

MATHEMATICS SYLLABUS

Primary One to Six

Implementation starting with
2013 Primary One Cohort



Ministry of Education
SINGAPORE

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Learning Mathematics

A 21st Century Necessity

Learning mathematics is a key fundamental in every education system that aims to prepare its citizens for a productive life in the 21st century.

As a nation, the development of a highly-skilled and well-educated manpower is critical to support an innovation- and technology-driven economy. A strong grounding in mathematics and a talent pool in mathematics are essential to support the wide range of value-added economic activities and innovations. Many countries are paying attention to the quality of their mathematics education. The growing interest in TIMSS and PISA speaks of the global interest and importance placed on mathematics education.

At the individual level, mathematics underpins many aspects of our everyday activities, from making sense of information in the newspaper to making informed decisions about personal finances. It supports learning in many fields of study, whether it is in the sciences or in business. A good understanding of basic mathematics is essential wherever calculations, measurements, graphical interpretations and statistical analysis are necessary. The learning of mathematics also provides an excellent vehicle to train the mind, and to develop the capacity to think logically, abstractly, critically and creatively. These are important 21st century competencies that we must imbue in our students, so that they can lead a productive life and be life-long learners.

Students have different starting points. Not all will have the same interests and natural abilities to learn mathematics. Some will find it enjoyable; others will find it challenging. Some will find the theorems and results intriguing; others will find the formulae and rules bewildering. It is therefore important for the mathematics curriculum to provide differentiated pathways and choices to support every learner in order to maximise their potential. The curriculum must engage the 21st century learners, who are digital natives comfortable with the use of technologies and who work and think differently. The learning of mathematics must take into cognisance the new generation of learners, the innovations in pedagogies as well as the affordances of technologies.

It is the goal of the national mathematics curriculum to ensure that all students will achieve a level of mastery of mathematics that will serve them well in their lives, and for those who have the interest and ability, to pursue mathematics at the highest possible level. Mathematics is an important subject in our national curriculum. Students begin to learn mathematics from the day they start formal schooling, and minimally up to the end of secondary education. This gives every child at least 10 years of meaningful mathematics education.

About this document

This document provides an overview of the curriculum. It explains the design of the curriculum from the primary to the pre-university level, and provides details of the Primary Mathematics Syllabus, including the aims, content, outcomes and the approach to teaching and learning.

This document comprises 4 chapters as described below.

Chapter 1 provides an overview of the curriculum review, the goals and aims of the different syllabuses of the entire mathematics curriculum (primary to pre-university) as well as the syllabus design considerations across the levels.

Chapter 2 elaborates on the Mathematics Framework which centres around mathematical problem solving. The framework serves as a guide for mathematics teaching, learning and assessment across the levels.

Chapter 3 focuses on the process of teaching and learning so as to bring about engaged learning in mathematics. It highlights the principles of teaching and phases of learning as well as the learning experiences to influence the way teachers teach and students learn so that the aims of the curriculum can be met. The role of assessment and how it can be integrated to support learning in the classroom is also highlighted in this chapter.

Chapter 4 details the Primary Mathematics syllabuses in terms of its aims, syllabus organisation, mathematical processes, content and learning experiences.

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Chapter 1

Introduction

Background
Goals and Aims
Syllabus Design

Background

Staying Relevant and Forward Looking

As in all previous reviews, the 2010 full-term review aims to update the syllabuses so that they continue to meet the needs of our students, build a strong foundation in mathematics, and make improvement in the school mathematics education. It takes into consideration the analyses of students' performances in national examinations as well as international studies such as TIMSS and PISA. This review also takes on board the curriculum-wide recommendations from envisaging studies into the overall Singapore curriculum such as seeking a better balance between content and skills, creating opportunities to develop 21st century competencies, promoting self-directed and collaborative learning through ICT-based lessons, and developing assessment to support learning.

It is clear at the start of the review that there is more to be considered than just focusing on the content. While there is a need to constantly review what students learn, the changes in content will not be the key lever. In fact, little has been changed in the content as this has stabilised over the years. Instead, more focus has now been given to skills and competencies that will make a better 21st century learner – the process of learning becomes more important than just what is to be taught and remembered. The syllabuses are therefore written with the view that not only will it inform teachers on what to teach, it will also influence the way teachers teach and students learn. One key feature of this set of syllabuses is the explication of learning experiences, besides the learning outcomes. This gives guidance to teachers on the opportunities that students should be given as part of their learning. Ultimately, how students learn matters.

Curriculum review and design is ongoing work. The quality of the curriculum is as much in its design as in its implementation. Teachers, who are the frontline of curriculum delivery, must believe in the value of the changes. Support, resources and training will be provided to build capacity in our teachers. All these will be part of the continuous effort to deliver the best mathematics curriculum for the students.

The Primary Mathematics Syllabus will be implemented level by level starting from Primary One in 2013. The implementation schedule is as follows:

Year	2013	2014	2015	2016	2017	2018
Level	Primary 1	Primary 2	Primary 3	Primary 4	Primary 5 Standard Maths Primary 5 Foundation Maths	Primary 6 Standard Maths Primary 6 Foundation Maths

This online syllabus document will be updated yearly according to the implementation schedule.

Goals and Aims

Different Syllabuses, Different Aims

The overarching goal of the mathematics curriculum is to ensure that all students will achieve a level of mastery of mathematics that will serve them well in life, and for those who have the interest and ability, to pursue mathematics at the highest possible level.

The broad aims of mathematics education in Singapore are to enable students to:

- acquire and apply mathematical concepts and skills;
- develop cognitive and metacognitive skills through a mathematical approach to problem solving; and
- develop positive attitudes towards mathematics.

The mathematics curriculum comprises a set of syllabuses spanning 12 years, from primary to pre-university, and is compulsory up to the end of secondary education. Each syllabus has its own specific set of aims to guide the design and implementation of the syllabus. The aims also influence the choice of content, skills as well as context to meet the specific needs of the students at the given level or course. Each syllabus expands on the three broad aims of mathematics education differently to cater for the different needs and abilities of the students (see table of aims).

What does it mean to teachers?

Understanding the aims of the syllabus helps teachers stay focused on the larger outcomes of learning and guides teachers when they embark on the school-based curriculum innovations and customisations.

Overview of Aims across the Levels

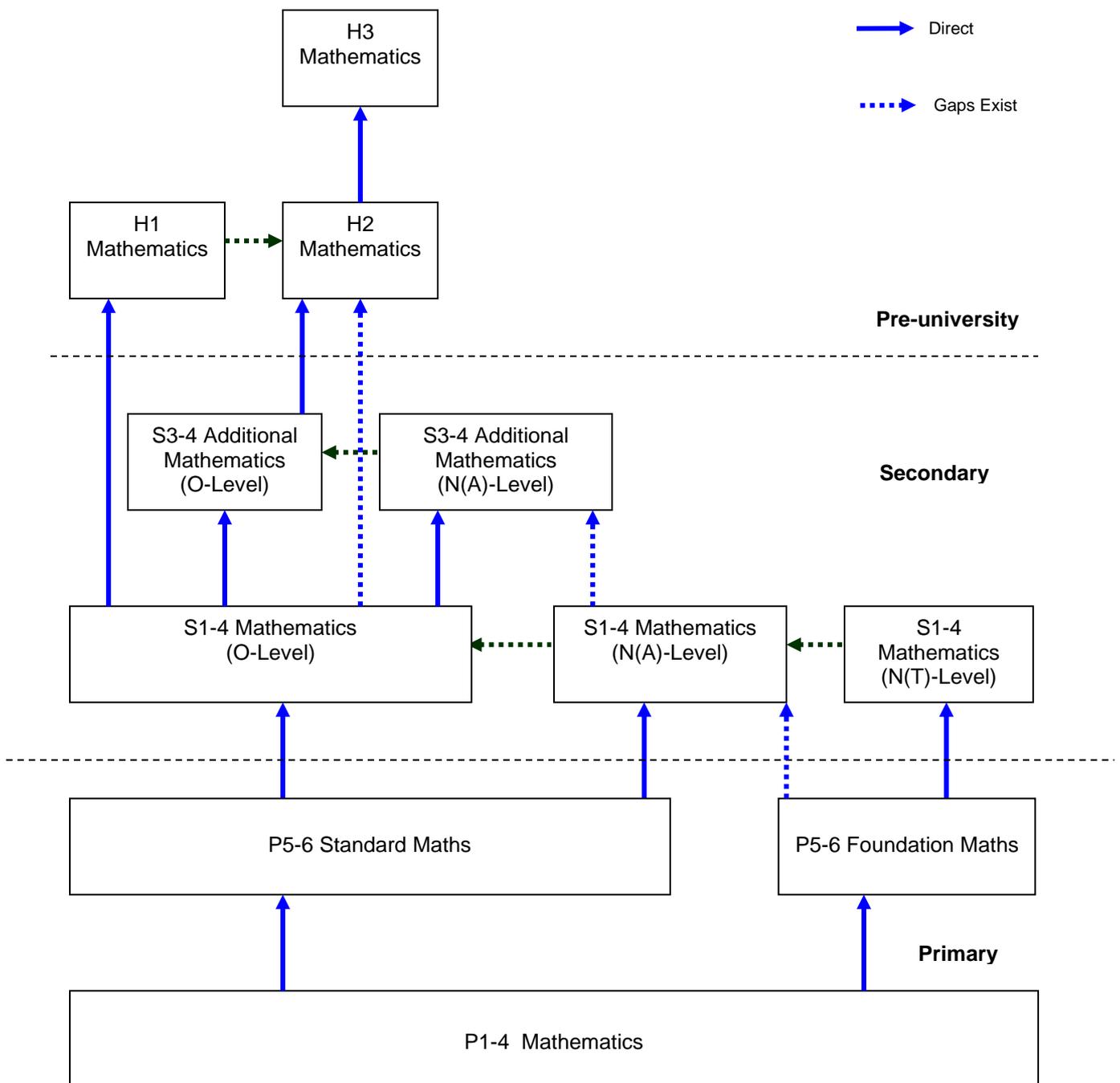
Primary Laying a Strong Foundation	
<p>The Primary Mathematics Syllabus aims to enable all students to:</p> <ul style="list-style-type: none"> • acquire mathematical concepts and skills for everyday use and continuous learning in mathematics; • develop thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem-solving; • build confidence and foster interest in mathematics. 	
Secondary Building Up Strengths	
<p>The O/N(A)-Level Mathematics Syllabus aims to enable all students to:</p> <ul style="list-style-type: none"> • acquire mathematical concepts and skills for continuous learning in mathematics and to support learning in other subjects; • develop thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem-solving; • connect ideas within mathematics and between mathematics and other subjects through applications of mathematics; • build confidence and foster interest in mathematics. 	<p>The N(T)-Level Mathematics Syllabus aims to enable students who are bound for post-secondary vocational education to:</p> <ul style="list-style-type: none"> • acquire mathematical concepts and skills for real life, to support learning in other subjects, and to prepare for vocational education; • develop thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem solving; and • build confidence in using mathematics and appreciate its value in making informed decisions in real life.
<p>The O/N(A)-Level Additional Mathematics Syllabus aims to enable students who have an aptitude and interest in mathematics to:</p> <ul style="list-style-type: none"> • acquire mathematical concepts and skills for higher studies in mathematics and to support learning in the other subjects, in particular, the sciences; • develop thinking, reasoning and meta-cognitive skills through a mathematical approach to problem-solving; • connect ideas within mathematics and between mathematics and the sciences through applications of mathematics; • appreciate the abstract nature and power of mathematics. 	
Pre-University Gearing Up for University Education	
<p>The H1 Mathematics Syllabus aims to enable students who are interested in pursuing tertiary studies in business and the social sciences to:</p> <ul style="list-style-type: none"> • acquire mathematical concepts and skills to support their tertiary studies in business and the social sciences; • develop thinking, reasoning, communication and modelling skills through a mathematical approach to problem-solving; • connect ideas within mathematics and between mathematics and other disciplines through applications of mathematics; • appreciate the value of mathematics in making informed decisions in life. 	<p>The H2 Mathematics Syllabus aims to enable students who are interested in pursuing tertiary studies in mathematics, sciences and engineering to:</p> <ul style="list-style-type: none"> • acquire mathematical concepts and skills to prepare for their tertiary studies in mathematics, sciences and engineering; • develop thinking, reasoning, communication and modelling skills through a mathematical approach to problem-solving and the use of mathematics language; • connect ideas within mathematics and between mathematics and other disciplines through applications of mathematics; • appreciate the beauty of mathematics and its value in making informed decisions in life.
	<p>The H3 Mathematics Syllabus aims to enable students who have an aptitude and passion for mathematics to:</p> <ul style="list-style-type: none"> • acquire advanced mathematical concepts and skills to deepen their understanding of mathematics, and to widen the scope of applications of mathematics; • develop rigorous habits of mind through mathematical reasoning and proof, creative mathematical problem solving, and use of mathematical models; • connect ideas within mathematics at a higher level and between mathematics and other disciplines through applications of mathematics; • appreciate the beauty, rigour and abstraction of mathematics through mathematical proof and applications.

Syllabus Design

Spiral Curriculum, Connected Syllabuses

Mathematics is largely hierarchical in nature. Higher concepts and skills are built upon the more foundational ones and have to be learned in sequence. A spiral approach is adopted in the building up of content across the levels.

The mathematics curriculum consists of a set of connected syllabuses to cater to the different needs and abilities of students. This section gives an overview of the syllabuses and their connections so that teachers are better able to appreciate the mathematics curriculum as a whole.



The Primary Mathematics syllabus assumes no formal learning of mathematics. However, basic pre-numeracy skills such as matching, sorting and comparing are necessary in providing a good grounding for students to begin learning at Primary 1 (P1).

The P1-4 syllabus is common to all students. The P5-6 Standard Mathematics syllabus continues the development of the P1-4 syllabus whereas the P5-6 Foundation Mathematics syllabus re-visits some of the important concepts and skills in the P1-4 syllabus. The new concepts and skills introduced in Foundation Mathematics is a subset of the Standard Mathematics syllabus.

The O-Level Mathematics syllabus builds on the Standard Mathematics syllabus. The N(A)-Level¹ Mathematics syllabus is a subset of O-Level Mathematics, except that it re-visits some of the topics in Standard Mathematics syllabus. The N(T)-Level² Mathematics syllabus builds on the Foundation Mathematics syllabus.

The O-Level Additional Mathematics syllabus assumes knowledge of O-Level Mathematics content and includes more in-depth treatment of important topics. The N(A)-Level Additional Mathematics is a subset of O-Level Additional Mathematics. O-Level Additional Mathematics together with O-Level Mathematics content provide the prerequisite knowledge required for H2 Mathematics at the pre-university level.

At the pre-university level, mathematics is optional. The H1 Mathematics syllabus builds on the O-level Mathematics syllabus. H2 Mathematics assumes some of the O-Level Additional Mathematics content. H3 Mathematics is an extension of H2 Mathematics.

¹ N(A)-Level refers to Normal (Academic) Level

² N(T)-Level refers to Normal (Technical) Level

Flexibility and Choice

There are two mathematics syllabuses at the P5-6 level. Most students would offer Standard Mathematics and for students who need more time to learn, they could offer Foundation Mathematics.

There are five mathematics syllabuses in the secondary mathematics curriculum. O-Level Mathematics, N(A)-Level Mathematics and N(T)-Level Mathematics provide students from the respective courses the core mathematics knowledge and skills in the context of a broad-based education. The more mathematically able students from the N(A) course can choose to take O-Level Mathematics in four years instead of five years. Likewise, the more able N(T) students can also offer N(A)-Level Mathematics. The variation in pace and syllabus adds to the flexibility and choice within the secondary mathematics curriculum. At the upper secondary level, students who have the interests and abilities in mathematics may choose to offer Additional Mathematics as an elective at the O-Level or N(A)-Level. This gives students with an inclination towards and interest in mathematics the opportunity to learn more mathematics that would prepare them well for courses of study that require higher mathematics.

