International Journal of Education and Psychological Research (IJEPR) Volume 14, Issue 4, December 2025
e - ISSN: 2279 – 0179 Print ISSN: 2349-0853 Available online at www.ijepr.org
Orignal Research Article Open Access

Cognitive Dimensions of Mathematical Problem-Solving-A Theoretical Study of Completeness, Pattern Recognition, Mental Processing, and Observational Insight

Geetha T [1]
Ph. D Research Scholar, AUCE, School of Education, Alagappa University.

Dr. N. Johnson[2]
Head of the Department, Dept of Journalism and Mass Communication, Alagappa University.

Abstract: *Problem-solving ability is central to mathematical learning and cognitive development. Contemporary research highlights heuristics, metacognition, and working memory as key contributors to effective problem solving; however, ancient mathematical frameworks offer parallel cognitive insights that remain underexplored. This theoretical study examines four cognitive abilities derived from Vedic Mathematics—Nikhilam (Completeness Ability), Anurupya (Pattern Recognition Ability), Samskara (Mental Processing Ability), and Vilokanam (Observation Ability)—as foundational components of mathematical problem solving. Rather than interpreting these sutras as computational techniques, the paper conceptualizes them as problem-solving abilities that support holistic understanding, strategic reasoning, mental efficiency, and insight formation. A conceptual model is proposed linking these abilities with modern cognitive theories of problem solving. The study suggests that integrating these abilities into mathematics instruction may enhance learners' adaptability, reasoning depth, and transfer of knowledge. The paper contributes a novel theoretical perspective suitable for future empirical validation.*

Keywords: Problem-solving ability, Vedic Mathematics, cognitive skills, pattern recognition, observation, mental processing

Article History*: Received: 17th January, 2026, Revised: 4th February, 2026, Accepted: 12th February, 2026, Published: 14th February, 2026*

I. INTRODUCTION

Problem solving represents the essence of mathematical thinking and is a primary objective of mathematics education. Effective problem solving extends beyond procedural fluency and involves observation, pattern recognition, mental manipulation, and holistic reasoning. Despite advances in educational psychology, classroom practices often remain algorithm-driven, limiting students' ability to transfer knowledge to unfamiliar contexts.

Vedic Mathematics, traditionally regarded as a system of rapid calculation, embeds deeper cognitive principles within its sutras. This paper argues that selected sutras function as **problem-solving abilities** rather than mere computational shortcuts. The study focuses on four abilities—Nikhilam, Anurupya, Samskara, and Vilokanam—and examines their relevance to mathematical problem-solving processes.

II. REVIEW OF LITERATURE

Research on mathematical problem solving emphasizes cognitive structures, schema development, and metacognitive regulation. Studies reveal that expert problem solvers rely on pattern recognition and structural understanding rather than surface-level operations. Working memory efficiency and observational insight further differentiate successful problem solvers from novices.

Although limited studies report improved arithmetic performance through Vedic Mathematics, systematic theoretical analysis of its cognitive foundations remains scarce. This study addresses this gap by interpreting Vedic sutras as cognitive abilities aligned with modern problem-solving theory.

III. CONCEPTUAL FRAMEWORK

This study proposes a four-dimensional framework for problem-solving ability:

Sutra	Cognitive Ability	Problem-Solving Contribution
Nikhilam	Completeness	Holistic problem representation
Anurupya	Pattern Recognition	Strategy selection and transfer
Samskara	Mental Processing	Cognitive efficiency
Vilokanam	Observation	Insight and interpretation

These dimensions collectively support flexible and adaptive problem-solving behavior.

1. Nikhilam Ability (Completeness) and Problem Solving

Nikhilam emphasizes completeness and complementary reasoning. In problem solving, this ability allows learners to perceive problems as unified structures, identify reference points, and simplify complexity. Such holistic thinking reduces cognitive load and enhances strategic decision-making.

2. Anurupya Ability (Pattern Recognition) and Strategy Selection

Anurupya reflects proportional and analogous reasoning. Pattern recognition enables learners to map unfamiliar problems onto known structures, facilitating

efficient strategy selection. This ability is essential for transfer learning and creative problem solving.

3. Samskara Ability (Mental Processing) and Cognitive Efficiency

Samskara denotes refinement through mental processing. In problem solving, it supports internal manipulation of numerical and symbolic information, optimizing working memory use. This ability enables faster evaluation of solution paths while preserving conceptual understanding.

4. Vilokanam Ability (Observation) and Insight Formation

Vilokanam represents careful observation and awareness. Accurate observation is crucial for correct problem representation and identification of constraints. Insight-driven solutions often emerge from this ability, distinguishing meaningful problem solving from mechanical execution.

IV. INTEGRATED PROBLEM-SOLVING MODEL

The four abilities function synergistically:

1. **Nikhilam** provides holistic structure
2. **Anurupya** identifies patterns
3. **Samskara** ensures efficient execution
4. **Vilokanam** initiates understanding

This integrated model supports both routine and non-routine mathematical problem solving. The four abilities operate in a coordinated and mutually reinforcing manner during the problem-solving process.

