

Mathematics Education

Mathematics is the art and science of discovering patterns and explaining them. These patterns are all around us, in nature, in technology, and in the motion of the earth, sun, moon, and stars. There is Mathematics in everything that we do and see, from shopping and cooking, to throwing a ball and playing games, to solar eclipses and climate patterns. Mathematics thus gives us the foundational concepts and capacities required to think about the world around us and the world beyond us. But most of all, when taught well, Mathematics is truly enjoyable and can become a lifelong passion. The goal of Mathematics Education is to bring to life these aspects of Mathematics.

Mathematics, including Computational Thinking, has never been more important globally, for students and for society, with the growing challenges with respect to artificial intelligence, machine learning, data science, climate modelling, infrastructure development, and the numerous other related scientific issues faced by India and all nations today. Quality education in mathematics and mathematical thinking will thus be indispensable for India's future, and indeed for ensuring India's leadership role in these critically important and emerging fields.

Mathematics Education aims to develop capacities of logical thinking, finding patterns, explaining patterns, making, refuting, and proving conjectures, problem solving, computing fluently, and communicating clearly and precisely, through content areas such as arithmetic, algebra, geometry, probability, statistics, trigonometry, and calculus.

Aims

Mathematics helps students develop not only basic arithmetic skills, but also the crucial capacities of logical reasoning, creative problem solving, and clear and precise communication (both oral and written). Mathematical knowledge also plays a crucial role in understanding concepts in other school subjects, such as Science and Social Science, and even Art, Physical Education, and Vocational Education. Learning Mathematics can also contribute to the development of capacities for making informed choices and decisions. Understanding numbers and quantitative arguments is necessary for effective and meaningful democratic and economic participation.

Mathematics thus has an important role to play in achieving the overall aims of School Education. The specific aims of Mathematics Education in this NCF are as follows:

a. Basic Numeracy: Numbers and quantities along with words (language) are the two ways in which human beings understand and interpret the world. Numbers and quantities also play a very important role in day-to-day interactions within a complex society. Fluency in quantifying and performing calculating is essential for basic daily interactions, such as shopping and banking. Mathematics Education in schools should ensure that all students are fluent in basic numeracy. This would include not just fluency in numbers and number operations using Indian numerals, but also the capacities to handle situations that involve space and measurement.

b. Mathematical Thinking: Mathematical thinking involves systematic and logical ways to think about and interpret the world. The capacities for identifying patterns, explaining patterns, quantifying and measuring, using deductive reasoning, working with abstractions, and communicating clearly and precisely are some illustrations of mathematical thinking. Mathematics Education in schools should aim for developing such mathematical thinking in all students.

c. Problem Solving: The capacity to formulate well-defined problems that can be solved through mathematical thinking is an important aspect of learning Mathematics. Clear and precise formulation of problems and puzzles, knowing the appropriate mathematical concepts and techniques that can model the problems, and possessing the techniques and the creativity to solve the problems are core aspects of problem solving. Mathematics Education in schools should aim for developing such problem-solving capacities in all students. Problem solving also develops the capacities of perseverance, curiosity, confidence, and rigour.

d. Mathematical Intuition: Developing an intuition for what should or should not be true in Mathematics is often just as important as the more formal 'paper-pencil' doing of Mathematics. Focusing on the common themes and patterns of reasoning across mathematical areas, guessing correct answers (in terms of, e.g., 'order of magnitude') before working out precise answers, and engaging in informal argumentation before carrying out rigorous proofs are all effective ways of developing such mathematical intuition in students. Developing such mathematical intuition in all students should be one of the aims of Mathematics Education in schools.

e. Joy, Curiosity and Wonder: Discovering, understanding, and appreciating patterns and other mathematical concepts, ideas, and models can require great creativity and

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often generates great wonder and joy. To see Mathematics as merely calculations and mechanical procedures is very limiting. Mathematics Education in schools should nurture this sense of joy, curiosity, aesthetics, creativity, and wonder in all students.

Fear of Mathematics

There are two major aspects that cause fear of Mathematics: (1) the nature of the subject and how it is taught and assessed; and (2) how it is perceived in society.