For students who wish to study in the Engineering-type courses at the polytechnics, Additional Mathematics will be a good grounding. The N(A)-Level and N(T)-Level Mathematics syllabuses will prepare students well for ITE courses. Students who aspire to study Mathematics or mathematics-related courses at the universities could offer H2 Mathematics, and if possible H3 Mathematics.

What does it mean to teachers?

Teachers need to have the big picture in mind so that they can better understand the role of each syllabus, the connection it makes with the next level and the dependency relationship between syllabuses. This enables teachers to better understand what they have to do at their level, as well as to plan and advise students in their learning of mathematics. For example, H2 Mathematics assumes some of the O-Level Additional Mathematics content but may be offered by students without Additional Mathematics background as long as effort is made to bridge the gap.

Chapter 2

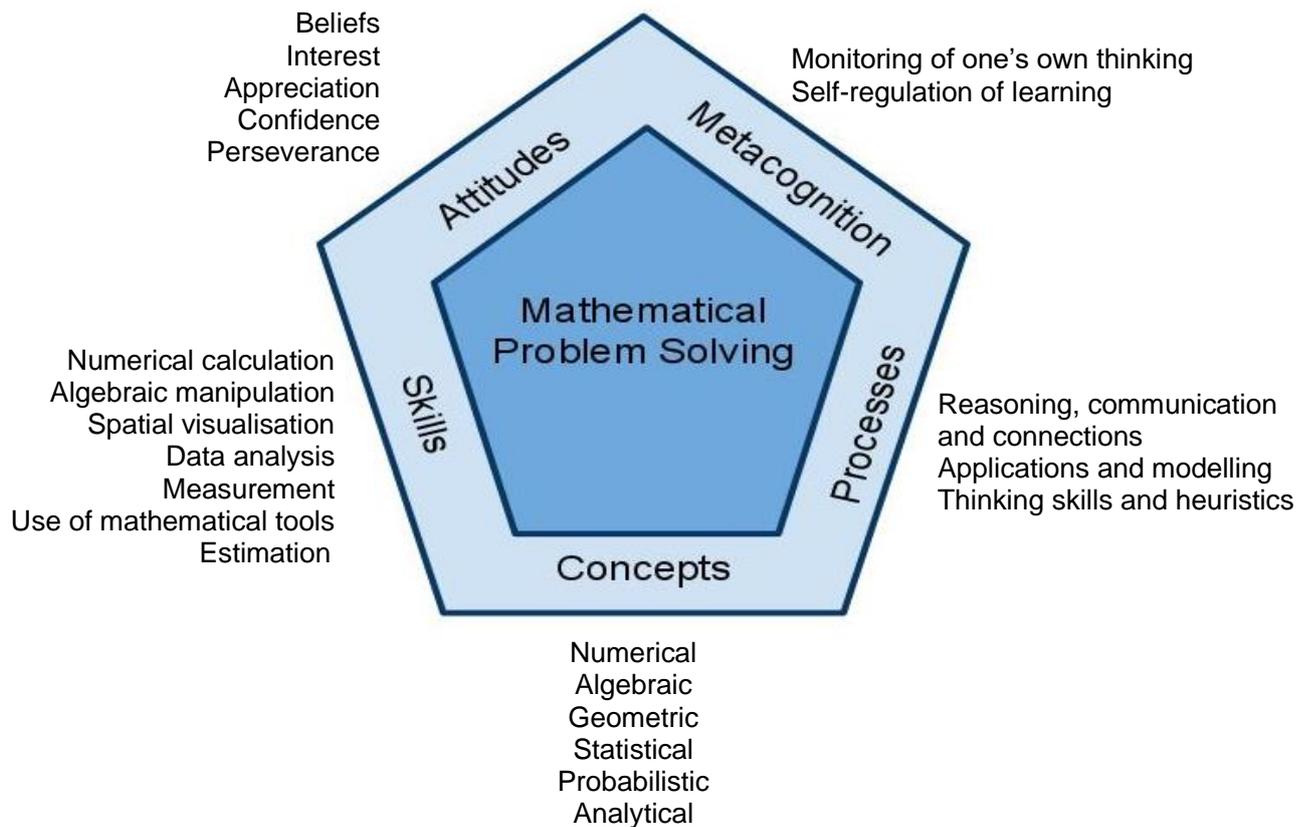
Mathematics Framework

Problem Solving

Problem Solving

Concepts, Skills, Processes, Metacognition, Attitudes

The Mathematics Framework has been a feature of our mathematics curriculum since 1990, and is still relevant to date. The central focus of the framework is mathematical problem solving, that is, using mathematics to solve problems. The framework sets the direction for and provides guidance in the teaching, learning, and assessment of mathematics at all levels, from primary to pre-university. It reflects also the 21st century competencies³.



The framework stresses *conceptual understanding*, *skills proficiency* and *mathematical processes*, and gives due emphasis to *attitudes* and *metacognition*. These five components are inter-related.

Concepts

Mathematical concepts can be broadly grouped into *numerical*, *algebraic*, *geometric*, *statistical*, *probabilistic*, and *analytical* concepts. These content categories are connected and interdependent. At different stages of learning and in different syllabuses, the breadth and depth of the content vary.

³ Information on the MOE framework for 21st century competencies and student outcomes can be found on edumall2.0.

To develop a deep understanding of mathematical concepts, and to make sense of various mathematical ideas as well as their connections and applications, students should be exposed to a variety of learning experiences including hands-on activities and use of technological aids to help them relate abstract mathematical concepts with concrete experiences.

Skills

Mathematical skills refer to *numerical calculation, algebraic manipulation, spatial visualisation, data analysis, measurement, use of mathematical tools, and estimation*. The skills are specific to mathematics and are important in the learning and application of mathematics. In today's classroom, these skills also include the abilities to use spreadsheets and other software to learn and do mathematics.

To develop proficiencies in mathematics skills, students should have opportunities to use and practise the skills. These skills should be taught with an understanding of the underlying mathematical principles and not merely as procedures.

Processes

Mathematical processes refer to the process skills involved in the process of acquiring and applying mathematical knowledge. This includes *reasoning, communication and connections, applications and modelling, and thinking skills and heuristics* that are important in mathematics and beyond.

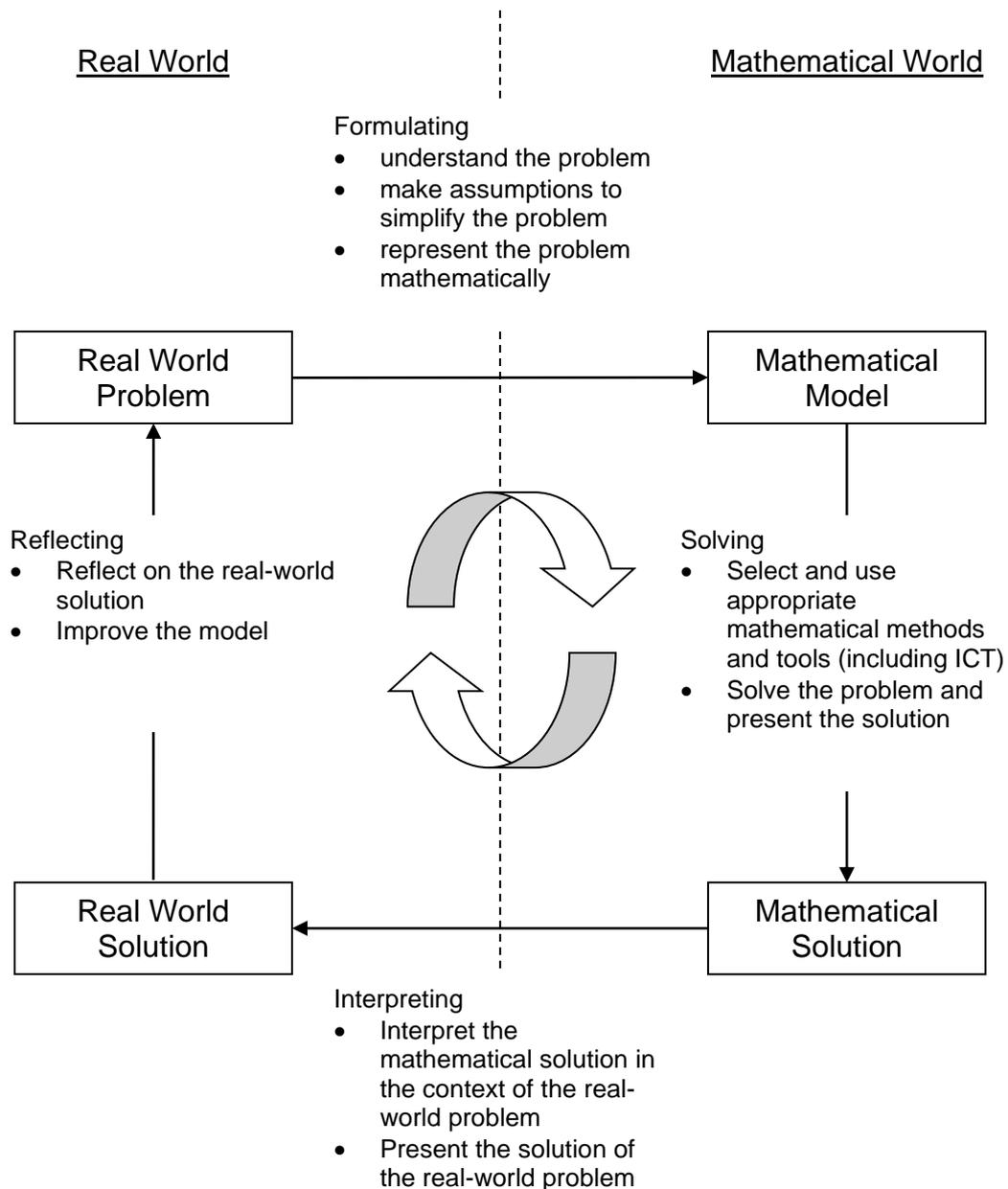
In the context of mathematics, *reasoning, communication and connections* take on special meanings:

- Mathematical reasoning refers to the ability to analyse mathematical situations and construct logical arguments. It is a habit of mind that can be developed through application of mathematics in different contexts.
- Communication refers to the ability to use mathematical language to express mathematical ideas and arguments precisely, concisely and logically. It helps students develop their understanding of mathematics and sharpen their mathematical thinking.
- Connections refer to the ability to see and make linkages among mathematical ideas, between mathematics and other subjects, and between mathematics and the real world. This helps students make sense of what they learn in mathematics.

Applications and modelling allow students to connect mathematics that they have learnt to the real world, enhance understanding of key mathematical concepts and methods, as well as develop mathematical competencies. Students should have opportunities to apply mathematical problem-solving and reasoning skills to tackle a variety of problems, including open-ended and real-world problems. Mathematical

modelling is the process of formulating and improving a mathematical model⁴ to represent and solve real-world problems. Through mathematical modelling, students learn to deal with ambiguity, make connections, select and apply appropriate mathematics concepts and skills, identify assumptions and reflect on the solutions to real-world problems, and make informed decisions based on given or collected data.

Mathematical Modelling Process (version 2010)



⁴ A mathematical model is a mathematical representation or idealisation of a real-world situation. It can be as complicated as a system of equations or as simple as a geometrical figure. As the word “model” suggests, it shares characteristics of the real-world situation that it seeks to represent.

Thinking skills and heuristics are essential for mathematical problem solving. Thinking skills are skills that can be used in a thinking process, such as classifying, comparing, analysing parts and whole, identifying patterns and relationships, induction, deduction, generalising, and spatial visualisation. Heuristics are general rules of thumb of what students can do to tackle a problem when the solution to the problem is not obvious. These include using a representation (e.g., drawing a diagram, tabulating), making a guess (e.g., trial and error/guess and check, making a supposition), walking through the process (e.g., acting it out, working backwards) and changing the problem (e.g., simplifying the problem, considering special cases).

Metacognition

Metacognition, or thinking about thinking, refers to the awareness of, and the ability to control one's thinking processes, in particular the selection and use of problem-solving strategies. It includes monitoring of one's own thinking, and self-regulation of learning.

To develop metacognitive awareness and strategies, and know when and how to use the strategies, students should have opportunities to solve non-routine and open-ended problems, to discuss their solutions, to think aloud and reflect on what they are doing, and to keep track of how things are going and make changes when necessary.

Attitudes

Attitudes refer to the affective aspects of mathematics learning such as:

- beliefs about mathematics and its usefulness;
- interest and enjoyment in learning mathematics;
- appreciation of the beauty and power of mathematics;
- confidence in using mathematics; and
- perseverance in solving a problem.

Students' attitudes towards mathematics are shaped by their learning experiences. Making the learning of mathematics fun, meaningful and relevant goes a long way to inculcating positive attitudes towards the subject. Care and attention should be given to the design of the learning activities to build confidence in and develop appreciation for the subject. Above all, students' beliefs can influence their attitudes in learning, especially in student-centred learning where students are encouraged to take on more responsibility for their own learning.

What does it mean to teachers?

The five components of the mathematics framework are integral parts of mathematics learning and problem solving. The intent of the framework is to help teachers focus on these components in their teaching practice so as to provide a more engaging, student-centred, and technology-enabled learning environment, and to promote greater diversity and creativity in learning.

Chapter 3

Learning, Teaching & Assessment

**Learning Experiences
Teaching and Learning
Assessment in the Classroom**

Learning Experiences

It matters how students learn

Learning mathematics is more than just learning concepts and skills. Equally important are the cognitive and metacognitive process skills. These processes are learned through carefully constructed learning experiences. For example, to encourage students to be inquisitive, the learning experiences must include opportunities where students discover mathematical results on their own. To support the development of collaborative and communication skills, students must be given opportunities to work together on a problem and present their ideas using appropriate mathematical language and methods. To develop habits of self-directed learning, students must be given opportunities to set learning goals and work towards them purposefully. A classroom, rich with these opportunities, will provide the platform for students to develop these 21st century competencies.

Learning experiences are stated in the mathematics syllabuses to influence the ways teachers teach and students learn so that the curriculum objectives can be achieved. These statements expressed in the form “students should have opportunities to ...” remind teachers of the student-centric nature of these experiences. They describe actions that students will perform and activities that students will go through, with the opportunities created and guidance rendered by teachers. The descriptions are sufficiently specific to provide guidance yet broad enough to give flexibility to the teachers.

For each topic, the learning experiences focus on the mathematical processes and skills that are integral parts of learning of that topic. There are also generic learning experiences that focus on the development of good learning habits and skills such as:

Students should have opportunities to:

- take notes and organise information meaningfully;
- practise basic mathematical skills to achieve mastery;
- use feedback from assessment to improve learning;
- solve novel problems using a repertoire of heuristics;
- discuss, articulate and explain ideas to develop reasoning skills; and
- carry out a modelling project.

These learning experiences, whether they are topical or generic, are not exhaustive. Teachers are encouraged to do more to make learning meaningful and effective.

Teaching and Learning

Principles of Teaching and Phases of Learning

This section outlines three principles of mathematics teaching and the three phases of mathematics learning in the classrooms.

Principles of Teaching

Principle 1

Teaching is for learning; learning is for understanding; understanding is for reasoning and applying and, ultimately problem solving.

Teaching is an interactive process that is focused on students' learning. In this process, teachers use a range of teaching approaches to engage students in learning; students provide teachers with feedback on what they have learnt through assessment; and teachers in turn provide feedback to students and make decisions about instructions to improve learning.

The learning of mathematics should focus on understanding, not just recall of facts or reproduction of procedures. Understanding is necessary for deep learning and mastery. Only with understanding can students be able to reason mathematically and apply mathematics to solve a range of problems. After all, problem solving is the focus of the mathematics curriculum.

Principle 2

Teaching should build on students' knowledge; take cognizance of students' interests and experiences; and engage them in active and reflective learning.

