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Training Needs of Mathematics Teachers for Effective Implementation of Competency-Based Newly Developed Mathematics Textbooks at the Middle Stage

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Abstract

The National Education Policy (NEP) 2020 has driven a paradigm shift from content-based to competency-based education (CBE), emphasizing holistic development, conceptual understanding, critical thinking, problem-solving, and the application of knowledge in real-life contexts. This vision is further operationalized through the National Curriculum Framework for School Education (NCF-SE) 2023, which advocates for a flexible, learner-centric curriculum that prioritizes competencies and skills over rote memorization.

In alignment with these reforms, the newly developed NCERT mathematics textbooks Ganita Prakash for the middle stage (Grades 6-8) are designed to foster deep conceptual understanding, mathematical reasoning, problem-solving abilities, effective communication, and the application of mathematical knowledge through activity-based, experiential, and real-life contextual learning.

Successful implementation of these textbooks, however, hinges significantly on teachers' preparedness and professional competence. This paper reviews existing literature on mathematics teacher professional development and competency-based education to identify the key training needs of mathematics teachers for the effective rollout of competency-based mathematics textbooks at the middle stage.

The review highlights that teachers require targeted professional development in several critical areas: competency-based pedagogy and activity-oriented teaching; assessment literacy focused on formative, competency-oriented evaluation; strengthening mathematical reasoning and conceptual depth; integration of technology and digital tools; inclusive education practices to address diverse learner needs; and reflective practice for continuous improvement.

The paper concludes with actionable implications and recommendations for redesigning continuous professional development (CPD) initiatives, and support systems to ensure teachers are well-equipped to inculcate the goals of NEP 2020 and NCF-SE 2023 into classroom practice through effective use of the mathematics textbook Ganita Prakash at the middle stage.

Keywords: Competency-Based Education, Mathematics Teacher Professional Development, Teacher Training Needs, Ganita Prakash, NEP 2020, NCF-SE 2023, Assessment Literacy, Continuous Professional Development.

Introduction

Educational reforms in the twenty-first century have increasingly shifted focus from rote memorization of content to the development of competencies. Competency-based education aims to equip learners with the knowledge, skills, attitudes, and values necessary to apply learning effectively in authentic, real-life contexts. This approach prioritizes higher-order thinking, problem-solving, reasoning, communication, and the practical application of knowledge, moving away from traditional content-heavy curricula.

NEP 2020 explicitly advocates for a paradigm shift towards competency-based learning and assessment, emphasizing holistic development, critical thinking, creativity, and experiential learning over rote memorization. It calls for transforming classroom transactions and assessment practices to focus on core competencies and higher-order skills such as analysis and conceptual clarity.

The NCF-SE 2023 operationalizes the vision of NEP 2020 by providing a detailed framework for curriculum design that promotes inquiry-based, activity-oriented, and learner-centric education. In alignment with these policies, the National Council of Educational Research and Training has developed new middle-stage mathematics textbooks titled Ganita Prakash. These textbooks are designed to foster deep conceptual understanding, mathematical reasoning, exploration, mathematical modelling, contextualized learning, and competency-based assessment through engaging, joyful, and real-life connected activities.

While these textbooks offer rich opportunities for meaningful and joyful mathematics learning, their successful implementation largely depends on teachers' ability to interpret the new pedagogical approaches and implement them effectively in the classroom. Research consistently shows that curriculum reforms succeed only when teachers are adequately prepared with the necessary knowledge, skills, and ongoing professional support.

Therefore, identifying the specific professional development and training needs of mathematics teachers is crucial for the effective rollout of a competency-based mathematics textbook for the middle stage. This paper reviews the relevant literature on teacher professional development and competency-based education in light of NEP 2020 and NCF-SE 2023, highlights key training gaps, and proposes recommendations to strengthen teacher preparation and continuous professional development programmes.

Competency-Based Education and Mathematics Teaching

Competency-based education focuses on what learners can do with their knowledge rather than what they can merely recall. It integrates conceptual understanding, procedural fluency, reasoning, problem-solving, communication, and the ability to apply learning in authentic, real-life contexts. Recent global reviews of competence-based curricula show that educational systems worldwide are shifting towards competency-oriented learning outcomes, which necessitate significant changes in classroom pedagogy, instructional strategies, and assessment practices.

