Mathematics Education: A Practice-based Pedagogical Approach
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Aim and Scope:
Mathematics Education: A Practice-Based Pedagogical Approach provides an in-depth understanding of mathematics teaching for Indian schools and classroom contexts. This book adopts a research and practice-based approach to discuss important issues and approaches in the teaching of mathematics, which emerge from the varied perspectives on mathematics and mathematics education research like historical, cognitive, socio-cultural and critical perspectives. The main aim of the book is to develop a deeper interconnected understanding of concepts, processes and practices for teaching mathematics. It aims to create awareness among student-teachers, M.Ed. and PhD students of Mathematics Education, teachers and teacher-educators about mathematics, mathematics teaching, about students and student learning and their identity through inquiry and self-examination of beliefs and practices. A range of resources and activities are used to develop Pedagogical Content Knowledge (PCK) for teaching key topics of mathematics at the middle and secondary levels. PCK will be contextualised, taking into consideration the social, cultural, linguistic and mathematics knowledge diversity that exist in Indian classroom contexts. A deeper engagement with ICT and hands-on mathematics teaching resources aims to develop a critical perspective on their use and the capability to curate, evaluate and integrate resources in the teaching of mathematics. Concerns of social justice, equity, access, diversity of languages present in multilingual contexts, gender and mathematics will inform the topics covered in the book.

This book uses a practice-based approach to discussing the teaching of mathematics using examples from the ‘work’ of teaching mathematics. The chapters include excerpts and examples from lesson plans, problems and tasks used in mathematics classes, textbooks, ICT based tasks and games, students solutions and mistakes, student interviews and interviews of teachers and teacher educators. These artefacts from diverse teaching contexts are discussed, and connections are drawn with contemporary research literature available to establish a link between theory and practice.

The Rationale:
Mathematics Education: A Practice-based Pedagogical Approach addresses the need to focus on developing an understanding of mathematical concepts as well as processes such as problem-
solving, proving, reasoning, representing, and communicating, among others. The textbook emphasises mathematics learning as a social activity in which classroom interaction, peer learning and mathematics talk can support the development and understanding of concepts and processes through varied approaches that have been developed and researched across the world for teaching mathematics.

Research studies in mathematics education have highlighted how different learning perspectives contribute to mathematics education in schools. Over the years, there has been a predominance of the cognitive perspective in mathematics education, which has highlighted an important aspect of considering student thinking and their conceptions while planning to teach. The field of ethnomathematics has shown how cultural tools used in everyday life can contribute towards understanding mathematics structures and processes, enabling educators to adopt alternative ways of doing mathematics in classrooms to make it more relevant for students. Additionally, the critical perspective has highlighted how mathematics has functioned as a role of gatekeeper in society, especially for the socio-economically marginalised and plays a role in foregrounding students’ future. This textbook will enable student-teachers to integrate multiple perspectives to develop pedagogies to create inclusive mathematics classrooms.

The teaching approaches that emanate from these perspectives, including problem-solving, realistic, constructionist and connectionist approaches would be discussed using examples of episodes from classrooms and artefacts from diverse teaching contexts. The topic of arithmetic, number systems, algebra, functions, graphs, statistics and probability and geometry will be discussed using examples of traditional and innovative teaching and artefacts drawn from the work of teaching and available research literature. For each topic, example of problems, tasks or worksheets, solutions and responses of students, teaching scenarios and episodes and reflective questions would be provided to the student-teachers to engage deeply in analysis and reflection.

Chapter 1: Nature of mathematics and mathematical thinking

This chapter discusses mathematical thinking, its nature and aspects to present a broad mathematical landscape. It will introduce the term mathematics education and how it draws from the disciplines of mathematics and education. It will also discuss the nature of mathematics education. The key features of nature of mathematics will be discussed like modelling, abstraction and generalization, the use of symbols, the place of proof and social nature of mathematical processes that are embedded in different cultural practices and everyday settings. It will also discuss what mathematical objects are, their structure and existence and relation between school mathematics content and mathematical processes such as problem-solving, reasoning, proving, communicating, connecting and representing along with suitable examples. The structure of mathematical knowledge and the role of axioms, postulates and proofs will be discussed with emphasis on supporting the development of conjectures and different types of proof (axiomatic, deductive versus empirical and visual) in mathematics classroom.

