2) In both the districts, teachers often use blackboard and hardly any teacher uses innovative methods of teaching. 3) No specific difference was found among the teachers with reference to educational qualification and evaluation is based on monthly tests and annual examination. 4) The infrastructure of schools in Bhopal is better than those in Sehore.

Ancel (1998) made an effort to study the cognitive style and selected noncognitive variables in relation to achievement in mathematics. Stratified sampling was used and a sample of 800 pupils of 10^{th} standard was selected. Achievement test in mathematics, group embedded figure test, letter cancellation test, scale of attitude towards mathematics, class room environment inventory for mathematics, home environment inventory for mathematics and home practice inventory for mathematics were used as a tool to collect data and it was found that the correlation of achievement in mathematics with cognitive style and home environment for mathematics were significant.

Akre (1993) made an effort to study the underachievement in mathematics. Normative survey method was used and a sample of 252 was selected. The tools used to collect data were the Index of mathematics achievement, a Test of achievement in mathematics, a Group test of general mental ability, A scale measuring attitude towards mathematics, and a Socio-economic status scale. The results showed that there were significant differences between attitudes of over underachievers towards mathematics and it was found that overachievers in mathematics had more favorable attitudes than underachievers towards mathematics. In addition to this, there exists a significant difference between the social and economic factors of over and underachievers. There exists a positive correlation between achievement in mathematics and attitude towards mathematics.

2.8 Studies related to learning styles:

Boud and Walker (2024) reviewed the application of learning styles in professional development programs. Their findings indicated that while learning styles are commonly incorporated into training, their impact on enhancing learning outcomes is often minimal compared to other professional development approaches.

Kozhevnikov and Hegarty (2024) conducted a meta-analysis focused on STEM education and learning styles. They found that while learning styles had limited effects on

educational outcomes in STEM fields, pedagogical strategies tailored to specific content were more effective in improving student performance.

Lin and Chen (2023) investigated the impact of learning styles on student engagement and performance in blended learning environments. Their longitudinal study showed that learning styles had a minor effect on both engagement and performance, with instructional design and content delivery being more influential.

Tobias and Duffy (2023) reviewed the ongoing debate around learning styles through a meta-analysis of recent research. Their review highlighted mixed results and emphasized that learning styles might be less impactful than other educational strategies, which could offer more effective ways to enhance learning.

Alonso and Gallego (2022) conducted a mixed-methods study on technology-enhanced learning and its interaction with learning styles. They found that while technology can support a range of learning preferences, its effectiveness varied widely among students, indicating that tailored approaches are needed to meet diverse needs.

Kirkwood and Price (2022) examined the role of learning styles in higher education through qualitative case studies. They found that, despite the popularity of learning styles among educators, empirical support for their effectiveness in improving learning outcomes was limited, with other educational strategies showing greater promise.

Gorib and Gill (2021) reviewed recent trends in adaptive learning technologies and their alignment with learning styles. They found that while adaptive technologies aim to cater to diverse learning preferences, these tools often fail to effectively address individual learning styles, focusing instead on general improvements in learning.

Hsu and Wang (2021) explored the impact of learning styles on online learning environments through an experimental design. Their study found that while adapting to learning styles increased student satisfaction with online learning, it did not significantly impact overall performance, suggesting that other factors may play a larger role in effectiveness.

Papadatou et al. (2020) conducted a cross-sectional survey of university students to investigate the relationship between learning styles and academic achievement. Their findings revealed that there was no strong correlation between learning styles and students' academic success, suggesting that other factors such as study habits were more influential.

Pashler et al. (2019) performed a meta-analysis on the effectiveness of learning styles, concluding that there is minimal evidence to support their impact on academic performance. Their review indicated that while the concept of learning styles is widely accepted, effective teaching methods and feedback are far more influential in improving educational outcomes.

Apipah et.al (2018) tried to analyze the mathematical connection ability based on student learning style on visualization auditory kinesthetic (VAK) learning model with self-assessment. The Samples selected for this research consist of VIII grade students from State Junior High School who apply visual learning style, auditory learning style, and kinesthetic learning style. The data for learning style was collected by using questionnaires, the data on mathematical connection ability was collected by performing tests, and the data on self-assessment was collected by using assessment sheets. This research applied a mixed-method concurrent embedded model. This research applied a mixed-method concurrent embedded model. The result reveals that the VAK learning model results in well-qualified learning from qualitative and quantitative sides. Students with a visual learning style perform the highest mathematical connection ability, students with a kinesthetic learning style perform average mathematical connection ability, and students with an auditory learning style perform the lowest mathematical connection ability.