1. The Nature of Mathematics and How it is Taught

a. Concepts in Mathematics are often cumulative in nature. If students struggle with place value, then certainly they will struggle with all four basic operations and decimal numbers, and hence in word problems. In early grades, the Teacher must provide differentiated learning experiences to ensure that each student has mastered the foundational concepts in Mathematics.

b. When symbols, part of the 'language' of Mathematics, are manipulated without understanding, after a point, boredom and bewilderment dominate many students, and dissociation develops. Hence, it is important for the Teacher to start teaching the concept by making connections to real life using the local language (especially up to Preparatory Stage), providing exposure to explore using concrete objects or examples, and gradually shift to more algebraic language.

c. Most of the assessment techniques and questions focus on facts, procedures, and memorisation of formulas. However, assessment should focus on understanding, reasoning, and when and how a mathematical technique is to be used in different contexts.

Alignment with NEP2020, NCF-FS2022 and NCF -SE 2023.

NEP 2020 (National Education Policy 2020)

- Focus on foundational Literacy and Numeracy (FLN)
- Early math learning is part of Foundational Stage (3–8 years).

Emphasis on numeracy skills

- Number sense
- Counting
- Comparison
- Basic operations (Addition, Subtraction, multiplication and Division)

Learning should be

- Play-based learning
- Activity-based learning
- Discovery-oriented learning.(let us know)
- Use the bilingual for better understanding the concept in early grades.
- Integrate mathematics with other subjects.

NCF-FS 2022 Says About Mathematics (Class 1 & 2)

The National Curriculum Framework for Foundational Stage 2022 (NCF-FS 2022) gives clear guidance for teaching Mathematics in Classes 1 & 2

(Foundational Stage). It focuses on making maths meaningful, activity-based, and connected to children's daily life.

Focus on Foundational Numeracy

Children should develop number sense (understanding numbers, not just memorizing).

Emphasis on Counting with understanding, Comparing quantities, Basic operation.(addition & subtraction)

Learning Through Play and Activities

Maths should be taught using Games, Stories and rhymes

Hands-on materials (beads, sticks, coins)

Children learn better when they do and get experience.

Concrete to Abstract Learning

Start with real objects → move to pictures → then numbers/symbols

Integration with Daily Life

Mathematics should be linked to real-life situations like, Money (₹10, ₹20), Time (day, night), Measurement (length, weight), Patterns in surroundings

Conceptual Understanding Over Rote Learning

Focus on “why” and “how”, not just answers. Avoid memorization without understanding. Use mother tongue along with maths terms while teaching.

Key Content Areas for Classes 1 & 2

Class 1 Numbers (0–100), class 2 – (100-1000)

Addition & subtraction

Multiplication (class-2)

Shapes around us (Cube, Cuboid, Cone,)

Let us measure (non-standard units like hand span, foot)

Time (day,afternoon, evening and night and days of a week)

Money. (Coins and Notes, Tendering upto 20 rupees)

Continuous Assessment

- Observing Face sheet and answering the questions

- Activities
- Oral questions
- Class room transaction.
- Do these
- Exercise
- Improve your learning.
- Worksheets

Inclusive and Joyful Learning

- Every child can learn maths at their own pace.
- Use different methods for different learners.(reamedial teaching)

NCF-SE2023

NCF 2023 says mathematics in Classes 1 & 2 should be joyful, activity-based, concept-focused. while assessing the student, teacher should be freedom to the student.

Aim of Mathematics

Understanding Mathematics by patterns, numbers, shapes, and measurements. It develops Logical thinking, Problem-solving skills, Reasoning ability, Communication of ideas.

Foundational Stage Approach (Class 1 & 2)

Learning should be Play-based and activity-based, Connected to real-life situations, Fun and stress-free. Toys, puzzles, objects, Stories and games, Hands-on material used in teaching learning process. Children learn by doing, exploring, and talking, not by memorizing.

Foundational Litrracy and numaracy.

FLN (Foundational Literacy and Numeracy) in mathematics focuses on ensuring that every child attains basic number sense and problem-solving skills. Text book promote FLN through activities, stories and rhymes aligned with curricular Goals (CG -8) referred by NCF-FS 2022, NCF-SE2023.

