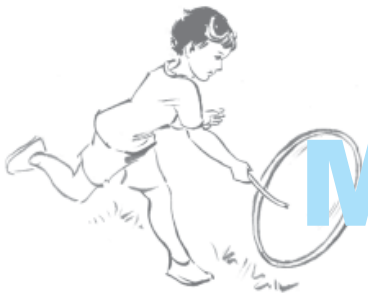

MATHEMATICS

MATHEMATICS
CLASSES VI – VIII

The development of the upper primary syllabus has attempted to emphasise the development of mathematical understanding and thinking in the child. It emphasises the need to look at the upper primary stage as the stage of transition towards greater abstraction, where the child will move from using concrete materials and experiences to deal with abstract notions. It has been recognised as the stage wherein the child will learn to use and understand mathematical language including symbols. The syllabus aims to help the learner realise that mathematics as a discipline relates to our experiences and is used in daily life, and also has an abstract basis. All concrete devices that are used in the classroom are scaffolds and props which are an intermediate stage of learning. There is an emphasis in taking the child through the process of learning to generalize, and also checking the generalization. Helping the child to develop a better understanding of logic and appreciating the notion of proof is also stressed.

The syllabus emphasises the need to go from concrete to abstract, consolidating and expanding the experiences of the child, helping her generalise and learn to identify patterns. It would also make an effort to give the child many problems to solve, puzzles and small challenges that would help her engage with underlying concepts and ideas. The emphasis in the syllabus is not on teaching how to use known appropriate algorithms, but on helping the child develop an understanding of mathematics and appreciate the need for and develop different strategies for solving and posing problems. This is in addition to giving the child ample exposure to the standard procedures which are efficient. Children would also be expected to formulate problems and solve them with their own group and would try to make an effort to make mathematics a part of the outside classroom activity of the children. The effort is to take mathematics home as a hobby as well.

The syllabus believes that language is a very important part of developing mathematical understanding. It is expected that there would be an opportunity for the child to understand the language of mathematics and the structure of logic underlying a problem or a description. It is not sufficient for the ideas to be explained to the child, but the effort should be to help her evolve her own understanding through engagement with the concepts. Children are expected to evolve their own definitions and measure them against newer data and information. This does not mean that no definitions or clear ideas will be presented to them, but it is to suggest that sufficient scope for their own thinking would be provided.

Thus, the course would de-emphasise algorithms and remembering of facts, and would emphasise the ability to follow logical steps, develop and understand arguments as well. Also, an overload of concepts and ideas is being avoided. We want to emphasise at this stage fractions, negative numbers, spatial understanding, data handling and variables as important corner stones that would formulate the ability of the child to understand abstract mathematics. There is also an emphasis on developing an understanding of spatial concepts. This portion would include symmetry as well as representations of 3-D in 2-D. The syllabus brings in data handling also, as an important component of mathematical learning. It also includes representations of data and its simple analysis along with the idea of chance and probability.

The underlying philosophy of the course is to develop the child as being confident and competent in doing mathematics, having the foundations to learn more and developing an interest in doing mathematics. The focus is not on giving complicated arithmetic and numerical calculations, but to develop a sense of estimation and an understanding of mathematical ideas.