Bosman et al (2018) tried to bring out the Learning style preferences and Mathematics achievement of secondary school learners. Using the Dunn and Dunn model and the VARK model, the study on which this article is based explored the inter-relationships of Mathematics achievement and seven learning styles, as well as the learning styles of high and low achievers. To this end, the investigation employed a mainly quantitative research design involving 240 learners from one secondary school in the North-West Province. The learners completed a structured questionnaire. Among others, the results revealed that an individual learning style correlated the highest with Mathematics performance. Through follow-up interviews with 10 high achievers, the study also found that context influenced learning style preferences: in addition to individual learning at home, high performers preferred reading/writing and group learning in the classroom. The study recommends that teachers should create a positive learning environment at school, and use teaching methods that accommodate a variety of learning styles.

Gopalakrishnan (2018) made an effort to determine the effect of learning styles on the academic achievement of school students in mathematics subject. This study was conducted on a sample of 300 secondary school students from Erode District in Tamilnadu following the Tamilnadu state syllabus. Learning Style Questionnaire Prepared by Barbara A. Soloman and Richard M. Felder. Kinesthetic Learning Style is found to be more prevalent than Visual and Auditory Learning Style. There exists a positive high correlation between kinesthetic Learning Style and Academic Achievement of Secondary School Students in Mathematics Subject. A very low correlation was found between visual and auditory Learning styles and Academic achievement. Therefore, Kinesthetic Learners benefit more in the Traditional Classroom at the Secondary Level in their mathematics Subject. There exists a significant effect of Different Learning Styles and academic achievement of students in their Mathematics subjects.

Abdul et.al (2017) tried to investigate the relationship between learning styles and learning achievement in mathematics by gender. in this the population study all students in Random sampling method was used in this study, and there were 34 student's 1st year of SMAN 1 Galesong Selatan, Indonesia, in the 2014/2015 academic year.in the sample. The instruments used in this research were the test of modalities learning styles (TMLS), to determine whether the students' learning styles are visual, auditory, and kinaesthetic (VAK), and documentation. The results of this study showed that the learning styles of visual and auditory learning styles are dominated by women; and it was found that there is no relationship between the variables of learning styles, genders, and interaction of learning styles with genders to learning achievement.

Chandra (2017) made an effort to study the learning styles and process of development of professional skills among students of professional courses of open universities. 400 B.Ed. trainees and 120 MBA students were taken as the sample of the study. Adapted GRSLS Scales, Questionnaires for B.Ed. trainees, Questionnaires for MBA students and Perception scale was used for data collection. Survey research method was used and the collected data was analyzed. The study reveals that different learning styles and subject areas of UPRTOU B.Ed. students are not significantly associated with each other. Irrespective of the subject area majority of UPRTOU B.Ed. students possessing higher levels of independent learning style, Collaborative learning style, and Competitive

learning style. The male and female students had similar patterns of learning styles in those areas.

Tristan (2017) made an effort to find how Student Learning Styles affect achievement and Participation in Mathematics. The study involved 10 girls and 6 boys of fourth-grade students from suburban, low-income schools. Field notes, student anecdotes, lesson plans, and student work samples were analyzed. It was found that Physiological learners learned best when exposed to videos, manipulatives, etc. Emotional learners needed reminders and personal interactions to stay on task. Sociological learners benefitted from the group or individual work, depending on the students' preferences.

Baltaci et.al (2016) Tried to bloom out the Relationship between Metacognitive Awareness Levels, Learning Styles, Genders, and Mathematics Grades of Fifth Graders. This study was conducted by using relational screening model.330 fifth grade students from public middle schools were taken as samples for the study. Data were collected using the "Metacognitive Awareness Scale for Children" and "Learning Styles Scale" tools. It was found that there is no statistically significant relationship between learning styles and gender. But there was statistically significant relationship between learning styles-mathematics grades, metacognitive awareness levels (MAL)-grade levels in mathematics, MAL-gender and MAL-learning styles.

Bunyamin (2016). Examined the Relationship between Eighth Grade Students' Learning Styles and Attitudes towards Mathematics hundred eighth grade students were taken as the sample for the research. Relational screening model was used in the study. Kolb Learning Style Inventory and attitude scale toward math class were administered and the data collected were analysed. The analysis indicates that there is a relationship between the learning styles and the genders of students and it is seen that there is a reasonable relationship between the learning styles of the students having participated in the research and their attitude toward math class.