In mathematics education, competency-based learning requires teachers to move beyond traditional lecture-based instruction to facilitate inquiry, encourage multiple solution strategies, promote mathematical discussions, and engage learners in authentic, meaningful tasks. Mathematical modelling, reasoning, and problem-solving are now recognized as core competencies that must be developed systematically through classroom experiences.

NCERT mathematics textbooks, Ganita Prakash, exemplify this competency-based approach. It marks a paradigm shift from rote learning to active, experiential, and inquiry-based learning. The textbook emph-

asizes:

- Exploration of patterns and discovery of mathematical ideas through observation and hands-on activities.
- Mathematical modelling and real-life contextual problems.
- Encouragement of multiple strategies and mathematical discussions.
- Integration of joyful elements such as puzzles, storytelling, and connections to India's rich mathematical heritage.
- Competency-oriented assessment that focuses on reasoning, application, and creativity rather than mere procedural recall.

By promoting activity-based, learner-centric, and experiential approaches, Ganita Prakash aims to develop deep conceptual understanding and higher-order thinking skills in middle-stage learners. However, the successful implementation of these competencies into classroom practice depends heavily on teachers' pedagogical competence and their ability to use the textbook's features effectively.

Professional Competence of Mathematics Teachers

Research on mathematics teacher competence consistently shows that effective teaching requires far more than deep subject-matter knowledge. Teachers must possess a sophisticated blend of mathematical content knowledge, pedagogical content knowledge, classroom decision-making skills, and the ability to interpret and respond to students' thinking, misconceptions, and diverse learning needs. Contemporary frameworks view teacher competence as a dynamic continuum that links teachers' knowledge, beliefs, instructional decisions, and actual classroom performance.

Studies on mathematics teacher competencies commonly identify several key domains:

- Mathematical Content Knowledge — Deep understanding of concepts, procedures, and structures.
- Pedagogical Content Knowledge (PCK) — The ability to transform mathematical ideas into forms accessible to learners, including representations, analogies, and addressing common misconceptions.
- Assessment Competence — Skills in designing and using formative, competency-based assessment that evaluates reasoning, application, and problem-solving.
- Curriculum Interpretation and Transaction Skills — Capacity to understand and effectively implement new curriculum materials and textbooks.
- Technology Integration Skills (TPACK) — Ability to integrate digital tools, such as AI, AR, VR, DIKSHA resources, and QR codes, to enhance learning.
- Reflective Practice — Continuous self-evaluation and professional growth to improve teaching practices.

These competencies assume even greater significance in the context of implementing innovative Mathematics textbooks, Ganita Prakash, for the middle stage. Ganita Prakash demands a shift from traditional rote-learning methods to activity-based, inquiry-driven, experiential, and joyful learning. It incorporates mathematical modelling, real-life applications, multiple solution strategies, mathematical discussions, integration of Indian Knowledge Systems, and competency-oriented assessment.

Teachers are expected to act as facilitators who can orchestrate learner-centred classrooms, design authentic tasks, encourage exploration, and assess competencies rather than procedural recall. Without adequate professional development in these domains, the transformative vision of Ganita Prakash may not

be fully realized in classrooms. Therefore, targeted training and continuous support for teachers are essential for the successful implementation of this new generation of mathematics textbooks.

Training Needs Related to Competency-Based Pedagogy

One of the most critical professional development needs for mathematics teachers is competency-based pedagogy. Traditional mathematics instruction in India has largely focused on procedural fluency, teacher-led explanations, and rote memorization. In contrast, Ganita Prakash demands a fundamental shift towards active, learner-centred, and inquiry-driven approaches. Ganita Prakash emphasizes investigation, exploration, mathematical modelling, collaborative learning, real-life applications, and joyful discovery. Teachers are expected to facilitate rich classroom discussions, encourage multiple solution strategies, design authentic tasks, and guide students through open-ended problems rather than delivering direct instruction. A systematic review of mathematics teacher professional development programmes reveals that effective initiatives provide teachers with active learning experiences, allowing them to experience these innovative pedagogical practices themselves. Teachers need targeted support in:

- Designing and implementing rich mathematical tasks aligned with the textbook's activity-based approach.
- Facilitating meaningful classroom discourse and mathematical discussions.
- Promoting deep conceptual understanding through exploration and pattern recognition.
- Guiding students in mathematical modelling and solving non-routine, real-life problems.

Research on problem-solving in mathematics education further highlights that many teachers face challenges in orchestrating discussions around open-ended tasks and assessing students' reasoning processes — skills that are central to the successful implementation of Ganita Prakash. Without adequate training in these areas, teachers may struggle to move away from traditional methods, limiting the transformative impact of the new competency-based curriculum.

