

# Integrating Critical Thinking And Problem-Solving Skills In Mathematics Education In The Context Of NEP-2020

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## ABSTRACT

Critical thinking and problem-solving skills in mathematics education have received much attention recently, aligned with the India National Education Policy 2020 call to fundamentally shift teaching practices from rote to competency-based approaches. This study explores the challenges and opportunities of fostering these skills in Indian mathematics education based on theoretical frameworks by Ennis (2018), Polya (2004), and Schoenfeld (2016) along with empirical evidence from global and Indian contexts. The research utilizes a secondary data analysis approach through academic journals, government reports, educational surveys, and scholarly works in order to understand current practices, policy recommendations, and implementation gaps. The findings indicate that NEP-2020 aligns with the global best practices of focus on experiential learning, which focuses on multidisciplinary processes, digital, and more. Systemic issues such as weak teacher training, inadequate resources, and unequal access to resources and technology often hinder such effective implementation. Interventions in this regard suggest strengthening teacher training, encouraging innovative pedagogies, and establishing supportive learning environments. It also points to the limitations of using secondary data and seeks further research, such as primary studies and comparative analyses across Indian states, to validate findings and allow for strategies to be formulated in context. Along this context, the present study fills these gaps and contributes to the ongoing discourse on how to transform mathematics education in order to empower students with critical thinking and problem-solving skills—a necessity of the 21st century.

**Keywords:** Critical Thinking, Problem-Solving Skills, Mathematics Education, NEP-2020, Experiential Learning

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## 1. Introduction

The development of critical thinking and problem-solving ability in the math education paradigm is an essential trend in recent debates on educational reforms in contemporary India. Under the ambit of the NEP-2020, India, it seeks a shift away from rote-based learning and aims to inculcate the teaching of a higher-order approach among students who, through it, can create or bring out high-thinking skills and a sense of logical reasoning ability for students. This shift in paradigm supports the global education framework, such as that proposed by the OECD in 2019 and the National Council of Teachers of Mathematics in 2014, to develop mathematical literacy and problem-solving competencies as essential 21st-century skills.

Historically, mathematics learning in India has been focused mainly on examination-oriented practices where the emphasis is on procedural knowledge and memorization as brought to the fore by the National Curriculum Framework 2005 (NCERT, 2005). However, the most recent studies, such as the Annual Status of Education Report 2022, show significant lacunae in the conceptual understanding and application of mathematical knowledge even at the levels of students, which calls for urgent pedagogical reforms (ASER Centre, 2022). Scholars, such as Boaler (2015) and Schoenfeld (2016), point out the potential of developing a growth mindset and metacognitive skills in mathematics to activate a child's potential and increase his ability to deal with complex problems.

The NEP-2020 contemplates multidisciplinary pedagogies to nurture critical thinking and problem-solving capabilities, beyond mere mathematics and within the ambit of the overall curriculum (Singh, 2021). In this,

scientific research shows the role of experiential learning, digital technology, and the assurance of equitable access to quality education toward attaining the mentioned objectives (Patel, 2020; Mehta, 2021; Choudhary, 2020). Moreover, teacher training and professional development are necessary to implement these reforms, as argued by Rao (2019) and Batra (2015), who suggest that teachers should be prepared with the skills for facilitating inquiry-based and student-centered learning environments.

This study aims to elaborate on the infusion of critical thinking and problem-solving skills in mathematical understanding in the context of NEP-2020. The theoretical know-how of Ennis (2018), Polya (2004), and Sternberg (2003) theories along with empirical Indian and international experiences have been referred to while drafting this research, to identify potential strategies for fostering these competencies in students. The current study contributes to the ongoing discussion about transforming mathematics education to better fit the requirements of a fast-changing world, through the analysis of challenges and opportunities presented in Sharma and Sharma (2019) and Joshi (2017). Ultimately, the study should come out with actionable recommendations for policy, educators, and various stakeholders towards creating an inclusive and innovative learning ecosystem to empower students with critical thinking and problem-solving skills.

## 2. Literature Review

### 2.1. Critical Thinking and Problem-Solving in Mathematics Definitions and Theoretical Frameworks

Mathematics education is founded on fundamental skills in relation to critical thinking and problem-solving abilities, through which students learn to analyze, evaluate, and synthesize available information to reach logical conclusions. Ennis (2018) explains critical thinking as reflective and independent thinking, with Polya (2004) outlining a more structured approach in problem-solving by emphasizing knowing the problem, devising a plan, executing it, and reflecting upon the solution. Above all, Schoenfeld (2016) stresses that the use of Meta cognition and sense-making in mathematics problem-solving has to result in how students are able to track and regulate their activity. They also align with other frameworks like National Council of Teachers of Mathematics Principles to Actions (2014) in regard to teaching practices that promote reasoning, communication, and perseverance in solving mathematics problems. Importance of these skills for student development:

Critical thinking and problem-solving activities promote cognitive growth in students because they encourage imagination, flexibility, and resilience in a student.