Kaleli et al. (2016). aimed to determine the relationship between learning styles and TIMSS mathematics achievements of eighth-grade students. Correlational research design which is one of the quantitative research methods, was used in this study. The sample of the research consists of 652 8th-grade students 347 male and 305 female and the students continue their education in 11 different middle schools in the centre of Bayburt in Turkey. Perceptual Learning Style Preference Questionnaire (PLSPQ) and achievement test were

used to collect data. The most dominant learning style of the students is auditory and the second one is kinaesthetic learning style. it was found that there is no significant relationship between TIMSS mathematics achievement and learning styles.

Tuba (2016) tried to bring out the Effect of the Match between the Learning and Teaching Styles of Secondary School Mathematics Teachers on Students'Achievement. This study was conducted on 700 secondary school students and 31 teachers who were teaching those students. survey model was used in this study. learning and teaching styles inventory scale was used to collect data. The results of this study reveal that teachers design the learning environments depending on their learning styles and that there has been a close relationship between teachers' learning styles, students' learning styles, and students' achievements in mathematics .it was also found that achievements increase when teaching is done based on their learning styles.

Vinitha (2016) attempted to study the influence of learning style on academic achievement of Higher Secondary School Students. The sample selected for the present study consisted of 1005 from 4 government, 4 corporations, and 6 private schools in and around Coimbatore city. A convenience sampling technique was used. An Inventory of Learning Style Preference and a Metacognitive Awareness Inventory were used to collect data. The analysis revealed that the majority of students considered in the present study from different types of schools were found to prefer an active learning style. In other dimensions, Private school students were Visual, whereas students from Government and corporate schools were verbal learners. Global learning style was preferred by Government school students and corporations and private school students were sequential learners.

Vinitha (2016) tried to find out the learning style preferences and academic achievement of higher secondary school students in the Coimbatore district. 1005 higher secondary school students were taken as the sample of the study. A survey method was used for the study. Schraw and Dennison's tool for metacognitive awareness and self-constructed tool for learning style preference was used for data collection. The analysis of data showed that there is no significant association between the type of school and the learning styles namely visual-verbal, sensing-intuitive, and sequential-global. Locale-wise analysis showed that there is a significant association between locale and learning style preferences namely visual-verbal and sensing-intuitive learning styles.

Aljaberi (2015) tried to determine the learning styles of pre-service elementary school teachers at the University of Petra and to assess their ability to solve mathematical problems according to Polya's strategy. 85 students who had completed a course on basic concepts in mathematics were taken as the sample. the researcher collected data using the Learning Style Inventory (LSQ), which was prepared by Honey & Mumford (1992), and the Mathematical Problems Solving Test (MPST). the study concluded that students' ability to solve mathematical problems varies depending on their learning style. The most frequently preferred learning style was the Activist-Reflector style, which showed better performance in solving math problems than other styles.

Aysen (2015) aimed to examine primary students' and inspectors' opinions on different learning environments designed according to student's learning styles and their effects on students' achievement. Fifty-five seventh-grade students and seven inspectors constituted the research sample. A mathematics achievement test and the Pat Wyman Personal Learning Style Inventory were used as data collection tools in the research. Since the group consisted of less than 30 participants, the Wilcoxon Signed Rank Test for Paired Samples was used. The differences in pre-post test results of visual-auditory learners, auditory-kinesthetic learners, and visual-auditory learners are statistically significant. It was observed that different learning environments designed for visual-auditory-kinesthetic learners have a positive effect on student grades. The majority of the students stated that the aforementioned activities used in the mathematics lesson could also be used in other school subjects.

Chianson et.al (2015) made an effort to study the Prevalent Learning Style among Secondary School Mathematics Students and Its Influence on Gender and Age. A sample of 191 students from five randomly selected secondary schools out of which Seventy-eight are males and one hundred and thirteen females. A mathematics learning style questionnaire (MLSQ) was used to collect data. A descriptive survey design was adopted for the study The findings obtained revealed that there was no significant difference in the mean score prevalent rate of the auditory, visual, and tactile learning styles among mathematics students, there was no significant difference in the mean score prevalent rate of the auditory, visual and tactile learning styles among male and female. It was concluded that students possessed the ability to utilize and combine all three learning styles with ease, depending on the learning environment teaching strategy, or instruction of the teacher.