Keywords: Mathematical structure, models, abstraction, generalisation, symbols, proofs

Chapter 2: Perspectives on teaching and learning of mathematics

This chapter discusses the cognitive perspective of teaching and learning of mathematics and the
emergence of socio-cultural and socio-political perspectives in mathematics education. The importance of considering history of mathematics and the various socio-cultural and socio-historical tools available to support learning in planning for teaching, and understanding the difficulties faced by learners will be exemplified. Critical perspective on mathematics education to develop practices that are inclusive and enable all students to succeed in school mathematics will be developed. Examples from national and international research from these different perspectives will be drawn to develop a broader multi-lens perspective and a holistic understanding of mathematics education in the Indian context.

Keywords: Cognitivist perspective, socio-cultural perspective, socio-historical perspective, critical perspective

Chapter 3: School mathematics curriculum

In this chapter the larger aims and objectives for teaching mathematics with respect to school curriculum will be discussed historically, tracing the development of mathematics education in India using various curriculum documents and the National Curriculum Framework 2005, in particular. The pertinent issues raised in the curriculum framework and its implications on the design of textbooks, teacher education and classroom interaction would be discussed. The multiplicity of approaches and resources to select and sequence tasks, drawing connections between and among concepts and representations by presenting ideas for designing learning environment and learning trajectories will be developed in this chapter.

Keywords: Curriculum, school mathematics, National Curriculum Framework, curriculum implementation, learning environment, learning trajectory

Chapter 4: Using historical and cultural resources for early numeracy and number systems

This chapter uses the historical and cultural resources to discuss mathematics as a cultural product constructed by humans, which embodies the cultural values in which it is situated. Anthropological and cross cultural research will be used to cite examples of mathematical topics like number systems and cultural support for early numeracy, multi digit operations on whole numbers and illustrate how the procedures for operation are intricately connected with underlying concepts like place value. The shift from rules and procedures to developing student’s mathematical processes giving importance to students to construct and express their understanding and to learn through social interaction will be discussed. The topic of rational and irrational numbers, real numbers and limits will be discussed using historical references to highlight how these topics emerged historically and what relevance they bear to the learning of mathematics.

Keywords: Early numeracy, cultural tools, whole numbers and operations, number system, rational and irrational numbers

Chapter 5: Connecting multiple representations in the teaching of algebra

The historical roots of algebra and the role it played in developing symbols with special meanings in mathematics will be discussed while identifying the need to connect across various representations. The justifications for these connections among representations would be developed using examples from research about students’ difficulties in doing algebra. Considering the goal of teaching algebra as sense making several approaches for teaching algebra will be discussed which
include the approach which establishes connection between arithmetic and algebra through algebrification of concepts learnt in elementary mathematics, realistic approach and modelling and generalisations.

Keywords: Algebraic representation, students’ conceptions, sense making, realistic approach, modelling, generalisation

Chapter 6: Reasoning in geometry and measurements

This chapter will discuss ways through which argumentation and reasoning can be supported for learning geometry using examples of classroom interaction. The differences between the Euclidean geometry approach and other historical accounts of geometrical explorations for doing mathematics will be discussed. Also discussed will be ways to integrate both the cognitive and sociocultural perspectives to develop pedagogies that enable students to interconnect geometric concepts, representations and ways of reasoning and to address misconceptions. The different pedagogical approaches like axiomatic deductive approach and realistic approach for teaching geometry will be compared while analysing tasks that can support the development of students’ understanding of geometric ideas.

Keywords: Geometric reasoning, measurements, argumentation, geometrical explorations, deductive and inductive thinking

Chapter 7: Problem solving approach for learning statistics and probability

Data handling and conceptions of chance and probability play an important role in making sense of real-world problems in daily lives and data presented in the media to make various claims. Use of technology has also played a role in mathematisation and de-mathematisation of artefacts and processes in our society thus making understanding of statistics and probability a key topic for developing critical citizenship. Problem solving approaches for teaching statistics and probability will be discussed along with the research review of the students’ misconceptions about the topic.