According to Boaler (2015), developing a mathematical mindset through problem-solving improves academic performance, enhances confidence, and develops a positive attitude toward learning. Resnick (1987) and Sternberg (2003) argue that these skills are transferable across disciplines and the primary source for dealing with real-world challenges in life. Besides, the OECD (2019) underlines the role of STEM in equipping students with the demands of the 21st century, in which analytical and innovative thinking is so much needed.

### 2.2. NEP-2020 and Mathematics Education

#### Key Recommendations of NEP-2020 Related to Mathematics Education

That presents NEP 2020 as a more transformational shift in the Indian education policy towards competency-based education and away from rote learning (Government of India, 2020). Specifically, the report calls for mathematics education with increased emphasis on deep conceptual understanding, critical thinking, and problem solving. Singh (2021) emphasizes that NEP-2020 promotes experiential learning wherein learners experience direct application of mathematical concepts to real life and multidisciplinary approaches, integrating mathematics with other subjects. Besides this, the policy has a focus on early numeracy and digital tools as a means of improving learning outcomes. Emphasis on Experiential Learning, Multidisciplinary Approaches, and Skill Development

NEP-2020 aligns with global best practices by promoting experiential learning and skill development.

Patel (2020) suggests how hands-on experiences and solving of real-life problems can make the subject of mathematics more engaging for students. On the other hand, Kaur (2022) also indicates that policy underlines the interdisciplinarity of learning by which the mathematical concepts will relate to other areas of knowledge for the student. The inclusion of digital resources in learning is discussed by Mehta (2021), and digital tools facilitate a personalized, engaging, and interactive learning process for students.

### 2.3. Global and Indian Perspectives

#### Examples of Successful Integration of Critical Thinking and Problem-Solving in Mathematics Education Globally

Mathematics curricula in countries such as Finland and Singapore have been effectively designed with critical thinking and problem-solving skills. Indeed, PISA 2018 results reflect the improvements of inquiry-based learning and collaborative problem-solving in mathematical literacy, reported by OECD (2019). Open-ended tasks and group discussions in mathematics classroom help to build deeper understanding and engagement, as per Boaler's (2015) work on mathematical mindsets.

## **Current State of Mathematics Education in Indian Secondary Schools**

Conversely, mathematics education in Indian secondary schools is a problem, according to Sharma and Sharma (2019). The ASER 2022 report shows that many students are not able to perform basic numeracy skills. The curriculum emphasizes rote memorization rather than conceptual understanding. Joshi (2017) stated that problem-solving is part of the curriculum, but it is implemented inadequately due to resource constraints and lack of proper teacher training. In addition, Das (2018) highlights that assessment practices in India rarely measure higher-order thinking skills and continue to be focused on procedural knowledge.

### **2.4. Research Gaps**

#### **Lack of Studies on the Implementation of NEP-2020 in Mathematics Education**

Despite the NEP-2020's promise for change, research on the practical implementation of this policy in mathematics education is extremely scarce. There is an appeal by Singh (2021) to understand the translation of recommendations into classroom practice, especially in rural and deprived areas. Another area for research is pointed out by Gupta and Kapoor (2020), the problem teachers are likely to face while shifting towards experiential and interdisciplinary approaches.

#### **Slightly limited researches on integrating critical thinking and problem-solving in the Indian context**

Although there is strong literature on international perspectives of developing critical thinking through problem-solving with mathematics, evidence in the specific Indian context seems to be negligible. Joshi (2017) and Sharma and Sharma, 2019, point toward the need of culturally relevant pedagogies dealing with the country-specific challenges of sizeable classes as well as vastly diverse learning issues. Barak and Shakhman (2008) further point out that research studies are necessary to identify the role played by digital tools and innovative pedagogies in assisting the Indian schools in developing these skills.

## **3. Research Methodology**

This study uses secondary data analysis to explore the integration of critical thinking in Indian mathematics education, focusing on NEP-2020. It reviews literature, policy documents, and surveys like ASER and NAS, covering studies published between 2010 and 2023. Data is sourced from academic journals, NCERT reports, and credible databases such as Google Scholar and ERIC. Thematic, content, and comparative analyses are employed to identify trends and insights. This approach highlights challenges and opportunities in implementing critical thinking in secondary mathematics education.