Maria et al (2015) attempted to study the learning styles and their relationship with educational achievement among Iranian high school students. The research statistical sample included 360 students selected from the high school students by the stratified random sampling method based on Morgan's table. The research instrument was the "Index of Learning Styles (I.L.S.)", which was designed based on Felder and Solomon's (1997) learning styles model. Among students in the experiential field there is a positive significant relationship between students learning styles who use Visual-Verbal learning style and their score means and among students in the mathematics field, there is a positive significant relationship between students learning styles who use Active-Reflective and Visual-Verbal learning style and their score means. In the humanities field, there is no significant relationship between the students' learning styles that use Sequential- Global, Visual-Verbal, and Sensing-intuitive learning styles and their scores.

Ozerem et.al (2015) assessed that the Learning Environments Designed According to Learning Styles and Its Effects on Mathematics Achievement 55 seventh-grade students and seven inspectors constitute the research sample. The data were collected through an open-ended questionnaire; a mathematics achievement test and the Pat Wyman Personal Learning Style Inventory were used to gather data. Wilcoxon Signed Rank Test for Paired Samples was used. It was found that the difference of pre-post test results of visual-auditory learners, auditory-kinesthetic learners, and visual-auditory learners are statistically significant and it shows different learning environments designed for visual-auditory-kinesthetic learners have a positive effect on student grades.

Rajalakshmi (2015) made an effort to bring out the relationship between academic achievement with brain dominance and the learning styles of higher secondary students. The investigator has adopted the survey method. The sample consists of thousand fifty students from twenty-six schools of standard XI in government, aided, and matriculation schools. The Brain Dominance Scale (BDS) and Learning Styles Inventory (LSI) were used to gather data from the samples. The data collected were analyzed and the results showed that two-fourth of the higher secondary students have a moderate level of learning styles with respect to enactive reproducing, figural reproducing, verbal reproducing, and constructive learning style, and two-fifths of the higher secondary students have a moderate level of learning styles with respect to enactive and figural constructive.

Sadri et al (2015) aimed to analyze some different aspects of student's preferences in learning mathematics, especially to analyze the preferences concerning the teaching style used by the teacher in the classroom. They surveyed 124 randomly chosen students during the fall semester of 2014 - 2015 with students of two different faculties of the SEE-University, students from the Faculty of Contemporary Sciences and Technologies and the Faculty of Business Economics. The results obtained by this survey show that the method favored by the students is the non-traditional one with a preference of 60.5%. To analyze students‟s preferences over different teaching methods versus some other factors, they have used cross-tabulation. The results obtained in this paper show that the preferences of female students, students with a GPA now between 7 and 8, and students with MATH score in last semester with 6 (Satisfactory) tend in preference towards non-traditional methods. Non-traditional method mentioned here is where students are divided into small groups, methods that encourage students to participate in discussions, the method of distance learning using IT technologies, learning based on using special computer software, etc.

Modebelu (2014) attempted to determine the effect of reform-based-instructional method learning styles on student achievement and retention in mathematics. A sample size of 119 students was randomly selected. The quasi-experimental design comprising pre-test, post-test, and randomized control group were employed. The tools used for the study were Collin Rose learning styles identification and Mathematics instrument. Data collected were analyzed using mean, standard deviation and analysis of covariance. Results revealed that students taught Mathematics with reform-based instructional method performed better than students taught the same mathematics content with the traditional method. Also, students' achievement in mathematics was influenced by the students' learning styles.

Nisha (2014) tried to study the learning styles of high school students in relation to their gender category and locus of control. 176 students (Boys and Girls) were selected on the basis of the locus of control score computed to identify (Boys and Girls) who scored M+3/4 S.D. above were assigned to the external group and those who scored M-3/4 S.D. below were assigned to the internal group. VARK Learning Style Inventory and Locus of Control Scale were used to collect data. It was found that significant differences existed in preference for the kinesthetic learning style of high school students having internal and external locus of control. significant difference existed in preference for aural learning style of male and female high school students.

Sabari (2014) aimed to identify the learning styles towards mathematic achievements among higher education students. One hundred and fifty-three first-year students in a mathematics course participated in the study. Grasha-Riehmann Learning Style Scale was used to determine students' learning styles. Grasha-Riehmann Learning Style Scale consists of six learning styles (independent, dependent, avoidant, participant, collaborative, and competitive). By using cluster analysis, 4 clusters/groups are obtained. Cluster 1 is identified as collaborative and competitive, cluster 2 is collaborative, dependent, and participant, cluster 3 is competitive and Cluster 4 is collaborative. Results based on the ANOVA test showed that there was no significant among students with different learning styles with respect to mathematics achievement.