General Points in Designing Textbook for Upper Primary Stage Mathematics

1. The emphasis in the designing of the material should be on using a language that the child can and would be expected to understand herself and would be required to work upon in a group. The teacher to only provide support and facilitation.
2. The entire material would have to be immersed in and emerge from contexts of children. There would be expectation that the children would verbalise their understanding, their generalizations, their formulations of concepts and propose and improve their definitions.
3. There needs to be space for children to reason and provide logical arguments for different ideas. They are also expected to follow logical arguments and identify incorrect and unacceptable generalisations and logical formulations.
4. Children would be expected to observe patterns and make generalisations. Identify exceptions to generalisations and extend the patterns to new situations and check their validity.
5. Need to be aware of the fact that there are not only many ways to solve a problem and there may be many alternative algorithms but there maybe many alternative strategies that maybe used. Some problems need to be included that have the scope for many different correct solutions.
6. There should be a consciousness about the difference between verification and proof. Should be exposed to some simple proofs so that they can become aware of what proof means.
7. The book should not appear to be dry and should in various ways be attractive to children. The points that may influence this include; the language, the nature of descriptions and examples, inclusion or lack of illustrations, inclusion of comic strips or cartoons to illustrate a point, inclusion of stories and other interesting texts for children.
8. Mathematics should emerge as a subject of exploration and creation rather than finding known old answers to old, complicated and often convoluted problems requiring blind application of un-understood algorithms.
9. The purpose is not that the children would learn known definitions and therefore never should we begin by definitions and explanations. Concepts and ideas generally should be arrived at from observing patterns, exploring them and then trying to define them in their own words. Definitions should evolve at the end of the discussion, as students develop the clear understanding of the concept.
10. Children should be expected to formulate and create problems for their friends and colleagues as well as for themselves.
11. The textbook also must expect that the teachers would formulate many contextual and contextually needed problems matching the experience and needs of the children of her class.
12. There should be continuity of the presentation within a chapter and across the chapters. Opportunities should be taken to give students the feel for need of a topic, which may follow later.

Class-wise Course Structure in Mathematics at Upper Primary Level

Class VI	Class VII	Class VIII
Number System (60 hrs) **(i) *Knowing our Numbers:*** Consolidating the *sense* of numberness up to 5 digits, Size, estimation of numbers, identifying smaller, larger, etc. Place value (recapitulation and extension), connectives: use of symbols =, <, > and use of brackets, word problems on number operations involving large numbers up to a maximum of 5 digits in the answer after all operations. This would include conversions of units of length & mass (from the larger to the smaller units), estimation of outcome of number operations. Introduction to a sense of the largeness of, and initial familiarity with, large numbers up to 8 digits and approximation of large numbers) **(ii) *Playing with Numbers:*** Simplification of brackets, Multiples and factors, divisibility rule of 2, 3, 4, 5, 6, 8, 9, 10, 11. (All these through observing patterns. Children would be helped in deducing some and then asked to derive some that are a combination of the basic patterns of divisibility.) Even/odd and prime/composite numbers, Co-prime numbers, prime	**Number System (50 hrs)** **(i) *Knowing our Numbers:*** ***Integers*** • Multiplication and division of integers (through patterns). Division by zero is meaningless • Properties of integers (including identities for addition & multiplication, *commutative, associative, distributive*) (through patterns). These would include examples from whole numbers as well. Involve expressing commutative and associative properties in a general *form*. Construction of counter-examples, including some by children. Counter examples like subtraction is not commutative. • Word problems including integers (all operations) **(ii) *Fractions and rational numbers:*** • Multiplication of fractions • Fraction as an operator • Reciprocal of a fraction • Division of fractions • Word problems involving mixed fractions • Introduction to rational numbers (with representation on number line) • Operations on rational numbers (all operations)	**Number System (50 hrs)** **(i) *Rational Numbers:*** • Properties of rational numbers. (including identities). Using general form of expression to describe properties • Consolidation of operations on rational numbers. • Representation of rational numbers on the number line • Between any two rational numbers there lies another rational number (Making children see that if we take two rational numbers then unlike for whole numbers, in this case you can keep finding more and more numbers that lie between them.) • Word problem (higher logic, two operations, including ideas like area) **(ii) *Powers*** • Integers as exponents. • Laws of exponents with integral powers **(iii) *Squares, Square roots, Cubes, Cube roots.*** • Square and Square roots • Square roots using factor method and division method for numbers containing (a) no more than total 4 digits and (b) no more than 2 decimal places