Mathematics is a hierarchical subject. Without understanding of pre-requisite knowledge, foundation will be weak and learning will be shallow. It is important for teachers to check on students' understanding before introducing new concepts and skills.

Teachers need to be aware of their students' interests and abilities so as to develop learning tasks that are stimulating and challenging. This is important in order to engage students in active and reflective learning where students participate and take ownership of the learning.

Principle 3

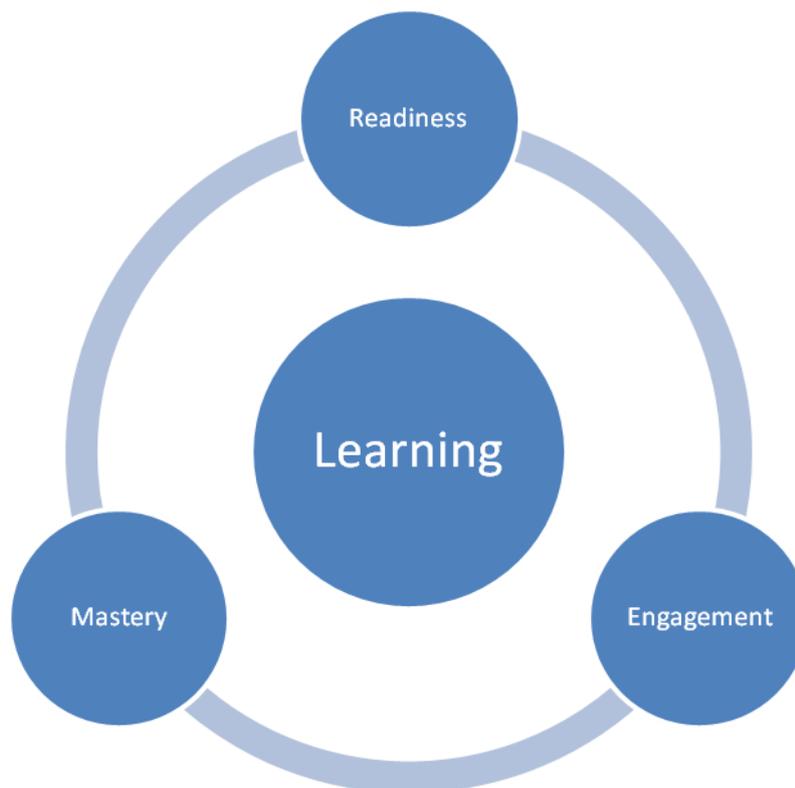
Teaching should connect learning to the real world, harness ICT tools and emphasise 21st century competencies.

There are many applications of mathematics in the real world. Students should have an understanding and appreciation of these applications and how mathematics is used to model and solve problems in real-world contexts. In this way, students will see the meaning and relevance of mathematics.

Teachers should consider the affordances of ICT to help students learn. ICT tools can help students understand mathematical concepts through visualisations, simulations and representations. They can also support exploration and experimentation and extend the range of problems accessible to students. The ability to use ICT tools is part of the 21st century competencies. It is also important to design learning in ways that promote the development of other 21st century competencies such as working collaboratively and thinking critically about the mathematical solution.

Phases of Learning

Effective instruction of a unit typically involves three phases of learning: *Readiness, Engagement and Mastery*.



Phase 1 - Readiness

Student readiness to learn is vital to learning success. In the readiness phase of learning, teachers prepare students so that they are ready to learn. This requires considerations of *prior knowledge, motivating contexts, and learning environment*.

- **Prior Knowledge**

For students to be ready to learn, teachers need to know students' prior knowledge in relation to the new learning. This requires knowing whether students have the pre-requisite concepts and skills. Some form of diagnostic assessment is necessary to check that students are ready to learn.

- **Motivating Contexts**

For students to be ready to learn, teachers need to provide motivating contexts for learning. These contexts should be developmentally appropriate. For example, younger students may like contexts such as stories and songs, and play-based activities such as games, whereas older students may appreciate contexts related to everyday life so that they can see the relevance and meaningfulness of mathematics. For the more advanced students, applications in other disciplines can serve as motivation for learning.

- **Learning Environment**

Shared rules help promote respectful and emotionally-safe interactions between teacher and students and among students that are necessary for productive and purposeful learning. Established procedures for organising students and managing resources will also facilitate a smooth start and transitions during lessons.

Phase 2 - Engagement

This is the main phase of learning where teachers use a repertoire of pedagogies to engage students in learning new concepts and skills. Three pedagogical approaches form the spine that supports most of the mathematics instruction in the classroom. They are not mutually exclusive and could be used in different parts of a lesson or unit. For example, the lesson or unit could start with an activity, followed by teacher-led inquiry and end with direct instruction.

- **Activity-based learning**

This approach is about learning by doing. It is particularly effective for teaching mathematical concepts and skills at primary and lower secondary levels, but is also effective at higher levels. Students engage in activities to explore and learn mathematical concepts and skills, individually or in groups. They could use manipulatives or other resources to construct meanings and understandings. From concrete manipulatives and experiences, students are guided to uncover abstract mathematical concepts or results.

For example, to develop problem solving skills, students investigate whether rectangles with the same perimeter can have different areas. Students are given sheets of 1-cm square grids to draw and cut out different rectangles of a given perimeter (e.g. 12 cm). They will record the length, breadth and area of each rectangle that they have cut out on a record sheet. Questions will be posed for students to discuss during the activity e.g. 'How do you figure out the length and breadth of a rectangle given its perimeter' 'What assumptions do you make about the length/breadth of the rectangle?' Students further explore different strategies and explain why the strategies work or do not work and finally, derive a conclusion as a team. During the discussion, students are also encouraged to communicate their ideas using appropriate mathematical language. Throughout the activity, the teacher will be observing what the students say and do and constantly making the decision on the

appropriate amount of feedback to be provided to them. Teacher ends the activity by summarising and highlighting some of the strategies that students use.

- ***Teacher-directed inquiry***

This approach is about learning through guided inquiry. Instead of giving the answers, teachers lead students to explore, investigate and find answers on their own. Students learn to focus on specific questions and ideas and are engaged in communicating, explaining and reflecting on their answers. They also learn to pose questions, process information and data and seek appropriate methods and solutions. This enhances the development of mathematical processes and 21st century competencies.

For example, in teaching the topic on Symmetry, teacher first shows two groups of shapes – symmetric and non-symmetric shapes, without introducing the concept of symmetry. Students are asked how the shapes are classified and how one group is different from the other. Teacher tests the rule for classification suggested by students. Eventually, teacher guides students to focus on the attributes of symmetric shapes and directs them to concept of symmetry. To check whether students understand the concept of symmetry, teacher gives students paper cut-outs of symmetric and non-symmetric shapes and asks them to classify them in the same way. Students can fold the shapes into halves and decide if they are symmetrical. They also visualise how a line of symmetry divides a symmetric shape into halves that fit exactly over each other.

- ***Direct instruction***

This approach is about explicit teaching. Teachers introduce, explain and demonstrate new concepts and skills. Direct instruction is most effective when students are told what they will be learning and what they are expected to be able to do. This helps them focus on the learning goals. Teachers draw connections, pose questions, emphasise key concepts, and role-model thinking. Holding students' attention is critical. Stimuli such as videos, graphic images, real-world contexts, and even humour, aid in maintaining a high level of attention.

For example, in teaching problem solving, the teacher demonstrates how to use Pólya's four-step problem-solving strategy⁵ and models thinking aloud to make visible the thinking processes. While explaining and demonstrating, the teacher also probes students' understanding of the process by asking questions and giving feedback to the students who respond to the questions. Teachers also use the students' response to modify her explanation and demonstration so that students are better able to follow the process. Teachers use additional examples if necessary and assign work for students to do on the spot. Teachers check on students' work and selectively pick a few responses for further discussion. During

⁵ G. Pólya, "How to Solve It", 2nd ed., Princeton University Press, 1957

lesson closure, the teacher reviews the key learning points of the lesson to consolidate the learning.

Phase 3 - Mastery

This is the final phase of learning where teachers help students consolidate and extend their learning. The mastery approaches include:

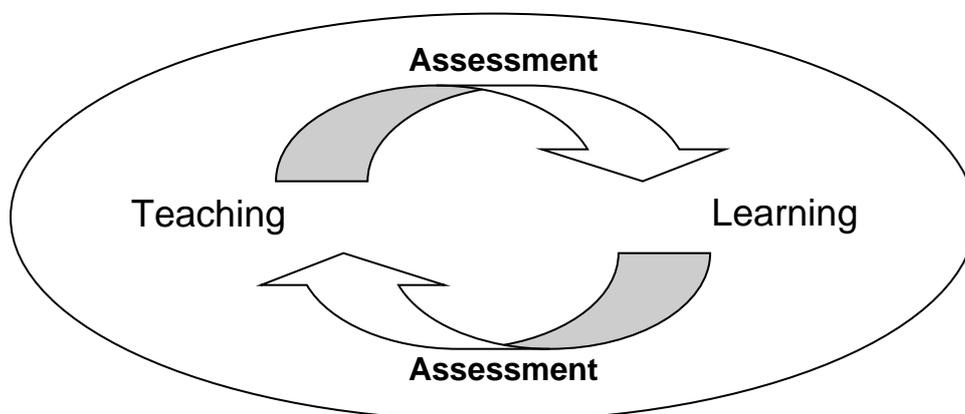
- ***Motivated Practice***
Students need practice to achieve mastery. Practice can be motivating and fun. Practice must include repetition and variation to achieve proficiency and flexibility. Structuring practice in the form of games is one good strategy to make practice motivating and fun, while allowing for repetition and variation. There should be a range of activities, from simple recall of facts to application of concepts.
- ***Reflective Review***
It is important that students consolidate and deepen their learning through tasks that allow them to reflect on their learning. This is a good habit that needs to be cultivated from an early age and it supports the development of metacognition. Summarising their learning using concept maps, writing journals to reflect on their learning and making connections between mathematical ideas and between mathematics and other subjects should be encouraged. Sharing such reflections through blogs makes learning social.
- ***Extended Learning***
Students who are mathematically inclined should have opportunities to extend their learning. These can be in the form of more challenging tasks that stretch their thinking and deepen their understanding.

Assessment in the Classroom

Supporting Teaching and Learning in Mathematics

Role of assessment

Assessment is an integral part of the interactive process of teaching and learning, as illustrated in the diagram below. It is an ongoing process by which teachers gather information about students' learning to inform and support teaching. An important product of assessment is feedback. Feedback must be timely and rich. It must inform students where they are in their learning and what they need to do to improve their learning. It must also inform teachers what they need to do to address learning gaps and how to improve their instruction.



Range of assessment

Assessments can be broadly classified as summative, formative, and diagnostic.

- Summative assessments, such as tests and examinations, measure what students have learned. Teachers usually report the assessment result as a score or a grade.
- Formative and diagnostic assessments are used as assessment for learning to provide timely feedback to students on their learning, and to teachers on their teaching.

Assessment in the classroom should focus on helping students improve their learning. Therefore, they are primarily formative and diagnostic in purpose.

Though teachers are comfortable with the use of traditional pen-and-paper tests to find out how much students know and can do, there is value in exploring a wider variety of assessment strategies. These strategies allow teachers to gather information that is not easily available through traditional methods of assessment, but are nevertheless valuable to support learning. Ultimately, the choice of assessment strategies must be guided by its purpose, that is, it must be fit-for-purpose.

Integrating assessment with instruction

It is important that teachers know what and when to assess student learning, and how to embed the assessment in the learning process. Assessment can be integrated into classroom discourse and activities using different assessment strategies. For example, teachers may watch students solve problems and get them to explain their strategies. Teachers may also engage students in assessing their own work and reflecting on their own learning and how to improve it. Both moment-by-moment assessment and planned assessment should be considered.

Effective questioning can scaffold learning and probe understanding. It creates teachable moments for teachers to correct a misconception, reinforce a point or expand on an idea. The questions can be open-ended to encourage students to consider alternative approaches. Sufficient wait-time is necessary so that students can formulate their thoughts, communicate and share their ideas, and hear the ideas of others. In the process, students learn to articulate their thinking and deepen their understanding, and develop confidence in talking about mathematics and using it. Teachers can assess students' thinking and understanding, and provide useful feedback to improve their learning.

Teachers can integrate performance assessments into the instructional process to provide additional learning experiences for students. This type of assessment requires students to apply their knowledge and skills in context, and the focus is on mathematical processes rather than on mathematics content. A rubric is useful to show teachers what to look for in students' work, but more importantly, it shows what is expected of students in terms of processes and quality of work. The rubric also provides a structured means of giving qualitative feedback. Teachers may allow students to assess their own performances so that they can reflect on their work and make improvements.

Assessment for learning calls for new ways of assessment in the classroom. It involves a change in teachers' roles and in the expectations of students. By integrating assessment and instruction, students will be more engaged in and will take greater ownership of their learning.

Chapter 4

Primary Mathematics

Syllabus

Aims of Syllabus
Syllabus Organisation
Mathematical Process Strand
Content and Learning Experiences by Level

Aims of Syllabus

The Primary Mathematics Syllabus aims to enable all students to:

- acquire mathematical concepts and skills for everyday use and continuous learning in mathematics;
- develop thinking, reasoning, communication, application and metacognitive skills through a mathematical approach to problem-solving; and
- build confidence and foster interest in mathematics.

Syllabus Organisation

The syllabus is organised along 3 content strands with a listing of mathematical processes that cut across the 3 strands.

3 Content Strands + 1 Process Strand		
Number and Algebra	Measurement and Geometry	Statistics
Mathematical Processes		

Strand: Mathematical Processes

Mathematical processes refer to the process skills involved in the process of acquiring and applying mathematical knowledge. This includes *reasoning, communication and connections, applications, and thinking skills and heuristics* that are important in mathematical problem solving and beyond.

At the primary level, students develop these process skills through problem solving. They learn to lay out their working logically; communicate their thoughts clearly both in written and oral forms; and reason inductively by observing patterns, similarities and differences. They make connections among mathematical ideas, and between mathematics and everyday life. Through solving problems in real-world context, students see the relevance of mathematics in everyday situations. They formulate methods and strategies to solve problems, and develop the habit of checking the reasonableness of their answers against the real-world context. Most importantly, they develop reasoning and problem solving skills that are essential to lifelong learning.

The teaching of process skills should be deliberate and yet integrated with the learning of concepts and skills. Students should be exposed to heuristics and use problem-solving approaches such as the Polya's model in class. Teachers could "think aloud" to give attention to these processes and make them visible to students. Through practice, students will develop habits and strategies that will help them be better and more independent learners.

No.	Processes	Indicators
MATHEMATICAL PROCESSES		
MP1	Reasoning, Communication and Connections	<ul style="list-style-type: none"> • Use appropriate notations, symbols and conventions to present and communicate mathematical ideas • Reason inductively and deductively by: <ul style="list-style-type: none"> * Observing patterns, similarities and differences * Drawing logical conclusions and making inferences * Explaining or justifying solutions, writing out the solutions mathematically • Make connections within mathematics and between mathematics and everyday life
MP2	Applications	<ul style="list-style-type: none"> • Apply mathematics concepts and skills to solve problems in a variety of contexts within or outside mathematics, including: <ul style="list-style-type: none"> * Identifying the appropriate mathematical representations for a problem * Using appropriate mathematical concepts, skills (including tools and algorithm) to solve a problem * Interpreting the mathematical solution in the context of the problem and making sense of the solution
MP3	Thinking Skills and Heuristics	<ul style="list-style-type: none"> • Use thinking skills such as: <ul style="list-style-type: none"> * Classifying * Comparing * Sequencing * Generalising * Induction * Deduction * Analyzing (from whole to parts) * Synthesizing (from parts to whole) • Use a problem-solving model such as Polya's model • Use heuristics such as: <ul style="list-style-type: none"> * Drawing a diagram * Tabulating * Guess and check * Working backwards * Simplifying a problem * Considering special cases

Content & Learning Experiences by Level

In this section, the content is listed by levels and learning experiences statements are included.