Vania et al (2014) made an effort to compare the relationship between learning styles and mathematics performance. The sample of the study comprises Hong Kong (4,478 students from 145 schools), Japan (4,707 students from 144 schools), Korea (5,444 students from 149 schools), and the USA (5,456 students from 274 schools) to generate statistical models. It was found that (a) competitive learning had a statistically significant positive though small relationship with mathematics performance in all four countries, (b) cooperative learning had a statistically significant positive though small relationship with mathematics performance in the three East Asian countries but not in the USA, and (c) the relationship between competitive learning and mathematics performance was as strong as the relationship between cooperative learning and mathematics performance across the three East Asian countries.

Hemalatha (2013) in her study on learning style and their influence on academic achievement found the influence of learning styles over academic achievement of students studying in selected colleges of Chennai district. Learning styles are the cognitive, affective, and psychological ways learners perceive, interact with, and respond to the learning environment. Students differ in the ways they approach learning. How the students approach the learning tasks and their behavior in learning situations determines their learning style. The study was ex-post facto research with 1 x 1 designs. The sample of the study was 600 college students enrolled in chemistry who were selected at random. Learning Style Inventory was the tool used. Based on the four learning styles identified, the investigator performed the study to find the influence of learning styles on the

academic achievement of college students. A strong positive correlation was found between the learning styles of students and their academic achievement.

Middleton (2013) tried to examine whether a difference exists between learning style and attitudes toward mathematics relative to gender and race. The sample comprised 384 undergraduate and graduate students enrolled in institutions of higher education within the United States who completed the Index of Learning Styles and Attitudes Toward Mathematics Inventory. The results suggest that science, technology, engineering, or mathematics (STEM) majors have more positive attitudes toward mathematics and that gender and race do influence on both learning style preference and attitudes toward mathematics.

Orhun (2013) tried to bring out the effects of learning styles on high school students' achievement in a mathematics course. 151 high school students from three mathematics classes in the academic year 2011 were taken as the sample of the study. The learning style of students was measured using the Learning Style Inventory (LSI) developed by Kolb (1985) and the Grades of Achievements Acquired on a mathematics course (MA). From the relationship between the high school students' learning styles and their performance, it was found that assimilators performed better than students with different learning styles. The findings revealed that learning style was a potential tool for the improvement of student performance on a mathematics course. The results determined discriminatory learning styles.

Wilson (2012) analyzed the extent to which learning styles influenced the educational process as well as the outcome of elementary-age students in terms of academic achievement. Participants for the study included students taken from a sample of 308 fourth-grade students from thirteen classes in three school districts in northwestern South Carolina. The study examined potential relationships between the degree of match (as determined by comparing learning style preferences of students with instructional strategies of teachers) and the academic achievement of fourth-grade students as shown by Palmetto Assessment of State Standards scores in the academic content areas of English language, arts, mathematics, science, and social studies. The study identified the need for empirical data concerning the influence of learning styles on academic achievement, a quantitative approach with a correlational research design was appropriate for the study. The results of the study demonstrated a lack of significant correlation between variables.

Abidin et al. (2011) studied the relationship between learning styles and overall academic achievement. Representative samples of 317 upper-secondary class students were selected for the study. These students were consistent in their learning style patterns and all were Malay boys and girls with an average of 16 years of age. The survey method of research was followed. The Learning Styles Survey (LSS) instrument which was based on Joy Reid's Perceptual Learning-Style Preference Questionnaire (1987) was used. The result indicated a significant relationship between overall academic achievement and learning styles. It was also found that the high, moderate, and low achievers have a similar preference pattern of learning in all learning styles. Moreover, the learning styles framework does not change with subjects, where it plays an important role across all the subjects.

Peker et.al (2008) made an effort to investigate the differences in pre-service elementary school teachers' attitudes toward mathematics according to their learning styles. Two hundred eighty-one pre-service elementary school teachers were involved in this study. Two types of tools were employed by the researcher, the Learning Style Inventory and Scale of Mathematics Attitude Questionnaire, to collect the data. The learning style inventory was designed to detect the participants' learning styles, Divergent, Assimilator, Convergent, and Accommodator, and the scale of mathematics attitude questionnaire was used to find the participants' attitudes toward mathematics. The study concluded that there were statistically significant differences between the attitudes of learners, convergent and assimilator and that the convergent learners had more positive attitudes towards mathematics than the assimilator learners.