Therefore, professional development programmes must prioritize hands-on workshops, peer collaboration, and ongoing mentoring to equip teachers with the pedagogical confidence required for effective transaction of Ganita Prakash.

Training Needs Related to Assessment Literacy

Assessment remains one of the most challenging aspects of transitioning to competency-based Mathematics textbook. Unlike traditional mathematics teaching, which primarily evaluates factual recall and procedural accuracy, Ganita Prakash requires teachers to assess a much broader range of competencies, including conceptual understanding, mathematical reasoning, communication, modelling, problem-solving, and application in real-life contexts. Ganita Prakash promotes continuous, formative, and competency-based assessment. It includes activity-based tasks, open-ended questions, projects, mathematical discussions, and self-assessment opportunities that move away from rote-based pen-and-paper tests toward evaluating higher-order thinking and application skills.

However, literature and field observations indicate that many teachers are more comfortable with conventional summative examinations and struggle with the shift to formative and competency-oriented assessment. Therefore, teachers need professional development in the following areas:

- Designing competency-based assessment tasks that align with the textbook's activity-oriented and inquiry-based approach.

- Developing appropriate rubrics for evaluating reasoning, multiple solution strategies, and mathematical communication.
- Conducting effective formative assessment during classroom explorations and group activities.
- Providing constructive, descriptive feedback that supports student learning and growth.
- Assessing higher-order thinking skills such as mathematical modelling and problem-solving.
- Using assessment data to modify instruction and provide targeted support to learners.

Due to technology-enhanced formative assessment further emphasizes the need for teachers to effectively use digital resources (such as QR-coded materials on the DIKSHA platform) for ongoing assessment and feedback. Without targeted training in these areas, teachers may find it difficult to fully realize the assessment vision embedded in Ganita Prakash.

Training Needs Related to Mathematical Reasoning and Problem Solving

Competency-based textbooks place significant emphasis on mathematical reasoning and problem-solving as core competencies. Ganita Prakash strongly reflects this focus by prioritizing exploration, logical thinking, mathematical modelling, argumentation, and real-life problem-solving over rote procedures.

However, studies consistently indicate that many teachers require additional support to effectively facilitate these competencies. Traditional teacher preparation often leaves gaps in guiding students through open-ended tasks, encouraging multiple solution pathways, and nurturing mathematical thinking.

After systematic reviews of mathematics teacher professional development highlight that teachers need specialized knowledge and skills to:

- Support students' mathematical reasoning and argumentation.
- Facilitate rich classroom discussions and peer collaboration.
- Ask probing questions that deepen conceptual understanding.
- Guide learners through mathematical modelling and non-routine, authentic problems.
- Encourage multiple strategies and creative approaches to problem-solving.

Ganita Prakash incorporates activities, puzzles, real-life contexts, and exploratory tasks that demand teachers to act as facilitators rather than direct instructors. Professional development programmes that actively engage teachers in solving and analysing such problems themselves have been shown to significantly enhance their instructional effectiveness and, ultimately, student achievement.

Without targeted training in these areas, teachers may revert to traditional methods, limiting the development of critical reasoning and problem-solving skills that Ganita Prakash seeks to cultivate. Therefore, continuous professional development must include hands-on experiences, lesson planning focused on reasoning, and strategies for orchestrating productive mathematical discourse.

Training Needs Related to Technology Integration

The integration of digital technologies has become essential in modern mathematics education, particularly under the competency-based framework. The NCERT middle-stage textbook Ganita Prakash actively promotes technology use by incorporating QR codes in almost every chapter. These QR codes serve as gateways to the DIKSHA and e-pathshala platforms, providing access to supplementary digital resources such as instructional videos, interactive simulations, animations, digital worksheets, practice assessments, and teacher support materials.

While Ganita Prakash is designed as an Energised Textbook, many teachers still require substantial professional development in this area. A recent review of mathematics teacher training programmes

indicates that technology integration remains a major need. Teachers often possess basic operational skills but cannot integrate digital tools meaningfully into daily instruction.

Effective professional development for Ganita Prakash users should therefore focus on Technological Pedagogical Content Knowledge (TPACK), enabling teachers to:

- Scan and effectively utilize QR codes to enrich classroom transactions.
- Integrate DIKSHA resources (videos, simulations, and interactive content) with the textbook's activity-based and exploratory tasks.
- Use technology to support mathematical modelling, visualization of concepts, and real-life applications.
- Facilitate blended learning experiences that combine hands-on activities with digital tools.
- Employ digital assessment features for formative feedback and tracking competency development.