The learning experiences for the Primary Mathematics syllabus should provide opportunities for students to:

- enhance conceptual understanding through use of the Concrete-Pictorial-Abstract approach and various mathematical tools including ICT tools;
- apply concepts and skills learnt in real-world context;
- communicate their reasoning and connections through various mathematical tasks and activities;
- build confidence and foster interest in mathematics.

Content	Learning Experiences
PRIMARY ONE	
NUMBER AND ALGEBRA	
SUB-STRAND: WHOLE NUMBERS	
1. Numbers up to 100	Students should have opportunities to:
<p>1.1 counting to tell the number of objects in a given set</p> <p>1.2 number notation, representations and place values (tens, ones)</p> <p>1.3 reading and writing numbers in numerals and in words</p> <p>1.4 comparing the number of objects in two or more sets</p> <p>1.5 comparing and ordering numbers</p> <p>1.6 patterns in number sequences</p> <p>1.7 ordinal numbers (first, second, up to tenth) and symbols (1st, 2nd, 3rd, etc)</p> <p>1.8 number bonds for numbers up to 10</p>	<p>(a) use number-bond posters and make number stories to build and consolidate number bonds for numbers up to 10.</p> <p>(b) work in groups using concrete objects to</p> <ul style="list-style-type: none"> - make a group of ten and count on from 10 to tell the number (less than 20). - make groups of ten and count tens and ones to tell the number (more than 20). - estimate the number of objects in a set before counting. - make sense of the size of 100. <p>(c) use concrete objects and the base-ten set to represent and compare numbers in terms of tens and ones, and use language such as 'more than', 'fewer than', 'the same as' and 'as many as' to describe the comparison.</p> <p>(d) play games using dot cards, picture cards, numeral cards and number-word cards etc. for number recognition and comparison.</p> <p>(e) describe a given number pattern using language such as '1 more/less' or '10 more/less' before continuing the pattern or finding the missing number(s).</p>
2. Addition and Subtraction	Students should have opportunities to:
<p>2.1 concepts of addition and subtraction</p> <p>2.2 use of +, – and =</p> <p>2.3 relationship between addition and subtraction</p> <p>2.4 adding more than two 1-digit numbers</p> <p>2.5 adding and subtracting within 100</p> <p>2.6 adding and subtracting using algorithms</p> <p>2.7 solving 1-step word problems involving addition and subtraction within 20</p> <p>2.8 mental calculation involving addition and subtraction</p> <ul style="list-style-type: none"> • within 20 • of a 2-digit number and ones without renaming • of a 2-digit number and tens 	<p>(a) work in groups to make addition and subtraction stories using concrete objects/pictures and write an addition or subtraction equation for each story.</p> <p>(b) write two addition facts and two subtraction facts for a given number bond within 10.</p> <p>(c) use strategies such as 'count on', 'count back', 'make ten' and 'subtract from 10' for addition and subtraction within 20 (before committing the number facts to memory) and thereafter, within 100.</p> <p>(d) compare two numbers within 20 to tell how much one number is greater (or smaller) than the other by subtraction.</p> <p>(e) achieve mastery of basic addition and subtraction facts within 20 through playing a wide range of games.</p> <p>(f) use the base-ten set to illustrate the standard algorithms for addition and subtraction of 2-digit numbers.</p>

Content	Learning Experiences
3. Multiplication and Division	
3.1 concepts of multiplication and division 3.2 use of \times 3.3 multiplying within 40 3.4 dividing within 20 3.5 solving 1-step word problems involving multiplication and division with pictorial representation	Students should have opportunities to: (a) make equal groups using concrete objects and count the total number of objects in the groups by repeated addition using language such as '2 groups of 5' and '2 fives'. (b) share a given number of concrete objects/picture cutouts and explain how the sharing is done and whether the objects can be shared equally. (c) divide a set of concrete objects into equal groups, and discuss the grouping and sharing concepts of division.
SUB-STRAND: MONEY	
1. Money	
1.1 counting amount of money <ul style="list-style-type: none"> • in cents up to \$1 • in dollars up to \$100 1.2 solving 1-step word problems involving addition and subtraction of money in dollars only (or in cents only)	Students should have opportunities to: (a) communicate and share their shopping experiences. (b) recognise coins and notes of different denominations, count money from the highest to the lowest denomination and represent money using \$ and ¢ symbols. (c) match a coin/note of one denomination to an equivalent set of coins/notes of another denomination using play money, and realise that a greater number of coins/notes is not necessarily a greater amount of money. (d) compare amounts of money using play money, and realise that when comparing two sets of notes (or coins), it is their values that are being compared and not the number of notes (or coins). (e) work in groups using play money to add, subtract and make change during shopping activities.
MEASUREMENT AND GEOMETRY	
SUB-STRAND: MEASUREMENT	
1. Length	
1.1 measuring and comparing the length of objects in non-standard units	Students should have opportunities to: (a) work in groups to measure length using a variety of non-standard units such as body parts, paper clips and common objects in their environment and explain their choices of units and how the measurement is done. (b) estimate the length of an object before measuring it and use the word 'about' to describe the measurement.

Content	Learning Experiences
2. Time	Students should have opportunities to:
2.1 telling time to the hour/half hour	(a) tell time from a clock face and relate time to the events of a day using 'o'clock' and 'half past'. (b) sequence events according to time and explain the appropriateness of events at different times of the day, e.g. lunch at 3 o'clock in the afternoon.
SUB-STRAND: GEOMETRY	
1. 2D Shapes	Students should have opportunities to:
1.1 identifying, naming, describing and classifying 2D shapes <ul style="list-style-type: none"> • rectangle • square • circle • triangle 1.2 making/completing patterns with 2D shapes according to one or two of the following attributes <ul style="list-style-type: none"> • size • shape • colour • orientation 	(a) recognise, name and describe the 4 basic 2D shapes (rectangle, square, circle and triangle) from real objects and pictures (drawings and photographs). (b) trace the outline of 2D shapes from 3D objects. (c) identify and describe 2D shapes in different sizes and orientations. (d) form a 2D shape from cut-out pieces of the shape. (e) guess a 2D shape from a description of the shape. (f) recognise and describe the differences/similarities between two 2D shapes according to attributes such as sides, corners, sizes and colours. (g) work in groups to sort 2D shapes in different ways and explain how the shapes are sorted. (h) use 2D shapes or applets to create patterns according to one or two attributes (size, shape, colour and orientation) and describe the patterns. (i) work in groups to create a pattern and invite other groups to guess the missing shape(s) in the pattern and explain the pattern.
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Picture Graphs	Students should have opportunities to:
1.1 reading and interpreting data from picture graphs	(a) work in groups to collect data from the class to answer questions such as "What kind of fruits do we like?" and use the data to make a picture graph for display. (b) discuss and describe the data presented in a picture graph using language such as 'most', 'least', 'greatest', 'smallest', 'as much as' and 'as many as'. (c) represent picture graphs in both vertical and horizontal forms, and make a story using information from a graph.

Content	Learning Experiences
PRIMARY TWO	
SUB-STRAND: WHOLE NUMBERS	
1. Numbers up to 1000	Students should have opportunities to:
1.1 counting in tens/hundreds 1.2 number notation, representations and place values (hundreds, tens, ones) 1.3 reading and writing numbers in numerals and in words 1.4 comparing and ordering numbers 1.5 patterns in number sequences 1.6 odd and even numbers	(a) give examples of numbers in everyday situations, and talk about how and why the numbers are used. (b) work in groups using concrete objects/the base-ten set/play money to <ul style="list-style-type: none"> - count in tens/hundreds to establish 10 tens make 1 hundred and 10 hundreds make 1 thousand. - represent and compare numbers. (c) make sense of the size of 100 and use it to estimate the number of objects in the size of hundreds. (d) use the base-ten set/play money to represent a number that is 1, 10 or 100 more than/less than a 3-digit number. (e) use place-value cards to illustrate and explain place values, e.g. the digit 3 stands for 300, 30 or 3 depending on where it appears in a number. (f) use place-value cards to compare numbers digit by digit from left to right, and use language such as 'greater than', 'greatest', 'smaller than', 'smallest' and 'the same as' to describe the comparison. (g) describe a given number pattern before continuing the pattern or finding the missing number(s).
2. Addition and Subtraction	Students should have opportunities to:
2.1 addition and subtraction algorithms (up to 3 digits) 2.2 solving up to 2-step word problems involving addition and subtraction 2.3 mental calculation involving addition and subtraction of a 3-digit number and ones/tens/hundreds	(a) write addition and subtraction equations for number stories and explain the meaning of the equal sign. (b) achieve mastery of basic addition and subtraction facts within 20 by <ul style="list-style-type: none"> - writing a family of 4 basic facts within 20 given any one of the basic facts (e.g. $9 + 7 = 16$, $7 + 9 = 16$, $16 - 9 = 7$ and $16 - 7 = 9$ are a family of addition and subtraction facts). - playing games, including applets and digital games. (c) work in groups using the base-ten set/play money to illustrate the standard algorithms for addition and subtraction up to 3 digits. (d) use the part-whole and comparison models to illustrate the concepts of addition and subtraction and use the models to determine which operation (addition or subtraction) to use when solving 1-step word problems. (e) use the comparison model to reinforce the language of comparison such as "Ali has 30 more stickers than Siti."

Content	Learning Experiences
	(f) solve 2-part word problems (1 step for each part) before solving 2-step word problems. (g) achieve mastery of addition and subtraction algorithms up to 3 digits by playing games, including applets and digital games. (h) work in groups to create word problems involving addition and subtraction for other groups to solve.
3. Multiplication and Division	Students should have opportunities to:
3.1 multiplication tables of 2, 3, 4, 5 and 10 3.2 use of \div 3.3 relationship between multiplication and division 3.4 multiplying and dividing within the multiplication tables 3.5 solving 1-step word problems involving multiplication and division within the multiplication tables 3.6 mental calculation involving multiplication and division within the multiplication tables of 2, 3, 4, 5 and 10	(a) work in groups to make multiplication and division stories, write a multiplication or division equation for each story and explain the meaning of the equal sign. (b) use concrete objects and pictorial representations to illustrate the concepts of multiplication and division such as 'multiplying 3 by 5' and 'dividing 12 by 4'. (c) explore number patterns in the multiplication tables of 2, 3, 4, 5 and 10 through activities such as colouring the hundred chart. (d) achieve mastery of multiplication and division facts by <ul style="list-style-type: none"> - using multiplication-fact cards and division-fact cards. - playing games, including applets and digital games. - writing a family of 4 basic facts within the multiplication tables given any one of the basic facts (e.g. $3 \times 4 = 12$, $4 \times 3 = 12$, $12 \div 4 = 3$ and $12 \div 3 = 4$ are a family of multiplication and division facts). (e) work in groups to create word problems (with pictorial representation if necessary) involving multiplication and division for other groups to solve. (f) solve non-routine problems using heuristics such as 'act it out' and 'draw a diagram' and share their ideas.
SUB-STRAND: FRACTIONS	
1. Fraction of a Whole	Students should have opportunities to:
1.1 fraction as part of a whole 1.2 notation and representations of fractions 1.3 comparing and ordering fractions with denominators of given fractions not exceeding 12 <ul style="list-style-type: none"> • unit fractions • like fractions 	(a) give examples of fractions in everyday situations and use language such as '2 out of 3' to describe fractions. (b) use concrete objects, fraction discs and pictorial representations to represent and interpret fractions in terms of unit fractions, e.g. $\frac{3}{5}$ is 3 units of $\frac{1}{5}$, $\frac{1}{5} + \frac{1}{5} + \frac{1}{5}$, or 3 fifths, and to compare the sizes of fractions referring to the same whole.

Content	Learning Experiences
	<p>(c) use fraction discs to represent and compare two unit fractions and explain why the greater the denominator, the smaller the unit fraction, e.g. $\frac{1}{6}$ is smaller than $\frac{1}{3}$.</p> <p>(d) use fraction discs to represent and compare two like fractions (i.e. fractions with the same denominator) and explain why the greater the numerator, the greater the like fraction, e.g. $\frac{6}{7}$ is greater than $\frac{4}{7}$.</p> <p>(e) achieve mastery of fraction recognition and comparison by playing games using fraction cards (pictures and symbols), including applets and digital games.</p>
2. Addition and Subtraction	Students should have opportunities to:
2.1 adding and subtracting like fractions within one whole with denominators of given fractions not exceeding 12	<p>(a) work in groups to write addition and subtraction stories involving like fractions.</p> <p>(b) use fraction discs to illustrate addition and subtraction of like fractions within one whole, e.g. $\frac{3}{5} + \frac{1}{5} = \frac{4}{5}$ (3 fifths + 1 fifth = 4 fifths)</p>
SUB-STRAND: MONEY	
1. Money	Students should have opportunities to:
<p>1.1 counting amount of money in dollars and cents</p> <p>1.2 reading and writing money in decimal notation</p> <p>1.3 comparing two or three amounts of money</p> <p>1.4 converting an amount of money in decimal notation to cents only, and vice versa</p> <p>1.5 solving word problems involving money in dollars only (or in cents only)</p>	<p>(a) read the prices of items from a supermarket advertisement or a grocery shopping list, write the prices in dollars and cents and in decimal notation, e.g. \$3.45 is 3 dollars and 45 cents, and use play money to make up an amount of money to pay for a selected item.</p> <p>(b) use play money to make up a given amount of money in different ways (e.g. \$1 is made up of 2 fifty-cent coins or 5 twenty-cent coins), and write the amount in different ways (e.g. \$1, \$1.00 and 100 cents).</p> <p>(c) use play money to make different amounts of money and to add, subtract and make change during shopping activities.</p> <p>(d) work in groups to create word problems involving shopping using data from supermarket advertisements etc. for other groups to solve.</p>

Content	Learning Experiences
MEASUREMENT AND GEOMETRY	
SUB-STRAND: MEASUREMENT	
1. Length, Mass and Volume	Students should have opportunities to:
1.1 measuring <ul style="list-style-type: none"> • length in metres/centimetres • mass in kilograms/grams • volume of liquid in litres 1.2 measuring and drawing a line segment to the nearest cm 1.3 using appropriate units of measurement and their abbreviations cm, m, g, kg, ℓ 1.4 comparing and ordering <ul style="list-style-type: none"> • lengths • masses • volumes 1.5 solving word problems involving length/mass/volume	(a) recognise that the term 'weight' is commonly used to mean mass in everyday situations. (b) compare masses of objects using balance scales. (c) use everyday examples to develop a sense of <ul style="list-style-type: none"> - how long 1 m/1 cm is, e.g. using a metre ruler, width of a fingernail. - how heavy 1 kg/1 g is, e.g. using a packet of sugar/flour/ rice, a pin, a piece of paper. - how much 1 litre of liquid is, e.g. using a bottle of mineral water/cooking oil, and 1-litre containers in different shapes. (d) use their arm span to show 1 m and estimate length in metres. (e) work in groups to measure the length of curves using a string. (f) work in groups to measure length/mass using appropriate units and explain their choices of units and how the measurement is done, e.g. measure the length of a longer object in metres and the mass of a heavier object in kg. (g) estimate length/mass/volume before measuring it and use the word 'about' (e.g. about 20 cm) to describe the estimation and measurement.
2. Time	Students should have opportunities to:
2.1 telling time to 5 minutes 2.2 use of 'a.m.' and 'p.m.' 2.3 use of abbreviations h and min 2.4 drawing hands on the clock face to show time 2.5 duration of 1 hour/half hour	(a) use a geared clock to tell time to 5 minutes and relate it to the events of a day. (b) count aloud in steps of 5 while the minute hand of a geared clock moves from one number to the next and make connections to the multiplication table of 5. (c) show time using a geared clock for others to read the time. (d) tell time and relate words such as 'morning', 'afternoon', 'night' to a.m. and p.m., and give examples such as "I watched a movie with my father at 7.30 p.m." (e) use everyday examples such as TV programme and bus schedules to tell and write time and to identify events that last about 1 hour/half hour, e.g. the Mathematics lesson lasted half an hour.
SUB-STRAND: GEOMETRY	
1. 2D Shapes	Students should have opportunities to:
1.1 identifying, naming and describing 2D shapes <ul style="list-style-type: none"> • semicircle 	(a) relate semicircle and quarter circle to circle. (b) guess 2D shapes from given descriptions of the shapes.