MATHEMATICS CURRICULUM – KEY FEATURES (Classes 3,4 & 5)

1. READINESS PROGRAMMES

13 Days Bridge Course for recaptulating

- Focus on Number recognition
- Fundamental Operations (+, -, $\times$, $\div$)
- Fractions, Measurements, Data Handling
- Roman Numbers

2. CURRICULUM ALIGNMENT

- Aligned with NCF-FS 2022 and NEP 2020.
- Competency-based learning outcomes.
- Number Counting, Naming, comparing, and classifying, Daily life problems with addition, subtraction, Multiplication & Division, Multiples & Factors, Data Handling, measurements, Fractions, Time

3. JOYFUL & CHILD-FRIENDLY DESIGN

- Colourful and engaging textbook design.
- Use of Pictures and real-life objects.
- Stories and rhymes in maths.
- Play-based learning to build interest and confidence.

4. CONCEPT BUILDING APPROACH

- Concrete $\rightarrow$ Pictorial $\rightarrow$ Abstract method.
- Hands-on learning using, beads, sticks, blocks, toys and classroom objects.
- Strong focus on understanding.

5. LEARNING TOOLS & STRUCTURE

- Activity-based exercises (learning by doing).
- Picture-based questions for better understanding.
- Structured sections.
- Observe $\rightarrow$ Think $\rightarrow$ Do $\rightarrow$ Practice.
- QR codes for interactive learning (DIKSHA).
- Simple word problems from daily life.

6. CORE MATHEMATICS CONTENT

- Numbers: From 4 digit to Crores
- Fundamental operations: Addition & subtraction; Multiplication & Division
- Multiples & Factors
- Data Handling
- Measurement, Length, weight, capacity (standard units: Metre, Centimetre, Millimetre, Kilo metre; Gram, Kilogram; Litre & Millilitre)

- Time and money (included in Chapters)

7. CONTINUOUS PRACTICE

- Regular practice for concepts.
- Oral and written activities.
- Worksheets are reduced and easy to understand.

8. HOLISTIC DEVELOPMENT

- Logical thinking .
- Problem-solving skills.
- Communication using maths language.
- Encourages group activities and discussions.

9. MULTILINGUAL APPROACH

- Use of home language along with school language.
- Helps children understand concepts easily.

10. ASSESSMENT (CBA)

- Competency-Based Assessment at end of units as Improve your Learning.
- Focusses on understanding, application and activity oriented.

CG-1 Understands numbers (counting numbers and fractions), represents whole numbers using the Indian place value system, understands and carries out the four basic operations with whole numbers, and discovers and recognises patterns in number sequences	C-1.1 Represents numbers using the place value structure of the Indian number system, compares whole numbers, and knows and can read the names of very large numbers C-1.2 Represents and compares commonly used fractions in daily life (such as $\frac{1}{2}$, $\frac{1}{4}$) as parts of unit wholes, as locations on number lines and as divisions of whole numbers C-1.3 Understands and visualises arithmetic operations and the relationships among them, knows addition and multiplication tables at least up to 10×10 (<i>Pahade</i>) and applies the four basic operations on whole numbers to solve daily life problems C-1.4 Recognises, describes, and extends simple number patterns such as odd numbers, even numbers, square numbers, cubes, powers of 2, powers of 10, and Virahanka–Fibonacci numbers.
CG-2 Analyses the characteristics and properties of two - and three-dimensional geometric shapes, specifies locations and describes spatial relationships, and recognises and creates shapes that have symmetry	C-2.1 Identifies, compares, and analyses attributes of two- and three-dimensional shapes and develops vocabulary to describe their attributes or properties C-2.2 Describes location and movement using both common language and mathematical vocabulary; understands the notion of map (<i>Najri Naksha</i>) C-2.3 Recognises and creates symmetry (reflection, rotation) in familiar 2D and 3D shapes C-2.4 Discovers, recognises, describes, and extends patterns in 2D and 3D shapes