Nikhilam represents a holistic approach to problem-solving, encouraging learners to view the problem as an integrated whole rather than a collection of separate steps. This perspective supports structured thinking and simplifies complex calculations by emphasizing overall relationships.

Anurupya focuses on identifying patterns, relationships, and proportionality within the problem. This ability helps learners recognize similarities with previously solved problems and select appropriate strategies based on observed patterns.

Samskara involves the efficient execution and refinement of the chosen method. It emphasizes accuracy, speed, and repeated practice, ensuring that solutions are applied smoothly and effectively. Together, these abilities form an integrated framework that supports both routine and non-routine mathematical problem-solving.

Vilokanam refers to the initial stage of careful observation and understanding of a mathematical problem. At this stage, the learner examines the given information, identifies what is known and what is required, and gains clarity about the nature of the problem before attempting a solution.

V. EDUCATIONAL IMPLICATIONS

Curriculum Development

Curriculum design should place greater emphasis on cultivating students' abilities to observe, recognize patterns, and think holistically. Instead of focusing solely on procedural steps, instructional content should encourage learners to explore relationships among concepts and develop deeper conceptual understanding.

Assessment Practices

Assessment methods should move beyond measuring final answers and place greater importance on evaluating students' reasoning processes. This includes examining how learners choose strategies, justify their approaches, and demonstrate insight while solving mathematical problems.

Teacher Education

Teacher education programs should prioritize the development of cognitive skills in mathematics teaching. Prospective teachers need to be trained to foster reasoning, problem-solving, and conceptual thinking in students rather than relying primarily on routine procedures and mechanical instruction.

VI. CONCLUSION

This theoretical analysis reinterprets selected Sutras of Vedic Mathematics as fundamental cognitive abilities that support effective mathematical problem-solving. Rather than viewing these Sutras merely as calculation techniques, the study positions them as mental processes that guide understanding, pattern recognition, holistic thinking, and efficient execution. By aligning these cognitive abilities with modern theories of cognition and learning, the framework offers a comprehensive perspective on how mathematical reasoning can be strengthened. This integration bridges traditional mathematical wisdom with contemporary educational psychology, providing a unified approach to problem-solving. The proposed model has the potential to enhance both routine and non-routine problem-solving skills among learners. It also highlights the relevance of Vedic Mathematics beyond speed calculation, emphasizing its cognitive and pedagogical value. However, as this study is theoretical in nature, empirical validation is necessary. Future research should examine the applicability and effectiveness of this framework across different educational levels and learning contexts. Such studies would help establish its practical value and inform curriculum design and instructional practices.

VII. REFERENCES

Anderson, J. R. (1996). *Cognitive psychology and its implications*. New York: W. H. Freeman.

Baddeley, A. D. (2003). Working memory: Looking back and looking forward. *Nature Reviews Neuroscience, 4*(10), 829–839.

Bharati Krishna Tirtha, S. (1965). *Vedic mathematics*. Delhi: Motilal Banarsidass.

Bransford, J. D., & Stein, B. S. (1993). *The IDEAL problem solver*. New York: Freeman.

Datta, B. (1993). *The science of Vedic mathematics*. New Delhi: Bharatiya Vidya Bhavan.

Dehaene, S. (2011). *The number sense: How the mind creates mathematics*. Oxford: Oxford University Press.

Flavell, J. H. (1979). Metacognition and cognitive monitoring: A new area of cognitive–developmental inquiry. *American Psychologist, 34*(10), 906–911.

Gupta, R., & Sharma, M. (2014). Vedic mathematics as an alternative approach to teaching mathematics. *Indian Journal of Educational Research, 3*(1), 55–62.

Kahneman, D. (2011). *Thinking, fast and slow*. New York: Farrar, Straus and Giroux.

Kumar, S. (2015). Impact of Vedic mathematics on cognitive abilities of secondary school students. *International Journal of Research in Education, 6*(1), 32–38.

Mayer, R. E. (1992). *Thinking, problem solving, cognition*. New York: W. H. Freeman.

Newell, A., & Simon, H. A. (1972). *Human problem solving*. Englewood Cliffs, NJ: Prentice-Hall.

Patil, V. B. (2010). Application of Vedic mathematics in school education. *Journal of Indian Education, 36*(2), 89–96.

Polya, G. (1957). *How to solve it*. Princeton, NJ: Princeton University Press.

Rao, K. S. (2011). *Vedic mathematics and its applications*. New Delhi: PHI Learning.

Resnick, L. B. (1987). *Education and learning to think*. Washington, DC: National Academy Press.

Schoenfeld, A. H. (1985). *Mathematical problem solving*. Orlando, FL: Academic Press.

Sharma, A. (2012). A study of the effectiveness of Vedic mathematics in enhancing mathematical ability. *Journal of Educational Studies, 8*(3), 21–27.

Singh, R. (2013). Effect of Vedic mathematics on achievement in mathematics. *International Journal of Educational Research and Technology, 4*(2), 45–49.

Skemp, R. R. (1976). Relational understanding and instrumental understanding. *Mathematics Teaching, 77*, 20–26.

Sweller, J. (1988). Cognitive load during problem solving. *Cognitive Science, 12*(2), 257–285.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.

Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice, 41*(2), 64–70.