Content	Learning Experiences
<ul style="list-style-type: none"> • quarter circle 1.2 identifying the basic shapes that make up a given figure 1.3 forming different 2D figures with <ul style="list-style-type: none"> • rectangle • square • triangle • semicircle • quarter circle 1.4 copying figures on dot grid or square grid	(c) recognise and describe the differences/similarities between two 2D shapes according to attributes such as straight lines, curves, sizes and colours. (d) work in groups to create composite figures (e.g. picture of a boat) using 2D shapes or applets, and get other groups to identify the basic shapes that make up the composite figures. (e) make/complete patterns with 2D shapes according to one or two attributes (size, colour, shape and orientation) and explain the patterns.
2. 3D Shapes	
2.1 identifying, naming, describing and classifying 3D shapes <ul style="list-style-type: none"> • cube • cuboid • cone • cylinder • sphere 	Students should have opportunities to: (a) recognise, name and describe 3D shapes found in their environment. (b) make a guess of the 3D shapes in a bag by touch and feel only. (c) recognise and describe the differences/similarities between two 3D shapes according to attributes such as faces, edges, corners, sizes, colours and rolling. (d) work in groups to sort 3D shapes in different ways and explain how the shapes are sorted. (e) work in groups to create different 3D figures using 3D shapes or applets. (f) make/complete patterns with 3D shapes (except sphere) according to one or two attributes (size, shape, colour and orientation) and explain the patterns. (g) work in groups to create a pattern and invite other groups to guess the missing shape(s) and explain the pattern.
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Picture Graphs with Scales	
1.1 reading and interpreting data from picture graphs with scales 1.2 solving 1-step problems using data from picture graphs	Students should have opportunities to: (a) work in groups to write a question and answer it by collecting data from more than one class, or use data from the internet to make a picture graph and explain why a scale is used instead of one-to-one representation. (b) represent and interpret picture graphs in both vertical and horizontal forms, and make a story using information from a graph.

Content	Learning Experiences
PRIMARY THREE	
NUMBER AND ALGEBRA	
SUB-STRAND: WHOLE NUMBERS	
1. Numbers up to 10 000	Students should have opportunities to:
1.1 counting in hundreds/thousands 1.2 number notation, representations and place values (thousands, hundreds, tens, ones) 1.3 reading and writing numbers in numerals and in words 1.4 comparing and ordering numbers 1.5 patterns in number sequences	(a) discuss examples of big numbers (in thousands) in real life. (b) work in groups using number discs/number line to represent and compare numbers. (c) use number discs/play money to count in hundreds/thousands. (d) make sense of the size of 1000 and use it to estimate the number of objects in the size of thousands. (e) use place-value cards to illustrate and explain place values, e.g. the digit 3 stands for 3000, 300, 30 or 3 depending on where it appears in a number. (f) use number discs/place-value cards to compare numbers digit by digit from left to right, and use language such as 'greater than', 'greatest', 'smaller than', 'smallest', 'the same as' to describe the comparison. (g) use number discs/play money to represent a number that is 1, 10, 100 or 1000 more than/less than a 4-digit number. (h) describe a given number pattern before continuing the pattern or finding the missing number(s).
2. Addition and Subtraction	Students should have opportunities to:
2.1 addition and subtraction algorithms (up to 4 digits) 2.2 solving up to 2-step word problems involving addition and subtraction 2.3 mental calculation involving addition and subtraction of two 2-digit numbers	(a) associate the terms 'sum' and 'difference' with the comparison model, e.g. "The sum of 35 and 60 is 95 and their difference is 25." (b) work in groups using number discs to illustrate the standard algorithms for addition and subtraction up to 4 digits. (c) achieve mastery of addition and subtraction up to 4 digits by using applets or playing digital games. (d) solve a variety of problems: 1-step word problems, 2-part word problems (1 step for each part), 2-step word problems and non-routine problems to become familiar with the problem-solving process. (e) work in groups to create 2-step word problems involving addition and subtraction up to 4 digits for other groups to solve. (f) do mental addition and subtraction of two 2-digit numbers and discuss the different mental calculation strategies.

Content	Learning Experiences
3. Multiplication and Division	Students should have opportunities to:
3.1 multiplication tables of 6, 7, 8 and 9 3.2 multiplying and dividing within the multiplication tables 3.3 division with remainder 3.4 multiplication and division algorithms (up to 3 digits by 1 digit) 3.5 solving up to 2-step word problems involving the 4 operations 3.6 mental calculation involving multiplication and division within the multiplication tables	(a) work in groups to make multiplication and division stories, and write multiplication and division equations for the stories. (b) use concrete objects and pictorial representations to illustrate the concepts of multiplication and division such as ‘multiplying 6 by 5’ and ‘dividing 49 by 7’. (c) explore number patterns in the multiplication tables of 6, 7, 8 and 9 through activities such as colouring the hundred chart. (d) work in groups using number discs to illustrate the standard algorithms for multiplication and division up to 3 digits by 1 digit. (e) divide a number of concrete objects into equal groups to discover that sometimes there are objects left over as remainder and write the answer as quotient and remainder. (f) achieve mastery of multiplication and division facts by <ul style="list-style-type: none"> - using multiplication-fact cards and division-fact cards. - playing games including applets and digital games. - writing a family of 4 basic facts within the multiplication tables given any one of the basic facts (e.g. $8 \times 4 = 32$, $4 \times 8 = 32$, $32 \div 4 = 8$ and $32 \div 8 = 4$ are a family of multiplication and division facts). (g) use the part-whole and comparison models to illustrate the concepts of multiplication and division and use the models to determine which operation (multiplication or division) to use when solving 1-step word problems. (h) use the comparison model to reinforce the language of comparison such as “Ali has 3 times as much money as Mary.” (i) work in groups to create 2-step word problems involving the 4 operations for other groups to solve. (j) solve non-routine problems using different heuristics such as ‘act it out’ and ‘draw a diagram’ and share their ideas.
SUB-STRAND: FRACTIONS	
1. Equivalent fractions	Students should have opportunities to:
1.1 equivalent fractions 1.2 expressing a fraction in its simplest form 1.3 comparing and ordering unlike fractions with denominators of given fractions not exceeding 12 1.4 writing the equivalent fraction of a fraction given the denominator or the numerator	(a) discuss examples of fractions in everyday situations. (b) represent fractions as numbers on a number line. (c) use fraction discs or the part-whole model to represent two equivalent fractions, and explain why they are equal and how one can be obtained from the other, e.g. $\frac{2}{3} = \frac{4}{6}$. (d) make a list of the first 8 equivalent fractions of a given fraction and use this method to compare two unlike fractions. (e) work in groups to compare fractions using different strategies such as drawing a diagram,

Content	Learning Experiences
	comparing with respect to half, and explain the strategies used. (f) identify fractions that are not in their simplest form and reduce the fractions to their simplest form. (g) achieve mastery of equivalent fractions and fraction comparison through playing games using fraction cards (pictures and symbols) including digital games.
2. Addition and subtraction	Students should have opportunities to:
2.1 adding and subtracting two related fractions within one whole with denominators of given fractions not exceeding 12	(a) use fraction discs to represent two related fractions (i.e. fractions with related denominators), and explain how the two fractions are related. (b) use fraction discs to illustrate addition and subtraction of related fractions within one whole, e.g. $\frac{3}{4} + \frac{1}{8} = \frac{6}{8} + \frac{1}{8} = \frac{7}{8}$ (c) work in groups to make addition and subtraction stories involving like fractions/related fractions.
SUB-STRAND: MONEY	
1. Money	Students should have opportunities to:
1.1 adding and subtracting money in decimal notation 1.2 solving word problems involving addition and subtraction of money in decimal notation	(a) discuss the value of \$1000 (e.g. things that can be bought with a \$1000 note), and use play money to illustrate that \$1000 is 10 times \$100. (b) use play money to illustrate the addition and subtraction algorithms and make connections between the algorithms for money and for whole numbers. (c) use a variety of strategies for adding and subtracting money, e.g. make \$1, make a whole number of dollars first, and explain the process. (d) work in groups to solve problems in real-world situations such as shopping and budgeting.
MEASUREMENT AND GEOMETRY	
SUB-STRAND: MEASUREMENT	
1. Length, Mass and Volume	Students should have opportunities to:
1.1 measuring <ul style="list-style-type: none"> • length in kilometres (km) • volume of liquid in millilitres (ml) 1.2 measuring length/mass/volume (of liquid) in compound units 1.3 converting a measurement in compound units to the smaller unit, and vice versa	(a) develop a sense of <ul style="list-style-type: none"> - how far 1 km is by relating it to the distance between two familiar landmarks or identifying/locating a spot which is 1 km away from the school. - how much 1 ml is using everyday examples, e.g. a drop of water from a dropper. (b) collect familiar objects with varying volume/capacity, e.g. cough syrup spoons, syrup bottles, food containers. (c) count aloud in steps of 100 ml to make 1 ℓ and relate 1 ℓ with 1000 ml, e.g. using a litre jug with

Content	Learning Experiences
<ul style="list-style-type: none"> • kilometres and metres • metres and centimetres • kilograms and grams • litres and millilitres (numbers involved should be within easy manipulation) 1.4 solving word problems involving length/mass/volume/capacity excluding fractions and compound units	100 ml markings. (d) work in groups to measure the volume of liquid in millilitres using cough syrup spoons, measuring beakers etc. (e) work in groups to estimate and measure using appropriate tools <ul style="list-style-type: none"> - length of more than 1 m using measuring tapes. - mass of more than 1 kg using measuring scales. - volume of liquid more than 1 l using measuring jars. (f) work in groups to measure the capacities of different sized containers using measuring tools such as measuring jars and beakers.
2. Time	Students should have opportunities to:
2.1 telling time to the minute 2.2 use of 'past' and 'to' to tell time 2.3 measuring time in hours and minutes 2.4 converting time in hours and minutes to minutes only, and vice versa 2.5 finding the starting time, finishing time or duration given the other two quantities 2.6 solving problems involving time in hours and minutes	(a) observe the movement of the hour and minute hands on a real/geared clock. (b) develop a sense of duration of 1 minute, and describe what can be done in a duration of 1 minute, e.g. number of squares drawn in 1 minute. (c) practise telling and writing time using everyday examples such as TV programmes, bus schedules, MRT operating hours and examination timetables. (d) represent given information such as starting time, finishing time and duration of activity on a timeline, and use it to solve problems. (e) work in groups to create problems involving time in hours and minutes for other groups to solve.
SUB-STRAND: AREA AND VOLUME	
1. Area and Perimeter	Students should have opportunities to:
1.1 concepts of area and perimeter of a plane figure 1.2 measuring area in square units, cm^2 and m^2 , excluding conversion between cm^2 and m^2 1.3 perimeter of <ul style="list-style-type: none"> • rectilinear figure • rectangle • square 1.4 area of rectangle/square	(a) compare and measure the areas of rectangles using different non-standard units, e.g. use their Mathematics textbook as an area unit to estimate and measure their desk and teacher's desk. (b) use real-life examples to explain the concepts of area and perimeter, and compare the sizes of rectangles/squares using area. (c) visualise the sizes of 1 cm^2 and 1 m^2 , e.g. use newspaper to measure and make a square of area 1 m^2 (i.e. 1 m by 1 m). (d) work in groups to make different rectangles and squares using square tiles, study the relationship between the area/perimeter and length(s) of each side, and observe that shapes with same area can have different perimeters, and shapes with same perimeter can have different areas. (e) work in pairs to find the area of squares and rectangles drawn on square grid by counting and by formula. (f) estimate the area of a figure drawn on square grid by counting whole and partial squares within the figure.

Content	Learning Experiences
SUB-STRAND: GEOMETRY	
1. Angles	Students should have opportunities to:
1.1 concepts of angle 1.2 right angles, angles greater than/smaller than a right angle	(a) illustrate an angle as an amount of turning using geostrips/riveted straws and use language such as 'acute angle' and 'obtuse angle' to describe angles. (b) find angles in the environment and use a 'paper right angle' to identify right angles, angles greater than a right angle and angles smaller than a right angle.
2. Perpendicular and Parallel Lines	Students should have opportunities to:
2.1 perpendicular and parallel lines 2.2 draw perpendicular and parallel lines on square grid	(a) recognise the relationship between two straight lines on a plane that are perpendicular/parallel and give examples of perpendicular/parallel lines from 2D figures and the environment. (b) identify horizontal and vertical lines and explain how to determine if a line is horizontal/vertical, e.g. a line is vertical when it is parallel to a plumb line. (c) recognise that two vertical lines are parallel, and that a horizontal line and a vertical line are perpendicular. (d) work in pairs to explore how to construct perpendicular and parallel lines using set squares and protractor, and to check whether two given straight lines are perpendicular or parallel. (e) work in pairs to explore how different pairs of perpendicular and parallel lines can be drawn on square grid.
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Bar Graphs	Students should have opportunities to:
1.1 reading and interpreting data from bar graphs 1.2 using different scales on axis 1.3 solving 1-step problems using data from bar graphs	(a) work in groups to discuss how to collect data, e.g. through interview or survey, and how to represent the data in a bar graph. (b) construct a bar graph using a spreadsheet e.g. Excel, and make a story using information from the graph. (c) discuss real-world examples of data presented in bar graphs.