CG-3 Understands measurable attributes of objects and the units, systems, and processes of such measurement, including those related to distance, length, weight, area, volume, and time using non-standard and standard units	C-3.1	Measures in non-standard and standard units and evaluates the need for standard units
	C-3.2	Uses an appropriate unit and tool for the attribute (like length, perimeter, time, weight, volume) being measured
	C-3.3	Carries out simple unit conversions, such as from centimetres to metres, within a system of measurement
	C-3.4	Understands the definition and formula for the area of a square or rectangle as length times breadth
	C-3.5	Devises strategies for estimating the distance, length, time, perimeter (for regular and irregular shapes), area (for regular and irregular shapes), weight, and volume and verifies the same using standard units
	C-3.6	Deduces that shapes having equal areas can have different perimeters and shapes having equal perimeters can have different areas
	C-3.7	Evaluates the conservation of attributes like length and volume, and solves daily-life problems related to them
CG-4 Develops problem-solving skills with procedural fluency to solve mathematical puzzles as well as daily-life problems, and as a step towards developing computational thinking	C-4.1	Solves puzzles and daily-life problems involving one or more operations on whole numbers (including word puzzles and puzzles from 'recreational' areas, such as the construction of magic squares)
	C-4.2	Learns to systematically count and list all possible permutations or combination given a constraint, in simple situations (e.g., how to make a committee of two people from a group of five people)
	C-4.3	Selects appropriate methods and tools for computing with whole numbers, such as mental computation, estimation, or paper-pencil calculation, in accordance with the context
CG-5 Knows and appreciates the development in India of the decimal place value system that is used around the world today	C-5.1	Understands the development of zero in India and the Indian place value system for writing numerals, the history of its transmission to the world, and its modern impact on our lives and in all technology

Assessment in Mathematics

Few key principles for assessment in Mathematics are:

- Students must be assessed for understanding of concepts and mathematical skills and capacities, such as procedural fluency, computational thinking, problem solving, visualisation, optimisation, representation, and communication.
- Students must be assessed through a variety of ways, e.g., solving a variety of problems testing procedural knowledge and conceptual understanding in key mathematical concepts, geometric

reasoning, algebraic thinking, word problems, and working in groups to solve mathematical problems.

c. Open book assessments can go a long way towards reducing anxiety in students. Examinations could provide 'fact sheets' consisting of information, such as formulae, and definitions, so that students need not memorise them but use them in actual problem solving.

Learning Outcomes- KEY FEATURES (Classes 3,4 & 5)- Mathematics

Aligned with NCF-FS 2022 and NEP 2020.

Competency-based learning outcomes.

Mathematics:

Number Counting, Naming, comparing, and classifying, Daily life problems with addition, subtraction, Multiplication & Division, Multiples & Factors, Data Handling, measurements, Fractions, Time

(Simple words reading, sentences reading, completing the activities, communicating in english)

How to introduce a Concept in any subject:

The process to introduce a new concept through experiences, explanation, exploration, examples and exercises to standardize the concept by inductive approach. The students can read and work together in peers or with other class students also. The teacher has to act as a facilitator but not to teach everything. This text book can be used for self pace learning. The students will engage in the school in a happy experiencing rather than feeling bore and stress while using the textbook.

Experiential Learning

NEP2020: In all stages, experiential learning will be adopted, including hands on experience, arts integrated learning and with exploration with other subjects

How learning occurs:

- Experiences

- Making
- Experimentation
- Reading
- Discussions
- Listening
- Thinking
- Reflecting
- Expressing
- Doing things
- Playful learning experiences
- (Note: Children can improve their thought, vocabulary, imagination, speaking and listening through imaginary plays)

How can we achieve the learning outcomes:

engaging with the textbook

Use of Pictures and real-life objects.

Rhymes, Stories and basic Grammar

Play-based learning to build interest and confidence.

Concrete → Pictorial → Abstract method.

Hands-on learning using, beads, sticks, blocks, toys and classroom objects.

Strong focus on understanding.

Using Print rich material provided by the Govt.(Jadui Pitara, Telugu story books, English picture cards, number charts,

LEARNING TOOLS & STRUCTURE

Activity-based exercises (learning by doing).

Picture-based questions for better understanding.

Structured sections.

Observe → Think → Do → Practice.

QR codes for interactive learning (DIKSHA).

Simple word problems from daily life.

CONTINUOUS PRACTICE

Regular practice for concepts.

Oral and written activities.

Worksheets Practicing

Logical thinking .

Problem-solving skills.

Communication using maths language.

Encourages group activities and discussions.