Class VI	Class VII	Class VIII
factorisation, every number can be written as products of prime factors. HCF and LCM, prime factorization and division method for HCF and LCM, the property LCM × HCF = product of two numbers. All this is to be embedded in contexts that bring out the significance and provide motivation to the child for learning these ideas. **(iii)** ***Whole numbers*** Natural numbers, whole numbers, properties of numbers (commutative, associative, distributive, additive identity, multiplicative identity), number line. Seeing patterns, identifying and formulating rules to be done by children. *(As familiarity with algebra grows, the child can express the generic pattern.)* $a^m \cdot b^m = (ab)^m$ **(iv)** ***Negative Numbers and Integers*** How negative numbers arise, models of negative numbers, connection to daily life, ordering of negative numbers, representation of negative numbers on number line. *Children to see* patterns, identify and formulate rules. What are integers, identification of integers on the number line, operation of addition and subtraction of integers, showing the operations on the number line (addition of negative integer reduces the value of the number) comparison of integers, ordering of integers.	• Representation of rational number as a decimal. • Word problems on rational numbers (all operations) • Multiplication and division of decimal fractions • Conversion of units (length & mass) • Word problems (including all operations) **(iii)** ***Powers:*** • Exponents only natural numbers. • Laws of exponents (through observing patterns to arrive at generalisation.) (i) $a^m \cdot a^n = a^{m+n}$ (ii) $(a^m)^n = a^{mn}$ (iii) $\frac{a^m}{a^n} = a^{m-n}$, where $m-n \in \mathrm{N}$ (iv)	• Cubes and cubes roots (only factor method for numbers containing at most 3 digits) • Estimating square roots and cube roots. Learning the process of moving nearer to the required number. **(iv)** ***Playing with numbers*** • Writing and understanding a 2 and 3 digit number *in generalized form* ($100a + 10b + c$, where a, b, c can be only digit 0-9) and engaging with various puzzles concerning this. (Like finding the missing numerals represented by alphabets in sums involving any of the four operations.) Children to solve and create problems and puzzles. • Number puzzles and games • Deducing the divisibility test rules of 2, 3, 5, 9, 10 for a two or three-digit number expressed in the general form.

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(v) ***Fractions:*** Revision of what a fraction *is*, Fraction as a part of whole, Representation of fractions (pictorially and on number line), fraction as a division, proper, improper & mixed fractions, equivalent fractions, comparison of fractions, addition and subtraction of fractions (Avoid large and complicated unnecessary tasks). (Moving towards abstraction in fractions) Review of the idea of a decimal *fraction*, place value in the context of decimal *fraction*, inter conversion of fractions and decimal fractions (avoid recurring decimals at this stage), word problems involving addition and subtraction of decimals (two operations together on money, mass, length and temperature)		
Algebra (15 hrs) **Introduction to Algebra** • Introduction to variable through patterns and through appropriate word problems and generalisations (example $5 \times 1 = 5$ etc.) • Generate such patterns with more examples. • Introduction to unknowns through examples with simple contexts (single operations)	**Algebra (20 hrs)** **Algebraic Expressions** • Generate algebraic expressions (simple) involving one or two variables • Identifying constants, coefficient, powers • Like and unlike terms, degree of expressions e.g., x^2y etc. (exponent$\leq$ 3, number of variables) • Addition, subtraction of algebraic	**Algebra (20 hrs)** **(i)** ***Algebraic Expressions*** • Multiplication and division of algebraic exp.(Coefficient should be integers) • Some common errors (e.g. $2 + x \neq 2x$, $7x + y \neq 7xy$) • Identities $(a \pm b)^2 = a^2 \pm 2ab + b^2$, $a^2 - b^2 = (a - b)$ (a + b) Factorisation (simple cases only) as examples the following types $a(x + y)$, $(x \pm y)^2$, $a^2 - b^2$, $(x + a).(x + b)$

