The Academic
International Journal of Multidisciplinary Research

An Online Peer Reviewed / Refereed Journal
Volume 3 | Issue 11 | November 2025
ISSN: 2583-973X (Online)
Website: www.theacademic.in

Strengthening Mathematical Thinking in Primary Education: Policy Perspectives from NEP 2020 and NCF 2023

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DOI : https://doi.org/10.5281/zenodo.17922123

ARTICLE DETAILS

Research Paper

Accepted: 21-11-2025

Published: 10-12-2025

Keywords:

Mathematical Thinking, Primary Education, NEP 2020, NCF 2023

ABSTRACT

Mathematical thinking is considered the core of meaningful mathematics learning because it enables learners to reason, analyze, explore patterns, and solves problems with understanding rather than mere memorization. This paper discusses the nature, significance, and development of mathematical thinking in early childhood and primary education, demonstrating its role in fostering cognitive flexibility, creativity, logical reasoning, and real-life decision making. It provides insights into how foundational experiences like pattern recognition, classification, comparison, and justification build children's conceptual understanding and support their transition from concrete to abstract reasoning. The paper also discusses in detail how national policy frameworks such as NEP (National Education Policy) 2020 and NCF (National Curriculum Framework) 2023, position mathematical thinking as a central competency for lifelong learning through joyful learning, inquiry-based pedagogy, teacher capacity-building, and concept-focused assessment. Further, it elaborates on effective classroom strategies of manipulatives, multiple-solution pathways, problem-based learning, visual representations, and mathematical discourse. Also included is the transformative role of digital tools in building conceptual clarity, facilitating engagement, differentiation, and inclusivity. The paper finally summarizes that there is an urgent

need to adopt holistic, exploratory, and learner centred approaches for making mathematics meaningful, relevant, and empowering to young learners.

Introduction

Mathematical thinking involves understanding, analysing, and solving problems logically and quantitatively. It refers to the recognition of patterns and making connections and the employment of such concepts as numbers, shapes, relations, and operations in reasoning. Mathematical thinking is not about remembering procedures; it is all about investigation, exploration, and justification. This ability will also enable learners to formulate problems, test solutions, make generalisations, and communicate reasoning clearly. This kind of thinking nurtures creativity, persistence, and critical judgement, enabling individuals to apply mathematics meaningfully in real-life situations and academic contexts.

Mathematical thinking lies at the heart of developing a learner's logical reasoning, problem-solving, and decision making capabilities. It fosters analysis, comparison, classification, and generalisation, moving learners beyond mere procedure to a deeper conceptual understanding. Children engage in mathematical thinking as they learn to break down complex problems into manageable steps, explore multiple strategies, and justify their reasoning. This strengthens cognitive flexibility and fosters confidence in tackling unfamiliar situations. The development of mathematical thinking in everyday life supports practical decision-making, from managing personal finances to interpreting data and gaining insight into patterns within nature, technology, and society. This approach will help them develop active learning, creativity, and perseverance as students experiment, discover relationships, and build meaning through reasoning. This helps develop their communication skills as learners explain their ideas, challenge assumptions, and evaluate the logic of others. Within the broader framework of a 21st-century world, mathematical thinking offers the learner individual competencies in both STEM fields and emerging careers highly influenced by data, modelling, and analytical competencies. As educators develop mathematical thinking starting from the early grades, they also equip students to be independent problem solvers, critical thinkers, and lifelong learners who are able to navigate an increasingly complicated and information-laden world.

Why Mathematical Thinking important in Primary level?

Mathematical thinking forms the basis of early childhood and primary education; it is paramount in the development of the way young children learn about the world, solve problems, and gain

confidence in them. During these stages, children are curious, observant, and gain an understanding of the world around them. Mathematical thinking capitalizes on these intuitive experiences to explore patterns, compare quantities, classify objects, and reason about phenomena occurring in their lives. These earliest experiences provide the foundation for later abstract reasoning, assisting children in making a smooth transition from concrete experiences to symbolic understandings. In the early years, mathematical thinking supports cognitive development by strengthening attention, memory, logical reasoning, and spatial awareness. Children sort objects, build with blocks, recognize patterns, or discuss similarities and differences, thus developing mathematical processes which enhance their thinking. Such experiences help them learn how to analyse situations, make predictions of outcomes, and draw conclusions abilities reaching far beyond mathematics. This becomes even more important at the primary level when children start working with formal mathematical ideas, such as the operations of numbers and measurement, geometry, and data handling. The encouragement of reasoning, exploration, and justification assists students to appreciate why the processes in mathematics work rather than merely memorizing the steps involved. Students benefit by deepening conceptual understanding and long-term learning. Thus, when students explain their thinking, compare strategies, or are involved with others in solving problems, they benefit from confidence, communication, and a growth mind set. It is also important in the development of problem-solving skills. In the case of early learners, encouraging them to try alternative strategies, learn from mistakes, and persist in overcoming setbacks makes them resilient. They come to understand that mathematics does not involve speed or right answers but creative thinking, exploration of possibilities, and making sense of problems. These changes in mind set are very crucial in decreasing math anxiety and developing positive attitudes toward learning. Moreover, mathematical thinking is strongly connected with real-life experiences, helping children learn in a meaningful and relevant way. Children use mathematics when sharing equally, comparing sizes, working out routes, following seasonal or day-to-day patterns in nature, or establishing routines during the day. Teachers help students view mathematics as a natural, helpful, and enjoyable human activity by incorporating mathematical thinking into play, stories, classroom routines, and manipulative activities. Such experiences foster curiosity, independence, and a sense of achievement.