Keywords: Problem solving, chance and probability, mathematisation, de-mathematisation, statistics

Chapter 8: Assessment in mathematics education

The focus of this chapter is to prepare teachers to use multiple approaches and tools to assess mathematical concepts, procedures, processes and conceptual understanding. The chapter will discuss different ways in which assessment and instruction are closely related to each other and the importance of formative assessment to support students continuous learning. The impact of different learning theories that contribute to the design of assessment and assessment practices will be presented. The readers will be guided on practical aspects of planning, designing and executing different types of assessments. The role played by open ended and performance based assessment in informing instruction will be discussed along with ICT based resources for assessing student learning. Implications for large scale assessment and nature of summative assessment on teaching of mathematics will be discussed.

Keywords: Assessment practices, formative assessment, summative assessment, open-ended assessment, performance based assessments, large scale assessments
Chapter 9: Status and identity of mathematics teachers

Several factors impact the status and identity of mathematics teachers as well as their mathematics pedagogies. The beliefs and values they hold about mathematics as a discipline, what topics should be included in school mathematics, beliefs about educatibility of students and their autonomy in schools and classrooms impact their formation as a professional. This chapter will use a self-reflexive approach to enable student-teachers to examine their beliefs and how it may impact their future practices. The role of professional communities and activities in the form of continued professional development that can foster and sustain the identity as reflective mathematics practitioners will be discussed to inform and advise ways to promote lifelong learning among teachers.

Keywords: Teacher status, teacher identity, teacher beliefs, professional development, professional communities, reflective practitioners

Chapter 10: Mathematics education and society

This chapter will explore the complex relationships between education and differential power. In particular, sections herein will discuss the intersecting dynamics of gender, class, language diversity and multilingualism and how they are represented and struggled over in pedagogic and evaluative practices in mathematics curricula and classrooms. This chapter will also discuss the growing use of technology in mathematics teaching and learning processes and what role mathematics education may play in developing 21st century skills. The issues of equity and access for mathematics learners run through the above topics. The purpose of this chapter is to identify, acknowledge and understand the broader socio-cultural-political dimensions of mathematics education and using this lens to evaluate pedagogy of mathematics.

Keywords: Power, equity, access, gender, foreground, identity, multilingualism, language diversity, ethnomathematics

Competing titles:

<table>
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<tr>
<th>Title of the Book/ Ed/ Pub Year</th>
<th>Author/Publisher</th>
<th>Approximate Extent/ Price</th>
<th>Strengths/Limitations of the Book vis-à-vis Yours</th>
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<tr>
<td>The Teaching Of Mathematics/ Sterling publications pvt limited /2010</td>
<td>Dr Kulbir Singh Sidhu</td>
<td>Rs 248</td>
<td>This textbook provides information about varied aspects in superficial manner, while the proposed textbook aims to include classroom based examples and discussion of approaches derived from cutting edge</td>
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MARKET & READERSHIP

The book will be of relevance to secondary and higher secondary school teachers, teacher educators, curriculum designers and developers of school mathematics courses, related activities, games, etc., NGOs, public and private sector bodies who work in mathematics teaching and learning practice.

The book caters to the course requirements of the core pedagogic papers of the integrated B.Ed./M.Ed. program offered at the Centre for Education, Innovation and Action Research (CEIAR), TISS Mumbai. It also comprises references and contents that are relevant to courses on ‘Pedagogy of Mathematics’ and ‘Mathematics Learning Parts 1 and 2’ offered as Master’s level specialisations and optional courses in MA (Education) and MA (Elementary Education) programs offered by TISS, Mumbai and TISS, Hyderabad. This apart, the book will hold and appeal to the international audience with an interest in pedagogy of mathematics courses.

The textbook maps to the syllabi of different national universities in the country offering the following courses:

- Primary Course/s: Mathematics education or Pedagogy of mathematics in B.Ed, M.Ed, B.Ed-M.Ed integrated, MA elementary education
- Secondary Course/s: In-service course for mathematics teachers, administrators, mathematics education for M. Phil and PhD students