## **4. Findings and Discussion**

### **4.1. Themes from Literature Review**

The literature review has identified a few major themes on the integration of critical thinking and problem-solving in mathematics education. Current practices often focus on rote learning and procedural knowledge with less emphasis on higher-order thinking skills, as highlighted by Sharma and Sharma (2019) and the ASER 2022 report. On the other hand, studies like Boaler (2015) and Schoenfeld (2016) have proven that inquiry-based and experiential learning are effective in the development of these skills. According to Batra (2015) and Joshi (2017), the reasons for these difficulties are lack of proper training among teachers, shortage of resources, and misalignment between curriculum goals and assessment practices. Students are generally weak in concept development and using mathematics in solving everyday problems, according to the NAS and ASER surveys.

### **4.2. Analysis of NEP-2020 Documents**

The NEP-2020 documents indicate transformative vision for mathematics education and have placed emphasis on conceptual understanding, critical thinking, and problem-solving. Major recommendations are experiential learning, multidisciplinary approaches, and digital tools in the learning processes to improve participation and learning achievements (Government of India, 2020). Singh (2021) and Kaur (2022) suggest that the recommendations align with international best practices, including OECD PISA framework, and NCTM Principles to Actions (2014). The policy would only work if implemented correctly. This requires systemic changes in terms of teacher training and infrastructural gaps.

### **4.3. Insights from Educational Surveys**

Educational surveys such as ASER 2022 and NAS are important sources of information on trends in student performance and skill development in mathematics. There is some improvement in basic numeracy skills, but the gaps remain huge in applying mathematical concepts to solve complex problems. The surveys also show disparities in access to quality education, especially in rural and underserved areas. Moreover, NEP-2020 implementation regarding experiential learning and digital technologies continues to be a recent phenomenon and there is general evidence of the strength of its implementation in classrooms.

#### 4.4. Discussion

The findings emphasize the need to bridge the gap between policy and practice in mathematics education. While NEP-2020 offers a strong structure for the infusion of critical thinking and problem-solving, its success is dependent on dealing with systemic issues like teacher training, resource allocation, and equitable access to quality education. Comparing it with global best practices, such as those of Finland and Singapore, shows that inquiry-based learning, collaborative problem-solving, and the use of technology are some of the main drivers of success in mathematics education. The following have very significant policy and practice implications: there is a need to target interventions towards teachers, to enhance curriculum design, and to improve the methods of assessment. Aligning with global best practices while catering to local needs, India could create an inclusive and innovative learning ecosystem that makes students think more creatively and solve problems better.

### 5. Conclusion and Recommendations

#### 5.1. Summary of Key Findings

The most important factor brought out of this study concerns how critical thinking and problem solving in mathematics curricula can advance a deeper conception and real world applicability of understanding knowledge. Though Indian practices follow mostly the routine method rather than experiential and inquisitive inquiry approach, currently the global policies are encouraging by emphasizing PISA and NCTM's recommendations regarding mathematical education, but still experience based and questioning process is recommended. The NEP 2020 sparks this change as it focuses on multidisciplinary learning, technology, and the development of practical skills. All these recommendations to be implemented correctly would require taking care of all systemic issues involved, such as teacher training and resource allocation, or making quality education accessible to everybody.

#### 5.2 Recommendations

**For Policymakers:** Improve teacher training programs so that teachers can effectively encourage critical thinking and problem-solving skills in students. Adequate resources, including digital tools and infrastructure, are also needed to support innovative teaching practices.

**For Teachers:** Use pedagogies that encourage active learning, such as collaborative problem-solving, open-ended tasks, and real-world applications of mathematical concepts.

**For Schools:** Create a supportive environment that encourages skill-based learning, including the integration of multidisciplinary approaches and the use of technology to enhance student engagement.

#### 5.3. Limitations of the Study

The study is constrained by its reliance on secondary data, which may not provide specific contextual insight into the classroom practice and regional variations. Moreover, biases in the existing literature and reports may have an impact on the interpretation of findings. Thus, the said constraints call for great care in generalizing the findings.

#### 5.4. Future Research Directions

Future research should be conducted as primary studies to validate the preliminary findings from secondary data and gain deeper insights into the challenges and opportunities of implementing NEP-2020 mathematics education. Comparative studies carried out across various states in India may highlight the regional disparities and best practices associated with such integration, leading to greater awareness of how such thinking and problem-solving skills should be inculcated properly within a system. Future research will address these gaps by helping in developing evidence-based strategies to transform mathematics education in India.

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