Mathematical Thinking: Policy Perspectives from NEP 2020 and NCF 2023

In modern education, mathematical thinking has been conceptualized as a core competency for lifelong learning, a notion that policies like NEP 2020 and NCF 2023 have emphasized repeatedly. Early mathematical thinking lays the groundwork for advanced learning in STEM subjects, data literacy, and decision-making in an increasingly technological world. Mathematical thinking in early childhood and

primary education provides an important means for developing cognitive competencies, problem-solving activities, creativity, and a disposition to approach learning positively. Educators develop reasoning, curiosity, and exploration since the early years, thus giving children tools that help them make sense of the world, be successful at school, and turn into confident, independent thinkers. NEP 2020 gives much importance to the development of mathematical thinking as a foundational competency for all learners. Recognizing that early mathematical abilities are closely linked to cognitive growth, problem-solving, and future academic success, the policy proposes a major shift from rote learning to meaningful understanding. NEP 2020 looks at mathematics not just as a subject involving numbers and procedures, but as a way of thinking that helps children reason, analyse, and make sense of the world.

At the foundational level, the policy identifies numeracy as an integral part and ensures that every child achieves the essential skills in mathematics by Grade 3. The approach to teaching should be playful, interesting, and linked with real-life experiences. Sorting, comparing, patterning, measuring, and exploration of shapes are emphasized to inspire curiosity and develop sound conceptual foundations. It thus aligns with the broader vision of joyful, discovery-driven learning as prescribed by the policy.The NEP 2020 further emphasizes a reduction in the load of content and enhancing conceptual clarity, reasoning, and application. It calls for rich mathematical tasks that would permit learners to employ multiple strategies, ask questions, justify thinking, and build confidence. An approach of this nature supports mathematisation the ability to think mathematically which the policy identifies as a key learning outcome. Teacher capacity-building forms another important pillar. It advocates for continuous professional development to help teachers move towards adopting activity-based approaches, using manipulatives, integrating technology, and conducting assessment of learning through observation and formative practices rather than memory-based tests. In general, NEP 2020 places mathematical thinking as one of the central elements that will help learners to be prepared for a rapidly changing and technology-driven world. This policy nurtures reasoning, problem-solving, and a deep understanding of mathematical ideas since the early years to create independent, confident, and future-ready learners.

The National Curriculum Framework for School Education, NCF 2023, positions mathematical thinking as the centre of mathematics learning. It emphasizes that it is a key competency for meaningful understanding and lifelong learning. The framework has recognized the fact that mathematics cannot be reduced to a set of formulas or procedures; rather, it is a strong way of making sense of the world. It recognizes mathematisation the process of thinking, reasoning, analysing, representing, and problem-solving as the central goal of mathematics education. NCF 2023 advocates for moving away from traditional and teacher-cantered instruction to learning experiences that facilitate exploration, inquiry,

and reasoning. It emphasizes that children must be made to observe patterns, establish connections, test ideas, justify their reasoning, and communicate their way of thinking. Learners do not memorise steps as they work through rich mathematical tasks that allow multiple strategies and solutions. This not only deepens conceptual understanding but also fosters creativity and builds confidence.

It stresses the use of age-appropriate pedagogy throughout different stages. The framework advocates for play-based and concrete experiences in foundational and preparatory years of schooling, which helps children build intuition about quantities, shapes, measurements, and relationships. Abstraction and formal reasoning are encouraged in the middle and secondary stages, with a strong connection between mathematical ideas and real-life contexts. Mathematical thinking is supported by assessment practices, too, recommended in NCF 2023. The framework discourages excessive emphases on speed and correct answers; rather, it advocates for the conduct of formative assessments to capture reasoning, conceptual clarity, and strategy use. Teachers are encouraged to observe, question, and facilitate discussions that reveal students' thought processes. Teacher preparation and continuous professional development are necessary components. NCF 2023 advocates for creating supportive learning environments where teachers use manipulatives, visual models, digital tools, and problem solving activities to make mathematics meaningful and engaging. Overall, NCF 2023 places mathematical thinking as central to the development of confident, analytical, and flexible thinkers who can successfully function in an ever-increasingly complex and data-driven society.