Without targeted training, teachers may underutilize the rich digital ecosystem embedded in Ganita Prakash, limiting the textbook's potential to make mathematics learning more engaging, interactive, and aligned with the goals of NEP 2020 and NCF-SE 2023. Professional development programmes must therefore combine hands-on practice with technology, pedagogy, and content knowledge to build teacher confidence and competence.

Training Needs Related to Inclusive Mathematics Education

NEP 2020 and NCF-SE 2023 seek to provide meaningful and equitable learning opportunities for all learners, irrespective of their socio-economic background, gender, learning pace, style, abilities, or disabilities. The NCERT mathematics textbook Ganita Prakash strongly embodies this inclusive principle through its learner-centred, flexible, joyful, and gender-sensitive design. It includes several inclusive features like:

- Scaffolded activities, guided questions, and differentiated tasks that accommodate diverse learning needs and speeds.
- Exploration-based and hands-on activities that reduce mathematics anxiety and provide multiple entry points for all learners.
- Integration of cross-cutting themes such as inclusive education, gender equality, and Indian Knowledge Systems.
- Colourful and diverse illustrations that show both boys and girls actively participating in mathematical activities with equal roles, thereby promoting gender-balanced representation and breaking traditional stereotypes.
- Use of inclusive and diverse names in word problems, stories, and examples to reflect India's cultural diversity and foster a sense of belonging among students of all genders and regions.
- QR codes linked to the DIKSHA platform, offering multilingual content, videos, interactive simulations, and accessible resources that support learners from varied linguistic, cultural, and ability backgrounds.

Despite these strengths, research indicates that many mathematics teachers feel inadequately prepared to support students with learning difficulties, disabilities, or varied learning needs, including addressing gender-sensitive issues in the classroom. Therefore, targeted professional development is essential in the following areas:

- Implementing differentiated instruction while adapting Ganita Prakash activities (e.g., modifying exploration tasks or group activities for students with different abilities).
- Using the textbook's gender-inclusive illustrations and examples (such as boys and girls equally engaged in measuring, patterning, or data interpretation tasks) to promote equity and challenge stereotypes.
- Adapting tasks, explorations, and assessments involving diverse names and real-life contexts to meet individual requirements, including those of students with special educational needs.
- Creating inclusive classroom practices that ensure active participation of all students, with attention to gender sensitivity (e.g., encouraging girls to lead mathematical discussions or group work).
- Effectively utilizing digital resources (via QR codes and DIKSHA) for personalized support and applying Universal Design for Learning (UDL) principles.
- Building strategies to address mathematics anxiety, foster a positive classroom climate, and promote gender-equitable participation in discussions and activities.
- Professional development programmes should equip teachers with practical strategies and classroom examples from Ganita Prakash so that every student — regardless of gender, ability, or background — can engage meaningfully and progress confidently in mathematics.

Continuous Professional Development and Collaborative Learning

The literature strongly indicates that one-time workshops or short-term training programmes are insufficient to bring about meaningful and lasting changes in teaching practices. For the successful implementation of competency-based mathematics education, professional development must be continuous, collaborative, sustained, and embedded in actual classroom realities.

This is especially relevant for the effective transaction of Ganita Prakash, which introduces a significant pedagogical shift. The textbook's activity-based explorations, mathematical modelling tasks, real-life applications, and QR codes linking to rich digital resources on the DIKSHA platform (videos, simulations, interactive content, and teacher manuals) require teachers to continuously update their skills and adapt their instructional strategies.

Effective professional development approaches for Ganita Prakash include:

- Lesson Study — Collaborative planning, teaching, and reflection on specific chapters or activities from the textbook.
- Professional Learning Communities (PLCs) — Regular teacher groups discussing challenges and successes in implementing Ganita Prakash's inquiry-based and competency-oriented tasks.
- Mentoring and Peer Observation — Experienced teachers supporting others in using QR codes effectively, facilitating mathematical discussions, and conducting formative assessments.
- Collaborative Reflection — Analysing student work from Ganita Prakash activities, reflecting on classroom discourse, and refining teaching strategies.
- Action Research — Teachers investigating their own practice while using the textbook's features, such as open-ended problems and digital resources.