Content	Learning Experiences
PRIMARY FOUR	
NUMBER AND ALGEBRA	
SUB-STRAND: WHOLE NUMBERS	
1. Numbers up to 100 000	Students should have opportunities to:
<p>1.1 number notation, representations and place values (ten thousands, thousands, hundreds, tens, ones)</p> <p>1.2 reading and writing numbers in numerals and in words</p> <p>1.3 comparing and ordering numbers</p> <p>1.4 patterns in number sequences</p> <p>1.5 rounding numbers to the nearest 10, 100 or 1000</p> <p>1.6 use of \approx</p>	<p>(a) work in groups to</p> <ul style="list-style-type: none"> - look for examples of big numbers up to 100 000 from newspapers and magazines. - estimate a big number (e.g. the seating capacity of the Singapore Indoor Stadium) and discuss how the estimation is done. <p>(b) work in groups using number discs/number line to represent and compare numbers.</p> <p>(c) use place-value cards to illustrate and explain place values e.g. the digit 3 stands for 30 000, 3000, 300, 30 or 3 depending on where it appears in a number.</p> <p>(d) use number discs/place-value cards to compare numbers digit by digit from left to right, and use language such as 'greater than', 'greatest', 'smaller than', 'smallest' and 'the same as' to describe the comparison.</p> <p>(e) use number discs or digital manipulatives to represent a number that is 10, 100 or 1000 more than/less than a 5-digit number.</p> <p>(f) describe a given number pattern before continuing the pattern or finding the missing number(s).</p> <p>(g) place a given number on a number line between two consecutive tens/hundreds, and determine which ten/hundred is nearer to the given number.</p>
2. Factors and Multiples	Students should have opportunities to:
<p>2.1 factors, multiples and their relationship</p> <p>2.2 determining if a 1-digit number is a factor of a given number within 100</p> <p>2.3 finding the common factors of two given numbers</p> <p>2.4 determining if a number is a multiple of a given 1-digit number</p> <p>2.5 finding the common multiples of two given 1-digit numbers</p>	<p>(a) relate the concepts of factor and multiple to multiplication and division.</p> <p>(b) work in groups to express a given number within 100 as a product of two factors and share the different ways of writing the products e.g. $36 = 9 \times 4$ and $36 = 3 \times 12$.</p> <p>(c) make a list of the first 12 multiples of a given 1-digit number and use this method to identify the common multiples of two given 1-digit numbers.</p> <p>(d) make connections between the concept of common factor and simplifying a fraction, and between the concept of common multiple and finding a common denominator for two fractions.</p>

Content	Learning Experiences
3. Four Operations	Students should have opportunities to:
3.1 multiplication algorithm <ul style="list-style-type: none"> • up to 4 digits by 1 digit • up to 3 digits by 2 digits 3.2 division algorithm (up to 4 digits by 1 digit) 3.3 solving up to 3-step word problems involving the 4 operations	(a) use number discs or concrete manipulatives to visualise, illustrate and explain the multiplication of a number by 10 and a multiple of 10 (b) use the part-whole and comparison models to represent and solve word problems involving the four operations. (c) use a variety of mental strategies for the 4 operations and explain the process. (d) estimate the answer before doing the calculation and check the reasonableness of the calculated answer by comparing it with the estimated answer. (e) work in groups to create 3-step word problems involving the 4 operations for other groups to solve. (f) solve non-routine problems using different heuristics and share their ideas.
SUB-STRAND: FRACTIONS	
1. Mixed Numbers and Improper Fractions	Students should have opportunities to:
1.1 mixed numbers, improper fractions and their relationships	(a) give examples of fractions in everyday situations, including measurements, e.g. $\frac{1}{2}$ kg, $1\frac{1}{4}$ litres, $\frac{1}{2}$ m, etc. (b) use fraction discs/number line to represent and interpret fractions greater than one whole as improper fractions and mixed numbers. (c) compare two fractions using fraction discs, and then without using fraction discs by changing to common denominators. (d) compare and order whole numbers and fractions on a number line. (e) achieve mastery of conversion between mixed numbers and improper fractions by playing games using fraction cards (pictures and symbols) including digital games.
2. Fraction of a Set of Objects	Students should have opportunities to:
2.1 fraction as part of a set of objects	(a) divide a given set of concrete objects into equal parts and use this to <ul style="list-style-type: none"> - illustrate the concept of fraction of a set (e.g. when a set of objects is divided into 3 equal parts, '$\frac{2}{3}$ of the set' is 2 out of the 3 equal parts). - find a fraction of a set by adding up the objects in the parts (e.g. when a set of 24 objects are divided into 4 equal parts, '$\frac{3}{4}$ of the set' is $6 + 6 + 6$ or $3 \times 6 = 18$ objects). (b) Use pictorial model to illustrate the concept of fraction of a quantity.

Content	Learning Experiences
3. Addition and Subtraction	Students should have opportunities to:
3.1 adding and subtracting fractions with denominators of given fractions not exceeding 12 and not more than two different denominators 3.2 solving up to 2-step word problems involving addition and subtraction	(a) use fraction discs to illustrate addition and subtraction of fractions with answer greater than one whole, and express the answer as a mixed number or improper fraction. (b) work in groups to create 2-step word problems involving addition and subtraction of fractions for other groups to solve.
SUB-STRAND: DECIMALS	
1. Decimals up to 3 decimal places	Students should have opportunities to:
1.1 notation, representations and place values (tenths, hundredths, thousandths) 1.2 comparing and ordering decimals 1.3 dividing a whole number by a whole number with quotient as a decimal 1.4 converting decimals to fractions 1.5 converting fractions to decimals when the denominator is a factor of 10 or 100 1.6 rounding decimals to <ul style="list-style-type: none"> • the nearest whole number • 1 decimal place • 2 decimal places 	(a) look for decimals in everyday situations e.g. advertisements from newspapers and magazines. (b) record length/mass/volume of liquid in decimal notation e.g. 1 m 62 cm is 1.62 m, and identify the whole-number parts, tenths and hundredths in the decimal. (c) recognise that a decimal is made up of a whole-number part and a fractional part, represent the decimal on a number line, and make connections between decimals, fractions and measurement. (d) use number discs to extend the place-value concept of whole numbers to decimals. (e) count in tenths/hundredths using number discs from 0.1 to 1.2, or from 0.01 to 0.12, e.g. 11 tenths is 1.1. (f) write whole numbers and decimals in 3 digits (or 4 digits), arrange these numbers in increasing/decreasing order and explain how it is done. (g) use number discs to represent a number that is 0.1, 0.01 or 0.001 more than/less than a given decimal. (h) create, describe and continue number sequences such as 0.4, 0.8, 1.2, 1.6, ... (i) compare decimals using number line. (j) compare two decimals by first comparing the whole-number parts, and then compare the tenths, hundredths, thousandths in that order. (k) represent equivalent decimals such as 0.2, 0.20 and 0.200, and explain that they are the same number. (l) divide a whole number by a 1-digit whole number and write the answer as a decimal instead of as quotient and remainder. (m) place a given decimal on a number line between two consecutive whole numbers/tenths/hundredths, and determine which whole number/tenth/hundredth is nearer to the given decimal.

Content	Learning Experiences
2. Addition and Subtraction	Students should have opportunities to:
2.1 adding and subtracting decimals (up to 2 decimal places)	(a) use number discs or digital manipulatives to illustrate the addition and subtraction algorithms and make connections between the algorithms for decimals and for whole numbers. (b) use a variety of mental strategies for addition and subtraction and explain the process. (c) work in groups on problems involving decimals in everyday situations such as shopping receipts, food prices in school canteen, and budgeting. (d) estimate the answer before doing the calculation and check the reasonableness of the calculated answer by comparing it with the estimated answer.
3. Multiplication and Division	Students should have opportunities to:
3.1 multiplying and dividing decimals (up to 2 decimal places) by a 1-digit whole number 3.2 solving up to 2-step word problems involving the 4 operations 3.3 rounding off answers to a specified degree of accuracy	(a) use number discs or digital manipulatives to illustrate the multiplication and division algorithms and make connections between the algorithms for decimals and for whole numbers. (b) estimate the product and quotient using multiplication and division within the multiplication tables and use the estimation to check the reasonableness of the calculated answer. (c) work in groups to create 2-step word problems based on everyday experiences, e.g. using data from supermarket advertisements/receipts for other groups to solve.
MEASUREMENT AND GEOMETRY	
SUB-STRAND: MEASUREMENT	
1. Time	Students should have opportunities to:
1.1 measuring time in seconds 1.2 24-hour clock 1.3 solving problems involving time in 24-hour clock	(a) develop a sense of 1 second or 10 seconds, e.g. what they can do in 1 second or the number of words they can write in 10 seconds. (b) read and write time in 24-hour clock from flight schedules or train schedules, and give reasons why 24-hour clock is used instead of 12-hour clock. (c) describe everyday events using 24-hour clock, including starting time, finishing time and duration. (d) represent given information such as starting time, finishing time and duration of activity on a timeline and use it to solve problems. (e) work in groups to create word problems involving time in 24-hour clock for other groups to solve.

Content	Learning Experiences
SUB-STRAND: AREA AND VOLUME	
1. Area and Perimeter	Students should have opportunities to:
1.1 finding one dimension of a rectangle given the other dimension and its area/perimeter 1.2 finding the length of one side of a square given its area/perimeter 1.3 finding the area and perimeter of composite figures made up of rectangles and squares	(a) apply multiplication and division concepts to find one dimension of a rectangle given its area/perimeter and the other dimension. (b) draw and cut out squares of different sizes, from 1 cm ² to 100 cm ² , and commit to memory the areas of the squares. (c) make a composite figure using cutouts of rectangles and squares or draw the figure on square grid, and calculate its area and perimeter. (d) visualise how a L-shaped figure can be partitioned into rectangles and squares, or can be formed by removing a rectangle/square from a bigger rectangle/square, and calculate the area and perimeter from given lengths.
SUB-STRAND: GEOMETRY	
1. Angles	Students should have opportunities to:
1.1 using notation such as $\angle ABC$ and $\angle a$ to name angles 1.2 measuring angles in degrees 1.3 drawing an angle of given size 1.4 relating quarter, half and complete turns to angles in degrees 1.5 8-point compass	(a) associate the amount of turning (rotation), clockwise or anti-clockwise, with an angle measured in degrees - $\frac{1}{4}$ turn is 90°. - $\frac{1}{2}$ turn is 180°. - $\frac{3}{4}$ turn is 270°. - a complete turn with 360°. (b) estimate before measuring angles using a protractor. (c) draw angles using a protractor. (d) find the angles (in degrees) between two 8-point compass directions.

Content	Learning Experiences
2. Rectangle and Square	Students should have opportunities to:
2.1 properties of rectangle and square, excluding diagonal properties 2.2 drawing rectangles and squares on square grid	(a) describe the properties of rectangles and squares in terms of perpendicular and parallel lines, e.g. two pairs of parallel sides, and discuss how rectangles and squares are related, e.g. a square is a special rectangle. (b) work in pairs to explore how to draw different squares and rectangles on square grid. (c) observe the different orientations of a rectangle (or square) when it is rotated through 90° (quarter turn), 180° (half turn), 270° (three-quarter turn) and 360° (a complete turn), clockwise or anti-clockwise. (d) sketch and draw rectangles and squares according to given length(s) using ruler, protractor and set squares.
3. Line Symmetry	Students should have opportunities to
3.1 identifying symmetric figures 3.2 determining whether a straight line is a line of symmetry of a symmetric figure 3.3 completing a symmetric figure with respect to a given line of symmetry on square grid	(a) work in groups to look for examples of symmetric figures in their environment and determine the lines of symmetry. (b) visualise folding a symmetric figure along a line of symmetry, justify that the figure is symmetric about the line of symmetry, and relate the two halves of the symmetric figure as reflections of each other in the line of symmetry. (c) work in pairs to create symmetric figures with origami paper.
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Tables and Line Graphs	Students should have opportunities to:
1.1 completing a table from given data 1.2 reading and interpreting data from tables/line graphs 1.3 solve 1-step problems using data from tables/graphs	(a) relate the data represented in a table to the corresponding bar graph, and explain why the data is presented in a graph instead of a table. (b) discuss examples of data presented in bar graphs/composite bar graphs found in newspapers and magazines, and how the data was collected and displayed in graphical form. (c) construct a line graph using a spreadsheet e.g. Excel, and make connections between bar and line graphs, and explain which type of graph should be used or both can be used. (d) discuss examples of inappropriate representations of data from newspapers, e.g. whether certain representations are misleading.

Content	Learning Experiences
PRIMARY FIVE	
NUMBER AND ALGEBRA	
SUB-STRAND: WHOLE NUMBERS	
1. Numbers up to 10 million	Students should have opportunities to:
1.1 reading and writing numbers in numerals and in words	(a) extend the number system to millions, and read and write large numbers in millions and thousands up to 10 million. (b) develop a sense of the size of 1 million by <ul style="list-style-type: none"> - discussing examples of numbers in millions up to 10 million e.g. population of Singapore, price of a property. - searching for examples of 1 million from the internet. - estimating the size of an indoor stadium that will have a capacity of 1 million spectators as compared to the Singapore Indoor Stadium.
2. Four Operations	Students should have opportunities to:
2.1 multiplying and dividing by 10, 100, 1000 and their multiples without calculator 2.2 order of operations without calculator 2.3 use of brackets without calculator 2.4 solving word problems involving the 4 operations	(a) use number discs to illustrate multiplication and division of a whole number by 10/100/1000, e.g. the result of multiplying 6 hundreds 2 tens 3 ones (623) by 10 is 6 thousands 2 hundreds 3 tens (6230). (b) discover the rules for the order of the 4 operations with a scientific calculator and explain why the rules are necessary. (c) estimate the answer before doing the calculation and check the reasonableness of the calculated answer by comparing it with the estimated answer. (d) solve problems using the part-whole and comparison models. (e) solve non-routine problems using different heuristics and share their ideas.
SUB-STRAND: FRACTIONS	
1. Fraction and Division	Students should have opportunities to:
1.1 dividing a whole number by a whole number with quotient as a fraction 1.2 converting fractions to decimals	(a) divide a whole number by a 1-digit whole number and write the answer as a fraction, instead of as quotient and remainder, or as a decimal.

Content	Learning Experiences
	<p>(b) explain how fraction and division are related, e.g. $\frac{3}{5}$ is 3 divided by 5; when 3 pies are shared equally among 5 children, each child gets $\frac{3}{5}$ of a pie.</p> <p>(c) use the part-whole model to illustrate the concepts of fraction and division, and their relationship, e.g. draw a model to show $12 \div 3$ as a whole divided into 3 equal parts which is also $\frac{1}{3}$ of 12.</p>
2. Four Operations	Students should have opportunities to:
<p>2.1 adding and subtracting mixed numbers</p> <p>2.2 multiplying a proper/improper fraction and a whole number without calculator</p> <p>2.3 multiplying a proper fraction and a proper/improper fractions without calculator</p> <p>2.4 multiplying two improper fractions</p> <p>2.5 multiplying a mixed number and a whole number</p> <p>2.6 solving word problems involving addition, subtraction and multiplication</p>	<p>(a) use fraction discs to illustrate addition and subtraction of mixed numbers which involve adding/subtracting the whole-number parts, followed by adding/subtracting the fractional parts.</p> <p>(b) relate multiplication of whole number and fraction to finding the number of objects in a fraction of a set, e.g. $\frac{3}{4} \times 60 = \frac{3}{4}$ of 60.</p> <p>(c) discuss the advantages of doing 'cancellation' before multiplying out the fractions.</p> <p>(d) solve problems using the part-whole and comparison models.</p> <p>(e) work in groups to solve multi-step word problems.</p>
SUB-STRAND: DECIMALS	
1. Four Operations	Students should have opportunities to:
<p>1.1 multiplying and dividing decimals (up to 3 decimal places) by 10, 100, 1000 and their multiples without calculator</p> <p>1.2 converting a measurement from a smaller unit to a larger unit in decimal form, and vice versa</p> <ul style="list-style-type: none"> • kilometres and metres • metres and centimetres • kilograms and grams • litres and millilitres <p>1.3 solving word problems involving the 4 operations</p>	<p>(a) use number discs to illustrate multiplication and division of a decimal by 10/100/1000, e.g. the result of multiplying 6 ones 2 tenths 3 hundredths (6.23) by 10 is 6 tens 2 ones 3 tenths (62.3), and relate the process to multiplication and division of a whole number by 10/100/1000.</p> <p>(b) collect and talk about real-life examples of the uses of different units of measurement, e.g. specifications of furniture in a manual, weighing scales, height of a mountain in metres (m), car capacity in cubic centimetres (cm³ or cc).</p> <p>(c) measure and compare amounts of liquid using measuring cylinders (ℓ) and beakers (ml) to determine the equivalence between the measurements, e.g. 0.2 ℓ = 200 ml.</p> <p>(d) use a linear scale to show the relationship between larger and smaller units of measurement.</p> <p>(e) work in pairs to convert between larger and smaller units through games or quizzes.</p> <p>(f) work in groups to create word problems based on everyday experiences for other groups to solve, e.g. using data from supermarket advertisements.</p>