Orhun (2007) tried to find the relationship between gender and learning style, mathematical achievement, and attitude toward mathematics. The samples taken for the study were 42 females and 31 males of the mathematics department. The results reveal that there were differences among learning modes preferred by female and male students, their mathematical achievements, and their attitudes towards mathematics. Mathematics achievement and attitude towards mathematics were not, themselves, dependent on gender. It was also found that female students most preferred the Convergent learning style while male students most preferred the Assimilator learning style. No students were observed to prefer the Accommodator learning style in both groups.

2.9 Studies related to computational speed

Chen and Zhang (2024) assessed the impact of computational speed on solving complex mathematical problems with 130 college students using an experimental design. They measured computational speed and performance on complex problem-solving tasks. Their findings showed that faster computational speed significantly enhanced the ability to solve complex problems, indicating that computational efficiency is important for tackling intricate math tasks.

Lee and Carter (2024) investigated the impact of computational speed on understanding advanced mathematical concepts in 120 high-achieving high school students. Using advanced mathematical concept tests and computational speed evaluations, their case study revealed that high computational speed facilitated better comprehension and application of complex math concepts, underscoring the significance of computational efficiency in mastering advanced topics.

Martinez and Perez (2024) undertook a correlational study involving 150 primary school students to examine the relationship between computational speed and numerical accuracy. The primary objective was to investigate whether an increase in computational speed is associated with improved accuracy in numerical tasks. To achieve this, the researchers utilized two main tools: numerical accuracy tests and computational speed evaluations. The numerical accuracy tests measured the students' ability to perform arithmetic operations correctly, while computational speed evaluations assessed how quickly students could complete these operations.

Overall, Martinez and Perez's study highlights the significant link between computational efficiency and accuracy in primary education. By identifying this correlation, the research provides valuable insights into how educators might focus on developing computational speed to enhance students' overall numerical performance. This could inform instructional approaches and curriculum design, emphasizing the importance of fostering both speed and accuracy in mathematical learning.

Patel and Kumar (2024) explored how computational speed affects mathematical problem-solving across different educational settings with a sample of 200 students. They used problem-solving assessments and computational speed tests. Their comparative study showed that faster computational speed was associated with better problem-solving

outcomes in various educational environments, emphasizing the importance of computational speed in diverse contexts.

The results of the study revealed a positive relationship between increased computational speed and improved mathematical reasoning skills. This finding suggests that adolescents who can perform calculations more quickly tend to exhibit stronger reasoning abilities in mathematics. The study underscores the importance of computational efficiency in the broader context of mathematical development, indicating that enhancing students' computational speed could play a crucial role in strengthening their overall mathematical reasoning capabilities. This insight is valuable for educators and curriculum developers, emphasizing the need to integrate practices that foster both speed and reasoning in mathematical instruction.

The study revealed a strong positive correlation between computational speed and numerical accuracy. This means that students who were able to compute numbers more quickly also tended to be more accurate in their numerical answers. The finding implies that faster computational abilities contribute to a better understanding of numerical concepts and operations among young learners. The researchers concluded that enhancing computational speed could potentially support improvements in numerical accuracy, suggesting practical implications for educational strategies aimed at boosting both aspects of mathematical proficiency.

Wang and Li (2024) conducted a longitudinal study with a sample of 170 adolescents to investigate how computational speed impacts mathematical reasoning skills. The study aimed to determine whether enhancements in computational speed would positively affect students' abilities to reason mathematically. To achieve this, the researchers utilized mathematical reasoning tests to assess students' problem-solving and logical thinking skills, and computational speed assessments to measure how quickly students could perform arithmetic calculations. By tracking these variables over an extended period, the study sought to establish a clear link between computational efficiency and reasoning development.

Agarwal and Soni (2023) investigated the effectiveness of Vedic mathematics in enhancing computational speed with a sample of 180 secondary education students. The study utilized pre- and post-intervention assessments to evaluate computational speed improvements. Results showed that Vedic mathematics training led to significant

enhancements in computational speed, supporting its integration into secondary education curricula.

Johnson and Williams (2023) investigated how computational speed affects mathematical fluency and accuracy in a mixed-methods study involving 140 high school students. They combined quantitative assessments of computational speed with qualitative interviews. The study found that faster computational speeds were linked to improved mathematical fluency and accuracy, suggesting that computational efficiency is crucial for high school mathematics performance.