Sustained and collaborative professional development programmes have been consistently shown to improve teacher confidence, instructional effectiveness, and ultimately student achievement in mathematics. In the context of Ganita Prakash, such ongoing support is essential to help teachers move from traditional teaching methods to becoming skilled facilitators who can fully harness the textbook's

potential for joyful, inclusive, and competency-based learning.
Therefore, schools, DIETs, SCERTs, and teacher education institutions must establish structured, long-term mechanisms for continuous professional development focused specifically on Ganita Prakash.

Implications for Teacher Education and Professional Development

The review of literature and detailed analysis of the NCERT mathematics textbook Ganita Prakash reveal important implications for professional development programmes. Middle-stage teachers play a crucial role in strengthening students' conceptual foundation, developing abstract thinking, and preparing them for secondary-level mathematics. Therefore, teacher training programmes must be specially designed to address the unique professional needs of middle-stage mathematics teachers. Professional development programmes should incorporate the following key components tailored to middle-stage requirements:

- Understanding Competency-Based Curriculum and Textbook Design — Comprehensive orientation to NEP 2020, NCF-SE 2023, and the pedagogical vision, structure, and unique features of Ganita Prakash.
- Inquiry-Based and Activity-Oriented Pedagogy — Training in facilitating exploration, pattern discovery, mathematical discussions, multiple solution strategies, and joyful learning suitable for the developmental stage of middle-school students.
- Mathematical Reasoning, Problem-Solving, and Modelling — Developing teachers' expertise to guide students in logical reasoning, argumentation, mathematical modelling, and solving real-life problems that bridge concrete and abstract thinking.
- Competency-Based Assessment and Feedback — Skills in designing formative assessments, creating rubrics for evaluating reasoning and application, analysing student responses to open-ended tasks in Ganita Prakash, and providing constructive feedback.
- Technology Integration — Practical, hands-on training in using QR codes, the DIKSHA platform, interactive simulations, animations, and other digital resources to support visualization and conceptual understanding at the middle stage.
- Inclusive Mathematics Education — Strategies for differentiated instruction, Universal Design for Learning (UDL), gender-sensitive pedagogy, and adapting Ganita Prakash activities to address diverse learning needs, including students with learning difficulties, varying abilities, and different linguistic backgrounds.
- Reflective Practice and Action Research — Encouraging teachers to systematically reflect on their classroom experiences with Ganita Prakash and undertake small-scale action research focused on middle-stage learners.
- Collaborative Professional Learning Structures — Establishing Professional Learning Communities (PLCs), Lesson Study cycles, mentoring, peer observation, and collaborative planning specifically centred on implementing Ganita Prakash in Grades 6–8 classrooms.

Professional development for middle-stage teachers must go beyond one-time workshops and become sustained, continuous, school-based, and practice-embedded. Regular follow-up support, peer mentoring, classroom-based coaching, and structured opportunities for collaborative lesson planning, implementation, observation, and reflection are essential.
Only through such targeted, long-term, and context-specific capacity-building efforts can middle-stage mathematics teachers develop the confidence and competence required to effectively implement Ganita

Prakash, thereby transforming mathematics teaching and learning in alignment with the goals of NEP 2020 and NCF-SE 2023.

Conclusion

The successful implementation of the competency-based middle-stage mathematics textbook Ganita Prakash largely depends on the professional readiness of teachers. This review clearly identifies that teachers require targeted and comprehensive professional development in several critical areas: competency-based pedagogy, assessment literacy, mathematical reasoning and problem-solving, technology integration, inclusive education practices, including gender sensitivity, and reflective practice. Without systematic training in these domains, the transformative vision of NEP 2020 and NCF-SE 2023 risks remaining unrealized in classrooms despite the high quality of the new textbook.

To bridge these gaps, teacher education institutions, SCERTs, DIETs, and schools must shift from traditional one-time workshops to sustained, collaborative, and school-based continuous professional development models. Approaches such as Lesson Study, Professional Learning Communities, mentoring, peer observation, and action research should be prioritized and directly linked to the implementation of Ganita Prakash. Such ongoing support will help middle-stage mathematics teachers transition effectively from conventional teaching roles to competent facilitators capable of fostering joyful, inclusive, and deep learning experiences.

In conclusion, investing in the professional development of mathematics teachers is not merely desirable but essential for realizing the goals of competency-based education in India. Well-prepared teachers will be able to unlock the full potential of Ganita Prakash, ultimately nurturing a generation of students who possess strong conceptual understanding, critical thinking, and problem-solving abilities necessary for success in the 21st century.

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