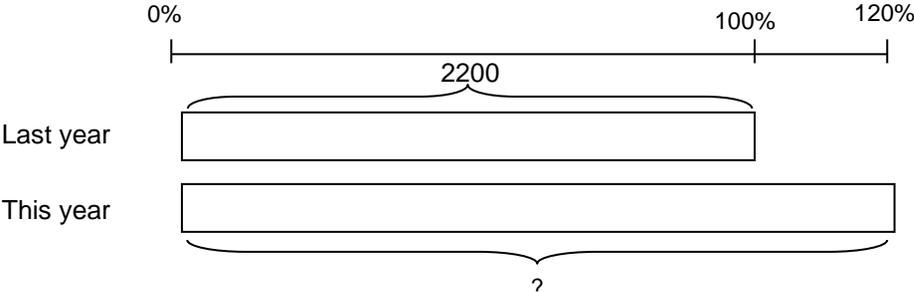
Content	Learning Experiences
	(g) estimate the answer before doing the calculation and check the reasonableness of the calculated answer by comparing it with the estimated answer.
SUB-STRAND: PERCENTAGE	
1. Percentage	Students should have opportunities to:
1.1 expressing a part of a whole as a percentage 1.2 use of % 1.3 finding a percentage part of a whole 1.4 finding discount, GST and annual interest 1.5 solving up to 2-step word problems involving percentage	<p>(a) look for examples where percentages are used in real life, e.g. newspaper cuttings showing discounts, bank brochures showing interest rates, and discuss their usage.</p> <p>(b) discuss different ways of expressing a part of a whole, e.g. the number of squares shaded to show 30% on 100-square and 200-square grids.</p> <p>(c) use a percentage scale to illustrate the part-whole concept of percentage, and to show the relationship between percentage and fraction, e.g. $30\% = \frac{3}{10}$</p> <div data-bbox="905 691 1661 824" data-label="Figure"> </div> <p>(d) use a linear scale to show the relationship between percentage and decimal</p> <div data-bbox="919 922 1654 1024" data-label="Figure"> </div> <p>(e) play card games/online games involving equivalent fractions, decimals and percentages, e.g. 20% is equivalent to $\frac{1}{5}$ or 0.2.</p> <p>(f) use the part-whole model to represent and solve percentage problems.</p> <p>(g) collect receipts that show discounts, GST, service charges etc., and use calculator to check how these values are calculated.</p> <p>(h) work in groups to plan a shopping list with a given budget using newspaper advertisements and promotion pamphlets.</p>

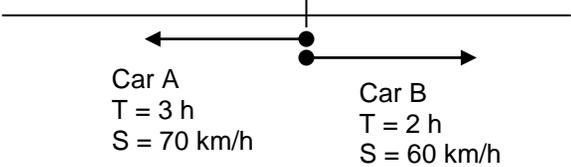
Content	Learning Experiences
SUB-STRAND: RATIO	
1. Ratio	Students should have opportunities to:
1.1 notation, representations and interpretation of $a:b$ and $a:b:c$, where a , b and c are whole numbers, excluding ratios involving fractions and decimals 1.2 equivalent ratios 1.3 dividing a quantity in a given ratio 1.4 expressing a ratio in its simplest form 1.5 finding the ratio of two or three given quantities 1.6 finding the missing term in a pair of equivalent ratios 1.7 solving up to 2-step word problems involving ratio	(a) use objects in the classroom to practise simplifying ratios and using ratio language, e.g. "The ratio of the number of boys to the number of girls is 15 to 20", and $15:20 = 3:4$. (b) work in groups to make different ratios from two or three given sets of objects, e.g. given 8 blue cubes and 12 green cubes, make different ratios by forming equal groups of varying sizes and recognise the ratios as equivalent ratios because the number of cubes remain unchanged, only groupings change. (c) make connections between simplifying fractions and ratios by dividing the terms of the fraction/ratio by a common factor. (d) solve problems using the part-whole and comparison models.
SUB-STRAND: RATE AND SPEED	
1. Rate	Students should have opportunities to:
1.1 rate as the amount of a quantity per unit of another quantity 1.2 finding rate, total amount or number of units given the other two quantities 1.3 solving word problems involving rate	(a) talk about examples of rate in everyday situations such as postage rates and utility rates (water and electricity consumption rates). (b) talk about a situation involving rate and recognise that there are three related quantities (rate, total amount, number of units) and given any two quantities, the third quantity can be calculated. (c) solve problems using proportional reasoning.
MEASUREMENT AND GEOMETRY	
SUB-STRAND: AREA AND VOLUME	
1. Area of Triangle	Students should have opportunities to:
1.1 concepts of base and height of a triangle 1.2 area of triangle 1.3 finding the area of composite figures made up of rectangles, squares and triangles	(a) associate the base and height of a triangle with the length and breadth of its related rectangle, and recognise the relationship between the area of the triangle and its related rectangle. (b) draw different triangles on square grid and identify the height of each triangle corresponding to a given base. (c) work in groups to determine the basic shapes (rectangle, square and triangle) that make up a composite figure, or use basic shape cutouts to form different composite figures.

Content	Learning Experiences
2. Volume of Cube and Cuboid	Students should have opportunities to:
2.1 building solids with unit cubes 2.2 measuring volume in cubic units, cm^3 and m^3 , excluding conversion between cm^3 and m^3 , 2.3 drawing cubes and cuboids on isometric grid 2.4 volume of a cube/cuboid 2.5 finding the volume of liquid in a rectangular tank 2.6 relationship between ℓ (or ml) and cm^3	(a) use unit cubes (or connecting cubes) to build different solids (3D figures) and express their volumes in cubic units. (b) compare the sizes of solids in terms of their volumes. (c) build cuboids and cubes layer by layer using unit cubes (or connecting cubes) to establish the formula for the volume of a cuboid/cube. (d) build cubes of sizes $1 \times 1 \times 1$, $2 \times 2 \times 2$, $3 \times 3 \times 3$, ... using unit cubes (or connecting cubes) and find the volumes of the cubes by counting and by formula. (e) pour 1 litre of water into a container measuring 10 cm by 10 cm by 10 cm to establish the equivalence of 1 litre (1000 ml) and 1000 cm^3 . (f) make connections between 1 cm^2 and 1 cm^3 , and between 1 m^2 and 1 m^3 , e.g. use newspaper and masking tape to make a square of area 1 m^2 and a cube of volume 1 m^3 . (g) work in groups to draw a cube or a cuboid taking into consideration size and orientation. (h) work in pairs to draw on square grid the top/side/front view of a solid made up of unit cubes.
SUB-STRAND: GEOMETRY	
1. Angles	Students should have opportunities to:
1.1 angles on a straight line 1.2 angles at a point 1.3 vertically opposite angles 1.4 finding unknown angles	(a) describe and illustrate the various angle properties. (b) look for examples of different types of angles in the environment. (c) use the angle properties to find unknown angles and explain how they obtain the answers.
2. Triangle	Students should have opportunities to:
2.1 properties of <ul style="list-style-type: none"> • isosceles triangle • equilateral triangle • right-angled triangle 2.2 angle sum of a triangle 2.3 finding unknown angles without additional construction of lines	(a) sort a set of different triangles into groups by their angles/lengths, explain how it is done and use terms such as 'acute-angled triangle', 'obtuse-angle triangle', 'right-angled triangle', 'isosceles triangle' and 'equilateral triangle' to describe the triangles. (b) look for the various types of triangles in the environment. (c) investigate and discover that the angle sum of any triangle is 180° using triangle cutouts or applets. (d) identify and justify the angle properties of triangles, e.g. fold an isosceles triangle cutout to show that the base angles are equal. (e) draw special triangles on square grid. (f) use the angle properties of triangles to find unknown angles and explain how they obtain the answers. (g) sketch and draw different triangles according to given angles and lengths using ruler, protractor and set squares.

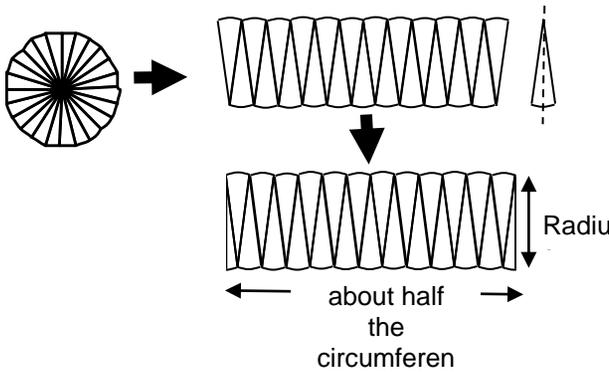
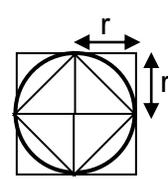
Content	Learning Experiences
3. Parallelogram, Rhombus and Trapezium	Students should have opportunities to:
3.1 properties of <ul style="list-style-type: none"> • parallelogram • rhombus • trapezium 3.2 finding unknown angles without additional construction of lines	(a) make a collection of quadrilaterals (4-sided figures) from pictures and photographs, and identify the various special quadrilaterals besides square and rectangles. (b) discuss how each special quadrilateral is different from the others, and explore its properties using cutouts or applets. (c) draw special quadrilaterals on square grid. (d) use the properties of special quadrilaterals to find unknown angles and explain how they obtain the answers. (e) sketch and draw special quadrilaterals according to given angles and lengths using ruler, protractor and set squares.
STATISTICS	
SUB-STRAND: DATA ANALYSIS	
1. Average of a Set of Data	Students should have opportunities to:
1.1 average as 'total value \div number of data' 1.2 relationship between average, total value and number of data	(a) discuss the meaning of average in real-life situations such as average height, average load in a lift, average temperature in a day or month. (b) recognise that there are three related quantities in a set of data (average, total value and number of data) and given any two quantities, the third quantity can be calculated.

Content	Learning Experiences
PRIMARY SIX	
NUMBER AND ALGEBRA	
SUB-STRAND: FRACTIONS	
1. Four Operations	Students should have opportunities to:
1.1 dividing a proper fraction by a whole number without calculator 1.2 dividing a whole number/proper fraction by a proper fraction without calculator 1.3 solving word problems involving the 4 operations	(a) use fraction discs or digital manipulatives to illustrate the concepts and algorithms for <ul style="list-style-type: none"> - division of a proper fraction by a whole number. - division of a whole number by a proper fraction. - division of a proper fraction by a proper fraction. (b) use calculator to do the 4 operations with fractions (including mixed numbers). (c) solve problems using the part-whole and comparison models. (d) work in groups to solve multi-step word problems and non-routine problems.
SUB-STRAND: PERCENTAGE	
1. Percentage	Students should have opportunities to:
1.1 finding the whole given a part and the percentage 1.2 finding percentage increase/decrease 1.3 solving word problems involving percentage	(a) use a pictorial model to represent a percentage part of a quantity in a given situation, and use the model to find the quantity, e.g. David saved \$30 last month. This was 10% of his pocket money. How much was his pocket money? (b) give real-life examples of percentage change (increase or decrease) and explain how the percentage change is calculated. (c) practise using calculator to find percentage change through games, e.g. In a group, students throw a dice twice and calculate the change (increase/decrease) and then express the change as a percentage of the original value. (d) make connections between the concepts of 'percentage of percentage' and 'fraction of fraction', e.g. John spent 20% of his money on a soccer jersey and 30% of the remaining money on a cap. What percentage of his money did he spend on the cap?

Content	Learning Experiences									
	<p>(e) use the before-after concept to illustrate percentage increase or decrease, e.g. Last year, the country club membership was 2200. This year, it increases by 20%. What is the membership this year?</p> 									
SUB-STRAND:RATIO										
1. Ratio	Students should have opportunities to:									
<p>1.1 relationship between fraction and ratio 1.2 solving word problems involving ratio including changing ratios</p>	<p>(a) use concrete objects or draw pictorial models to demonstrate their understanding of fraction statements such as 'A is $\frac{2}{3}$ of B', 'B is $\frac{3}{2}$ of A', and rewrite the statements using ratio.</p> <p>(b) find the ratio of two quantities in direct proportion and use it to solve direct proportion problems, e.g. Find the amount of each ingredient needed to bake 10 dozens of cookies using the following recipe for baking 3 dozen cookies</p> <table border="1" data-bbox="892 1063 1743 1299" style="width: 100%; border-collapse: collapse;"> <tbody> <tr> <td style="padding: 5px;">1 cup flour</td> <td style="padding: 5px;">$\frac{1}{3}$ cup sugar</td> <td style="padding: 5px;">1 cup chocolate chips</td> </tr> <tr> <td style="padding: 5px;">$\frac{1}{2}$ teaspoon baking soda</td> <td style="padding: 5px;">1 egg</td> <td style="padding: 5px;"></td> </tr> <tr> <td style="padding: 5px;">$\frac{1}{2}$ cup butter</td> <td style="padding: 5px;">$\frac{1}{2}$ teaspoon. vanilla</td> <td style="padding: 5px;"></td> </tr> </tbody> </table> <p>(c) use equivalent ratios and the before-after concept to solve problems involving changing ratio.</p>	1 cup flour	$\frac{1}{3}$ cup sugar	1 cup chocolate chips	$\frac{1}{2}$ teaspoon baking soda	1 egg		$\frac{1}{2}$ cup butter	$\frac{1}{2}$ teaspoon. vanilla	
1 cup flour	$\frac{1}{3}$ cup sugar	1 cup chocolate chips								
$\frac{1}{2}$ teaspoon baking soda	1 egg									
$\frac{1}{2}$ cup butter	$\frac{1}{2}$ teaspoon. vanilla									

Content	Learning Experiences
SUB-STRAND: RATE AND SPEED	
1. Distance, Time and Speed 1.1 concepts of speed and average speed 1.2 relationship between distance, time and speed exclude conversion of units e.g. km/h to m/min 1.3 writing speed in different units such as km/h, m/min, m/s and cm/s 1.4 solving up to 3-step word problems involving speed and average speed	Students should have opportunities to: (a) talk about speed in real life such as speed of vehicles (e.g. bicycle, motor car, train, aeroplane) and animals (e.g. horse, cheetah) and make comparisons between the different speeds. Also, discuss other examples such as speed limit traffic signs, 100-m run, speedometer in cars and fan speed. (b) talk about a journey and recognise that there are 3 related quantities (distance, time and speed) and given any two quantities, the third quantity can be calculated. (c) draw a diagram to show different scenarios of speed, distance and time (e.g. two vehicles starting from the same point but moving away from each other at constant speeds) and use it to solve problems, e.g. find the distance apart after 3 hours. <div style="text-align: center;"> <p>Starting Point</p>  </div>
SUB-STRAND: ALGEBRA	
1. Algebra 1.1 using a letter to represent an unknown number 1.2 notation, representations and interpretation of simple algebraic expressions such as <ul style="list-style-type: none"> • $a \pm 3$ • $a \times 3$ or $3a$ • $a \div 3$ or $\frac{a}{3}$ 1.3 simplifying simple linear expressions excluding brackets 1.4 evaluating simple linear expressions by substitution 1.5 solving simple linear equations involving whole number coefficient only in simple context	Students should have opportunities to: (a) solve simple equations where the unknown is represented by a box, e.g. $\square + 4 = 10$, $17 - \square = 5$, $6 \times \square = 18$, $\square \div 4 = 8$. (b) use concrete objects (e.g. cubes) or draw diagrams to model simple algebraic expressions. (c) form and solve simple linear equations in word problems and make explicit link with model drawing e.g. There are 50 children in a dance group. If there are 10 more boys than girls, how many girls are there? <div style="text-align: center;">  </div>

Content	Learning Experiences
	$2\chi = 50 - 10$ $= 40$ $\chi = 40 \div 2$ $= 20$ <p>There are 20 girls.</p>
MEASUREMENT AND GEOMETRY	
SUB-STRAND: AREA AND VOLUME	
1. Area and Circumference of Circle	Students should have opportunities to:
<p>1.1 area and circumference of circle</p> <p>1.2 finding the area and perimeter of</p> <ul style="list-style-type: none"> • semicircle • quarter circle <p>1.3 finding the area and perimeter of composite figures made up of square, rectangle, triangle, semicircle and quarter circle</p>	<p>(a) describe circles using terms such as 'centre', 'diameter', 'radius' and 'circumference'.</p> <p>(b) work in pairs to measure and recognise that</p> <ul style="list-style-type: none"> - the distance between the centre and any point on the circumference is always the same. - the bigger the circle, the longer the diameter. - the diameter of a circle is twice its radius. <p>(c) work in groups to measure the circumferences and diameters of different circles, use calculator to work out the value of π $\left(= \frac{\text{circumference}}{\text{diameter}} \right)$ and observe that the value is approximately 3.14 or $\frac{22}{7}$.</p> <p>(d) work in groups to measure and discover that the distance travelled by a circle/wheel along a straight line when it makes one complete turn without skipping is equal to its circumference.</p> <p>(e) estimate the area of a circle using square grid.</p> <p>(f) work in groups to cut a circle into 24 pieces and use the pieces to form a rectangle as shown (one of the pieces has to be cut further into halves) to find the area of the circle.</p>

Content	Learning Experiences
	<p style="text-align: center;">Area of the circle = $\pi \times \text{Radius} \times \text{Radius}$</p>  <p>(g) make connections between the area of a circle of radius r and the area of a square of length r</p>  <p>e.g.</p> <ul style="list-style-type: none"> • Area of circle is less than 4 squares ($4 r^2$) • Area of circle is more than 2 squares ($2 r^2$) • Area of circle is about $3 r^2$
<p>2. Volume of Cube and Cuboid</p> <p>2.1 finding one dimension of a cuboid given its volume and the other dimensions</p> <p>2.2 finding the length of one edge of a cube given its volume</p> <p>2.3 finding the height of a cuboid given its volume and base area</p> <p>2.4 finding the area of a face of a cuboid given its volume and one dimension</p> <p>2.5 use of $\sqrt{\quad}$, $\sqrt[3]{\quad}$</p>	<p>Students should have opportunities to:</p> <p>(a) build cubes of different sizes using unit cubes (or connecting cubes) and commit to memory the volumes of the cubes.</p> <p>(b) build a cuboid using unit cubes and determine its height given its volume (total number of unit cubes) and base area (product of two dimensions).</p> <p>(c) use calculator to explore</p> <ul style="list-style-type: none"> - the square roots of numbers and relate them to the lengths of squares given their areas. - the cube roots of numbers and relate them to the edge lengths of cubes given their volumes.