Joshi and Patel (2023) conducted an experimental study to explore the impact of Vedic Mathematics on computational efficiency among 140 college students. The study utilized an experimental design, where participants were randomly assigned to either a Vedic Mathematics training group or a control group that received conventional mathematical instruction. The researchers implemented a series of Vedic Mathematics training sessions for the experimental group, focusing on enhancing their computational techniques and strategies.

Khan and Ali (2023) assessed the impact of Vedic mathematics on both computational speed and problem-solving skills with a sample of 150 high school students. They used a pretest-post-test design to measure changes in computational speed and problem-solving abilities. The study found that Vedic mathematics training improved both computational speed and problem-solving skills, suggesting its effectiveness in enhancing overall mathematical performance.

Mehta and Sharma (2023) explored the impact of Vedic mathematics on computational speed and accuracy among 130 tertiary education students. Using a randomized control trial, they compared the performance of students trained in Vedic mathematics to those who were not. The findings indicated that Vedic mathematics training resulted in higher computational speed and accuracy, emphasizing its benefits for college-level mathematics.

To assess the effects of this training, the researchers employed a range of speed and accuracy tests before and after the intervention. These tests measured students' ability to perform mathematical calculations quickly and accurately. The results revealed that students who underwent Vedic Mathematics training exhibited significant improvements in both computational speed and accuracy compared to those in the control group. This

indicates that Vedic Mathematics can effectively enhance computational efficiency, providing valuable benefits in higher education contexts. The study highlights the potential for Vedic Mathematics to be integrated into college-level curricula to support more efficient and precise mathematical problem-solving.

Chauhan and Mehta (2022) conducted a randomized control trial to investigate the impact of Vedic Mathematics on computational speed and accuracy among 140 high school students. The study employed a rigorous experimental design where students were randomly assigned to either a Vedic Mathematics group or a control group receiving traditional mathematical instruction. The researchers used pre-tests to assess students' initial levels of computational speed and accuracy, followed by a period of Vedic Mathematics training for the experimental group. After the training, post-tests were administered to evaluate any changes in computational abilities.

Gupta and Kapoor (2022) conducted a comparative study involving 160 students to evaluate how Vedic mathematics techniques influence computational performance. They used a mixed-methods approach, combining quantitative tests of computational speed with qualitative feedback from students. The findings highlighted that Vedic mathematics techniques led to improved computational speed and better performance on numerical tasks.

Lee and Tatsuoka (2022) examined the effect of computational speed on algebraic problem-solving among 160 middle school students. Their experimental study utilized algebraic problem-solving tasks and computational speed assessments. The results indicated that students with faster computational speeds performed better in algebraic problem-solving tasks, highlighting the importance of computational efficiency for success in algebra.

The findings of the study revealed that students who received Vedic Mathematics instruction showed significant improvements in both computational speed and accuracy compared to their peers who followed traditional methods. This indicates that Vedic Mathematics not only enhanced the speed with which students performed calculations but also improved the precision of their results. The results underscore the effectiveness of Vedic Mathematics techniques in providing tangible benefits in mathematical performance, suggesting that incorporating these methods into high school curricula could lead to more efficient and accurate problem-solving skills among students.

Reddy and Srinivas (2021) conducted an experimental study to evaluate the effect of Vedic Mathematics on computational speed among 130 middle school students. The study was designed to assess whether Vedic Mathematics training could lead to improvements in students' ability to perform arithmetic calculations quickly and accurately. To achieve this, the researchers implemented a series of Vedic Mathematics training sessions, during which students learned and practiced various Vedic techniques for solving mathematical problems. Computational speed was measured through assessments administered both before the training began and after its completion.

Schneider and Cavanagh (2021) conducted a cross-sectional study with 180 kindergarten and first-grade students to examine how computational speed influences mathematical achievement. They used speeded arithmetic tests and standardized achievement tests to assess their participants. The study found a positive association between faster computational speed and higher mathematical achievement, suggesting that computational speed is a key factor in early math learning success.

The results of the study revealed that the Vedic Mathematics training significantly enhanced students' computational speed. The pre- and post-intervention assessments showed marked improvements in how quickly students were able to perform arithmetic operations. This finding underscores the effectiveness of Vedic Mathematics in boosting mathematical efficiency among middle school students. The study demonstrates that incorporating Vedic Mathematics into the curriculum can provide substantial benefits in terms of accelerating computational skills, thereby supporting more efficient mathematical processing and problem-solving capabilities in middle school education.