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	expressions (coefficients should be integers). • Simple linear equations in one variable (in contextual problems) with two operations (avoid complicated coefficients)	• Solving linear equations in one variable in contextual problems involving multiplication and division (word problems) (avoid complex coefficient in the equations)
Ratio and Proportion (15 hrs) • Concept of Ratio • Proportion as equality of two ratios • Unitary method (with only direct variation implied) • Word problems	**Ratio and Proportion (20 hrs)** • Ratio and proportion (revision) • Unitary method continued, consolidation, general expression. • Percentage- an introduction. • Understanding percentage as a fraction with denominator 100 • Converting fractions and decimals into percentage and vice-versa. • Application to profit and loss (single transaction only) • Application to simple interest (time period in complete years).	**Ratio and Proportion (25 hrs)** • Slightly advanced problems involving applications on percentages, profit & loss, overhead expenses, Discount, tax. • Difference between simple and compound interest (compounded yearly up to 3 years or half-yearly up to 3 steps only), Arriving at the formula for compound interest through patterns and using it for simple problems. • Direct variation – Simple and direct word problems • Inverse variation – Simple and direct word problems • Time & work problems – Simple and direct word problems
Geometry (65 hrs) **(i)** ***Basic geometrical ideas (2 -D)*****:** Introduction to geometry. Its linkage with and reflection in everyday experience. • Line, line segment, ray. • Open and closed figures. • Interior and exterior of *closed* figures.	**Geometry (60 hrs)** **(i)** ***Understanding shapes:*** • Pairs of angles (linear, supplementary, complementary, adjacent, vertically opposite) (verification and simple proof of vertically opposite angles) • Properties of parallel lines with transversal (alternate,	**Geometry (40 hrs)** **(i)** ***Understanding shapes:*** • Properties of quadrilaterals – Sum of angles of a quadrilateral is equal to 360^0 (By verification) • Properties of parallelogram (By verification) (i) Opposite sides of a parallelogram are equal,

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• Curvilinear and linear *boundaries* • Angle — Vertex, arm, interior and exterior, • Triangle — vertices, sides, angles, interior and exterior, altitude and median • Quadrilateral — Sides, vertices, angles, diagonals, adjacent sides and opposite sides (only convex quadrilateral are to be discussed), interior and exterior of a quadrilateral. • Circle — Centre, radius, diameter, arc, sector, chord, segment, semicircle, circumference, interior and exterior. **(ii) *Understanding Elementary Shapes (2-D and 3-D)*:** • Measure of Line segment • Measure of angles • Pair of lines – Intersecting and perpendicular lines – Parallel lines • Types of angles- acute, obtuse, right, straight, reflex, complete and zero angle • *Classification* of triangles (*on the basis of* sides, and of angles) • Types of quadrilaterals – Trapezium, parallelogram, rectangle, square, rhombus. • Simple polygons *(introduction)* (Upto octagons regulars as well as non regular). • *Identification of* 3-D shapes: Cubes, Cuboids, cylinder, sphere, cone,	corresponding, interior, exterior angles) **(ii) *Properties of triangles:*** • Angle sum property (with notions of proof & verification through paper folding, proofs using property of parallel lines, difference between proof and verification.) • Exterior angle property • Sum of two sides of a it's third side • Pythagoras Theorem (Verification only) **(iii) *Symmetry*** • Recalling reflection symmetry • Idea of rotational symmetry, observations of rotational symmetry of 2-D objects. (90^0, 120^0, 180^0) • Operation of rotation through 90^0 and 180^0 of simple figures. • Examples of figures with both rotation and reflection symmetry (both operations) • Examples of figures that have reflection and rotation symmetry and vice-versa **(iv) *Representing 3-D in 2-D:*** • Drawing 3-D figures in 2-D showing hidden faces. • Identification and counting of vertices, edges, faces, nets (for cubes cuboids, and cylinders, cones). • Matching pictures with objects (Identifying names)	(ii) Opposite angles of a parallelogram are equal, (iii) Diagonals of a parallelogram bisect each other. [Why (iv), (v) and (vi) follow from (ii)] (iv) Diagonals of a rectangle are equal and bisect each other. (v) Diagonals of a rhombus bisect each other at right angles. (vi) Diagonals of a square are equal and bisect each other at right angles. **(ii) *Representing 3-D in 2-D*** • Identify and Match pictures with objects [more complicated e.g. nested, joint 2-D and 3-D shapes (not more than 2)]. • Drawing 2-D representation of 3-D objects (Continued and extended) • Counting vertices, edges & faces & verifying Euler's relation for 3-D figures with flat faces (cubes, cuboids, tetrahedrons, prisms and pyramids) **(iii) *Construction:*** *Construction of Quadrilaterals:* • Given four sides and one diagonal • Three sides and two diagonals • Three sides and two included angles • Two adjacent sides and three angles