Strategies for enhancing Mathematical Thinking in Primary level

Enhancing mathematical reasoning at the primary level involves shifting from memorization strategies to approaches that enable reasoning, investigation, and problem-solving. Effective strategies help children to make sense of concepts deeply, express themselves, and establish strong connections between mathematics and life situations. The following strategies have been widely advocated for supporting mathematical reasoning at the primary level.

1. *Use of Concrete Materials and Manipulatives*: Manipulatives are hands on materials, which come in many forms: counters, blocks, beads, number lines, and fraction strips that help students visualize mathematics. Through the use of concrete materials, students explore relationships, discover patterns, and develop conceptual understanding. Manipulatives provide an easy transition from the concrete to the pictorial stage and finally to the abstract.

2. *Promotion of Multiple Strategies:* Permitting students to solve problems in a choice of ways helps build flexibility and creativity. When children present and contrast strategies such as using mental computation, modeling, or breaking down numbers they begin to understand that mathematics is not limited to a single "right" way. This creates confidence and solidifies conceptual understanding.

3. *Problem-Based and Inquiry-Driven Learning:* Real world, relevant problems stimulate students to think critically, question, and explore. Open-ended tasks, puzzles, and word problems foster curiosity and demand logical reasoning. Inquiry-based classrooms allow students to hypothesize, test concepts, make mistakes, and self-correct activities integral to mathematical reasoning.

4. *Application of Visual Representations:* Diagrams, illustrations, bar models, tables, charts, and number bonds help children to organize and express their thoughts clearly. Visual aids make abstract ideas more understandable and allow the recognition of relationships and patterns. They are especially helpful in problem-solving and the explanation of reasoning.

5. *Student Engagement in Mathematical Conversations and Explanations: Class discussions*, pair-share activities, and collaborative problem-solving sessions invite students to express their reasoning processes with peers, further deepening their conceptual understanding of mathematics.

Role of digital teaching

Digital teaching and learning play a transformative role in strengthening mathematical thinking among primary students by making abstract ideas more concrete, engaging, and accessible. Digital tools, including but not limited to interactive simulations, virtual manipulatives, educational apps, and multimedia-rich platforms, assist young learners in visualizing mathematical concepts that otherwise might well remain abstract. For example, such dynamic number lines, fraction bars, or geometric shapes enable children to experiment, observe patterns, and build conceptual understandings by means of hands-on virtual exploration. These tools foster active learning wherein students test ideas, get immediate feedback, and correct misunderstandings in real time-an essential process in developing reasoning and problem-solving skills. Digital environments further support differentiated learning whereby teachers can tailor tasks to student readiness levels, thus strengthening foundational numeracy for slower learners while challenging advanced learners with higher-order tasks. Mathematical discourse is furthered through digital collaborative platforms which enable students to explain their reasoning, compare strategies, and build confidence in expressing mathematical ideas. Furthermore, game-based learning enhances motivation and persistence in ways that students engage in meaningful challenges that reinforce

concepts through play. Digital assessments, including adaptive quizzes and analytics dashboards, support teachers in monitoring learning patterns, spotting misconceptions early, and informing targeted interventions that nurture deeper mathematical thinking. Of importance, digital learning supports inclusive education through the provision of multimodal content-audio, visual, and interactive-which makes mathematics more accessible to diverse learners, including those with learning difficulties. Thoughtfully integrated, digital teaching does not replace traditional methods but enriches them, creating a blended learning environment in which technology complements pedagogy. This holistic approach encourages curiosity, fosters logical reasoning, and readies primary students to approach mathematics not as a set of procedures but as a purposeful, exploratory, and creative discipline. Overall, digital teaching and learning significantly contribute to the fostering of mathematical thinking by encouraging understanding, engagement, and learner-centered exploration.

Conclusion

Mathematical thinking helps in developing reasoning, creativity, and problem-solving skills from the initial stages of early and primary schooling. It is beyond the memorization of steps, whereby learners explore patterns, test ideas, and justify reasoning. Developing it early instils confidence, communication, and real-life application in every learner. NEP 2020 and NCF 2023 policies emphasize concept-based and inquiry driven learning, teacher training, relevant assessment, and joyful classrooms. Manipulatives, multiple methods, visual models, problem-based tasks, and discussions are the means to strengthen understanding. With technology, engagement and access are further enhanced. Strong mathematical thinking therefore equips learners to reason well and cope with rapid changes in this data-driven world.

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