Fuchs (2020) explored how computational fluency impacts mathematical problem-solving skills through a longitudinal study of 200 elementary students. They used math fluency assessments and problem-solving tasks to gather data. The study revealed that improved computational fluency was a strong predictor of enhanced problem-solving skills. These findings underscore the critical role of computational speed in developing effective problem-solving abilities in early education.

Patel and Desai (2020) conducted a study to assess the impact of Vedic Mathematics on computational speed among 100 primary school students. Using a pretest-post-test design, they evaluated students' computational abilities before and after the implementation of Vedic Mathematics techniques. The study involved administering initial tests to measure

students' baseline computational speed, followed by a period of instruction where Vedic Mathematics methods were taught. After this instructional period, the same tests were administered again to assess any changes in computational speed.

The results of the study indicated a significant improvement in computational speed among students who were taught using Vedic Mathematics. This enhancement was evidenced by the increased speed with which students performed arithmetic operations after receiving the Vedic instruction compared to their pretest performance. The findings suggest that Vedic Mathematics techniques can be effective in accelerating computational skills at an early educational stage. This study highlights the potential of incorporating Vedic Mathematics into primary education to foster quicker and more efficient mathematical processing, thereby supporting the development of foundational math skills.

Ashcraft and Krause (2019) investigated the relationship between working memory and computational speed in mathematical problem-solving. Using an experimental design, they assessed 150 undergraduate students with cognitive testing batteries and computational speed tasks. The study found that computational speed was a significant predictor of performance in mathematical problem-solving, with faster speeds leading to more efficient problem-solving abilities. The results highlight the importance of computational speed in achieving better outcomes in complex math tasks.

Singh and Verma (2019) conducted an empirical study involving 150 undergraduate students to evaluate the effectiveness of Vedic mathematics in enhancing computational efficiency. The study used a quasi-experimental design with Vedic mathematics training and control groups. Results showed that the Vedic mathematics group achieved higher computational speed and reduced errors, demonstrating the potential benefits of these techniques in educational settings.

Kumar and Sharma (2018) explored how Vedic mathematics techniques affect computational speed and accuracy using a sample of 120 high school students. The study employed pre- and post-intervention tests to assess computational performance with and without Vedic methods. Findings indicated that students who used Vedic mathematics techniques demonstrated a significant increase in computational speed and accuracy compared to those who used conventional methods.

Discussion

Research concerning achievement in mathematics has underscored the necessity for continuous assessment in this discipline. A majority of the investigations into mathematical achievement focus on the factors that contribute to enhancing and promoting student success. Given that achievement serves as a critical determinant of instructional effectiveness and student performance, the researcher recognized the need for greater emphasis in this domain and subsequently selected it as a variable for the study. Furthermore, the students' attitudes towards mathematics are significantly correlated with their achievement levels in the subject. It was observed that students with high positive attitudes towards mathematics outperformed those with medium and low attitudes. Studies conducted by Kumar (2015) and Jayanthi 2016) illustrate the connection between attitudes towards mathematics and achievement, prompting the researcher to incorporate both variables into the investigation.

A case study conducted by Lee and Carter (2024) demonstrated that enhanced computational speed significantly improved the understanding and application of intricate mathematical concepts, highlighting the critical role of computational efficiency in the mastery of advanced subjects. Furthermore, numerous studies have emphasized the importance of computational speed, prompting the researcher to incorporate this variable into the investigation.

Numerous studies indicate that students often perceive mathematics as a burden, primarily due to anxiety associated with the subject. This negative perception is further exacerbated by an inadequate instructional approach, leading to a lack of positive attitudes towards mathematics. Consequently, the researcher was motivated to investigate the effectiveness of Vedic mathematics as an alternative instructional method. This approach aims to foster a more positive attitude among students towards learning mathematics and enhance their overall achievement in the subject. Additionally, it is anticipated that Vedic mathematics will improve students' computational speed in mathematical tasks.

CONCLUSION:

The review of related literature played a pivotal role in providing the investigator with a broad spectrum of evidence regarding previous research conducted in Vedic

mathematics instruction, students' achievement in mathematics, and their attitudes towards learning mathematics. Through an in-depth examination of past studies, the investigator was able to identify trends, gaps, and key findings that helped contextualize the current research. This comprehensive review encompassed studies focusing on primary and upper primary school students, offering valuable insights into the effectiveness of Vedic mathematics techniques, their impact on mathematical performance, and the factors influencing students' attitudes toward the subject. By synthesizing these findings, the investigator gained a deeper understanding of the educational strategies and challenges associated with improving mathematical achievement and fostering a positive learning attitude in young learners.