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prism (triangular), pyramid (triangular and square) Identification and locating in the surroundings • Elements of 3-D figures. (Faces, Edges and vertices) • Nets for cube, cuboids, cylinders, cones and tetrahedrons. **(iii) *Symmetry: (reflection)*** • Observation and identification of 2-D symmetrical objects for reflection symmetry • Operation of reflection (taking mirror images) of simple 2-D objects • Recognising reflection symmetry (identifying axes) ***(iv) Constructions (using Straight edge Scale, protractor, compasses)*** • Drawing of a line segment • Construction of circle • Perpendicular bisector • Construction of angles (using protractor) • Angle 60°, 120° (Using Compasses) • Angle bisector- making angles of 30°, 45°, 90° etc. (using compasses) • Angle equal to a given angle (using compass) • Drawing a line perpendicular to a given line from a point a) on the line b) outside the line.	• Mapping the space around approximately through visual estimation. **(v) *Congruence*** • Congruence through superposition (examples- blades, stamps, etc.) • Extend congruence to simple geometrical shapes e.g. triangles, circles. • Criteria of congruence (by verification) SSS, SAS, ASA, RHS **(vi) *Construction (Using scale, protractor, compass)*** • Construction of a line parallel to a given line from a point outside it.(Simple proof as remark with the reasoning of alternate angles) • Construction of simple triangles. Like given three sides, given a side and two angles on it, given two sides and the angle between them.	

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Mensuration (15 hrs) **CONCEPT OF PERIMETER AND INTRODUCTION TO AREA** Introduction and general understanding *of perimeter* using many shapes. Shapes of different kinds with the same perimeter. Concept of area, Area of a rectangle and a square *Counter examples to different misconcepts related to perimeter and area.* Perimeter of a rectangle – and its special case – a square. Deducing the formula of the perimeter for a rectangle and then a square through pattern and generalisation.	**Mensuration (15 hrs)** • Revision of perimeter, Idea of , Circumference of Circle ***Area*** Concept of measurement using a basic unit area of a square, rectangle, triangle, parallelogram and circle, area between two rectangles and two concentric circles.	**Mensuration (15 hrs)** (i) Area of a trapezium and a polygon. (ii) Concept of volume, measurement of volume using a basic unit, volume of a cube, cuboid and cylinder (iii) Volume and capacity (measurement of capacity) (iv) Surface area of a cube, cuboid, cylinder.
Data handling (10 hrs) (i) What is data - choosing data to examine a hypothesis? (ii) Collection and organisation of data - examples of organising it in tally bars and a table. (iii) Pictograph- Need for scaling in pictographs interpretation & construction. (iv) Making bar graphs for given data interpreting bar graphs+.	**Data handling (15 hrs)** (i) Collection and organisation of data – choosing the data to collect for a hypothesis testing. (ii) Mean, median and mode of ungrouped data – understanding what they represent. (iii) Constructing bargraphs (iv) Feel of probability using data through experiments. Notion of chance in events like tossing coins, dice etc. Tabulating and counting occurrences of 1 through 6 in a number of throws. Comparing the observation with that for a coin.Observing strings of throws, notion of randomness.	**Data handling (15 hrs)** (i) Reading bar-graphs, ungrouped data, arranging it into groups, representation of grouped data through bar-graphs, constructing and interpreting bar-graphs. (ii) Simple Pie charts with reasonable data numbers (iii) Consolidating and generalising the notion of chance in events like tossing coins, dice etc. Relating it to chance in life events. Visual representation of frequency outcomes of repeated throws of the same kind of coins or dice. Throwing a large number of identical dice/coins together and aggregating the

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		result of the throws to get large number of individual events. Observing the aggregating numbers over a large number of repeated events. Comparing with the data for a coin. Observing strings of throws, notion of randomness **Introduction to graphs (15 hrs)** **PRELIMINARIES:** (i) Axes (Same units), Cartesian Plane (ii) Plotting points for different kind of situations (perimeter vs length for squares, area as a function of side of a square, plotting of multiples of different numbers, simple interest vs number of years etc.) (iii) Reading off from the graphs • Reading of linear graphs • Reading of distance vs time graph