Content	Learning Experiences
SUB-STRAND: GEOMETRY	
1. Special Quadrilaterals	Students should have opportunities to:
<p>1.1 finding unknown angles, without additional construction of lines, in composite geometric figures involving</p> <ul style="list-style-type: none"> • square • rectangle • triangle • parallelogram • rhombus • trapezium 	<p>(a) use the properties of triangles and special quadrilaterals to find unknown angles and explain how they obtain the answers.</p>
2. Nets	Students should have opportunities to:
<p>2.1 identifying and drawing 2D representations of</p> <ul style="list-style-type: none"> • cube • cuboid • cone • cylinder • prism • pyramid <p>2.2 identifying the nets of 3D solids</p> <ul style="list-style-type: none"> • cube • cuboid • prism • pyramid <p>2.3 identifying the solid which can be formed by a given net</p>	<p>(a) look for examples of prisms and pyramids in their environment and discuss the similarities and differences between them.</p> <p>(b) draw 3D objects that are in the shape of prisms or pyramids.</p> <p>(c) visualise and draw a net of a cube, and justify that it is a net of the cube by cutting it out and folding it to form the cube.</p> <p>(d) work in groups to make nets of 3D shapes using geoshapes (or polydrons).</p>

Content	Learning Experiences
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Pie Charts	Students should have the opportunities to:
1.1 reading and interpreting data from pie charts 1.2 solving 1-step problems using data from tables/graphs	(a) discuss examples of data presented in pie charts, and make connections between pie charts and other graphic representations of data. (b) use the concept of proportionality to interpret data presented in pie charts in terms of percentages or fractions. (c) construct a pie chart using a spreadsheet e.g. Excel. (d) use data to make informed decisions and predictions.

Content	Learning Experiences
PRIMARY FIVE (FOUNDATION)	
NUMBER AND ALGEBRA	
SUB-STRAND: WHOLE NUMBERS	
1. Numbers up to 10 million	Students should have opportunities to:
1.1 reading and writing numbers in numerals and in words 1.2 comparing and ordering numbers up to 100 000 1.3 rounding numbers to the nearest 10, 100 or 1000 1.4 patterns in number sequences 1.5 use of \approx	(a) extend the number system to millions, and read and write large numbers in millions and thousands up to 10 million. (b) develop a sense of the size of 1 million by: <ul style="list-style-type: none"> - discussing examples of numbers in millions up to 10 million e.g. population of Singapore, price of a property. - searching for examples of 1 million from the internet. - estimating the size of an indoor stadium that will have a capacity of 1 million spectators as compared to the Singapore Indoor Stadium. (c) use number discs/place-value cards to compare numbers digit by digit from left to right, and use language such as 'greater than', 'greatest', 'smaller than', 'smallest' and 'the same as' to describe the comparison. (d) use number discs or digital manipulatives to represent a number that is 10, 100 or 1000 more than/less than a 5-digit number. (e) place a given number on a number line between two consecutive tens/hundreds, and determine which ten/hundred is nearer to the given number.
2. Four Operations	Students should have opportunities to:
2.1 addition and subtraction algorithms (up to 3 digits) without calculator 2.2 multiplication and division algorithms (up to 2 digits by 1 digit) without calculator 2.3 multiplying and dividing by 10, 100, 1000 and their multiples without calculator 2.4 order of operations 2.5 use of brackets 2.6 solving up to 3-step word problems involving the 4 operations	(a) work in groups using number discs/play money to illustrate the standard algorithms for <ul style="list-style-type: none"> - addition and subtraction up to 3 digits by playing games including applets and digital games. - multiplication and division up to 2 digits by 1 digit. - multiplication and division of a whole number by 10/100/1000, e.g. the result of multiplying 6 hundreds 2 tens 3 ones (623) by 10 is 6 thousands 2 hundreds 3 tens (6230). (b) divide a number of concrete objects into equal groups to discover that sometimes there are objects left over as remainder and write the answer as quotient and remainder. (c) discover the rules for the order of the 4 operations with a scientific calculator and explain why the rules are necessary.

Content	Learning Experiences
2.7 mental calculation involving <ul style="list-style-type: none"> • addition and subtraction of a 3-digit number and ones/tens/hundreds • multiplication and division within the multiplication tables 	(d) use the part-whole and comparison models to represent and solve word problems involving the 4 operations. (e) achieve mastery of multiplication and division facts by: <ul style="list-style-type: none"> - using multiplication-fact cards, division-fact cards. - playing games including applets and digital games. - writing a family of 4 basic facts within the multiplication tables given any one of the basic facts (e.g. $8 \times 4 = 32$, $4 \times 8 = 32$, $32 \div 4 = 8$ and $32 \div 8 = 4$ are a family of multiplication and division facts). (f) estimate the answer before doing the calculation and check the reasonableness of the calculated answer by comparing it with the estimated answer.
3. Factors and Multiples	Students should have opportunities to:
3.1 factors, multiples and their relationship 3.2 determining if a 1-digit number is a factor of a given number within 100 3.3 finding the common factors of two given numbers 3.4 determining if a number is a multiple of a given 1-digit number 3.5 finding the common multiples of two given 1-digit numbers	(a) relate the concepts of factor and multiple to multiplication and division. (b) work in groups to express a given number within 100 as a product of two factors and share the different ways of writing the products e.g. $36 = 9 \times 4$ and $36 = 3 \times 12$. (c) make a list of the first 12 multiples of a given 1-digit number and use this method to identify the common multiples of two given 1-digit numbers. (d) make connections between the concept of common factor and simplifying a fraction, and between the concept of common multiple and finding a common denominator for two fractions.
SUB-STRAND: FRACTIONS	
1. Concepts of Fractions	Students should have opportunities to:
1.1 fraction as part of a whole 1.2 fraction as part of a set of objects	(a) give examples of fractions in everyday situations and use language such as '2 out of 3' to describe fractions. (b) use concrete objects, fraction discs and pictorial representations to represent and interpret fractions in terms of unit fractions e.g. $\frac{3}{5}$ is 3 units of $\frac{1}{5}$, $\frac{1}{5} + \frac{1}{5} + \frac{1}{5}$, or 3 fifths, and to compare the sizes of fractions referring to the same whole. (c) divide a given set of concrete objects into equal parts and use this to <ul style="list-style-type: none"> - illustrate the concept of fraction of a set (e.g. when a set of objects is divided into 3 equal parts, '$\frac{2}{3}$ of the set' is 2 out of the 3 equal parts).

Content	Learning Experiences
	<p>- find a fraction of a set by adding up the objects in the parts (e.g. when a set of 24 objects are divided into 4 equal parts, $\frac{3}{4}$ of the set' is $6 + 6 + 6$ or $3 \times 6 = 18$ objects).</p> <p>(d) achieve mastery of fraction recognition by playing games using fraction cards (pictures and symbols), including applets and digital games.</p>
2. Equivalent Fractions	Students should have opportunities to:
<p>2.1 equivalent fractions 2.2 expressing a fraction in its simplest form 2.3 comparing and ordering unlike fractions, with denominators of given fractions not exceeding 12 2.4 writing the equivalent fraction of a fraction given the denominator or the numerator</p>	<p>(a) discuss examples of fractions in everyday situations. (b) represent fractions as numbers on a number line. (c) use fraction discs or the part-whole model to represent two equivalent fractions, and explain why they are equal and how one can be obtained from the other, e.g. $\frac{2}{3} = \frac{4}{6}$. (d) make a list of the first 8 equivalent fractions of a given fraction and use this method to compare two unlike fractions. (e) work in groups to compare fractions using different strategies such as drawing a diagram, comparing fractions with respect to half, and explain the strategies used. (f) identify fractions that are not in simplest form and reduce the fractions to their simplest form. (g) achieve mastery of equivalent fractions and fraction comparison by playing games using fraction cards (pictures and symbols) including digital games.</p>
3. Mixed Numbers and Improper Fractions	Students should have opportunities to:
<p>3.1 mixed numbers and improper fractions and their relationships</p>	<p>(a) give examples of fractions greater than one whole in everyday situations. (b) use fraction discs/number line to represent and interpret fractions greater than one whole as improper fractions and mixed numbers. (c) compare two fractions using fraction discs, and then without using fraction discs by changing to common denominators. (d) achieve mastery of conversion between mixed numbers and improper fractions by playing games using fraction cards (pictures and symbols) including digital games.</p>
4. Four Operations	Students should have opportunities to:
<p>4.1 adding and subtracting fractions with denominators of given fractions not exceeding 12 and not more than two different denominators without calculator</p>	<p>(a) use fraction discs to illustrate addition and subtraction of fractions with answer greater than one whole, and express the answer as a mixed number or improper fraction. (b) use fraction discs to illustrate addition and subtraction of mixed numbers which involve adding/subtracting the whole-number parts, followed by adding/subtracting the fractional parts.</p>

Content	Learning Experiences
4.2 adding and subtracting mixed numbers 4.3 multiplying a proper/improper fraction and a whole number without calculator 4.4 multiplying a proper fraction and a proper/improper fraction without calculator 4.5 solving up to 2-step word problems involving addition, subtraction and multiplication	(c) relate multiplication of whole number and fraction to finding the number of objects in a fraction of a set e.g. $\frac{3}{4} \times 60 = \frac{3}{4}$ of 60. (d) discuss the advantages of doing 'cancellation' before multiplying out the fractions. (e) solve problems using the part-whole and comparison models. (f) work in groups to solve 2-step word problems.
SUB-STRAND: DECIMALS	
1. Decimals up to 3 decimal places	Students should have opportunities to:
1.1 notation, representations and place values (tenths, hundredths, thousandths) 1.2 comparing and ordering decimals 1.3 converting decimals to fractions 1.4 converting fractions to decimals when the denominator is a factor of 10 or 100 1.5 rounding decimals to <ul style="list-style-type: none"> • the nearest whole number • 1 decimal place • 2 decimal places 	(a) look for decimals in everyday situations, e.g. advertisement from newspapers and magazines. (b) record length/mass/volume of liquid in decimal notation e.g. 5 m 26 cm is 5.26 m, and identify the whole-number parts, tenths and hundredths in the decimal. (c) recognise that a decimal is made up of a whole-number part and a fractional part, represent the decimal on a number line, and make connections between decimals, fractions and measurement. (d) use number discs to extend the place-value concept of whole numbers to decimals. (e) count in tenths/hundredths using number discs from 0.1 to 1.2, or from 0.01 to 0.12 e.g. 11 tenths is 1.1. (f) write whole numbers and decimals in 3 digits (or 4 digits), arrange these numbers in increasing/decreasing order and explain how it is done. (g) use number discs to represent a number that is 0.1, 0.01, 0.001 more than/less than a given number. (h) create, describe and continue number sequences such as 0.4, 0.8, 1.2, 1.6... (i) compare decimals using number line. (j) compare two decimals by first comparing the whole-number parts, and then compare the tenths, hundredths, thousandths in that order. (k) represent equivalent decimals such as 0.2, 0.20, 0.200 and explain that they are the same number. (l) divide a whole number by a 1-digit whole number and write the answer as a decimal instead of as quotient and remainder. (m) place a given decimal on a number line between two consecutive whole numbers/tenths/hundredths, and determine which whole number/tenth/hundredth is nearer to the given decimal.

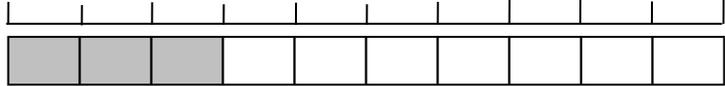
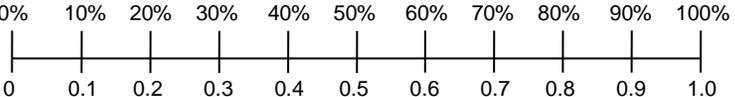
Content	Learning Experiences
<p>2. Four operations</p> <p>2.1 adding and subtracting decimals (up to 2 decimal places) without calculator</p> <p>2.2 multiplying and dividing decimals (up to 3 decimal places) by 10,100,1000 without calculator</p> <p>2.3 a measurement from a smaller unit to a larger unit in decimal form, and vice versa</p> <ul style="list-style-type: none"> • kilometres and metres • metres and centimetres • kilograms and grams • litres and millilitres <p>2.4 solving up to 2-step word problems involving addition and subtraction</p>	<p>Students should have opportunities to:</p> <p>(a) use number discs or digital manipulatives to illustrate the addition and subtraction algorithms and make connections between the algorithms for decimals and for whole numbers.</p> <p>(b) use number discs to illustrate multiplication and division of a decimal by 10/100/1000 e.g. the result of multiplying 6 ones 2 tenths 3 hundredths (6.23) by 10 is 6 tens 2 ones 3 tenths (62.3), and relate the process to multiplication and division of a whole number by 10/100/1000.</p> <p>(c) collect and talk about real-life examples of the uses of different units of measure e.g. specifications of furniture in a manual, weighing scales, height of a mountain in metres (m), car capacity in cubic centimetres (cm³ or cc).</p> <p>(d) measure and compare amounts of liquid using measuring cylinders (ℓ) and beakers (ml) to determine the equivalence between measurements, e.g. 0.2 ℓ = 200 ml.</p> <p>(e) use a linear scale to show the relationship between larger and smaller units of measurement.</p> <p>(f) work in pairs to convert between larger and smaller units through games or quizzes.</p> <p>(g) work in groups on problems involving decimals in everyday situations such as shopping receipts, food prices in school canteen, and budgeting.</p> <p>(h) estimate the answer before doing the calculation and check the reasonableness of the calculated answer by comparing it with the estimated answer.</p>
SUB-STRAND: RATE AND SPEED	
<p>1. Rate</p> <p>1.1 rate as the amount of a quantity per unit of another quantity</p> <p>1.2 finding rate, total amount or number of units given the other two quantities</p> <p>1.3 solving up to 3-step word problems involving rate</p>	<p>Students should have opportunities to:</p> <p>(a) talk about examples of rate in everyday situations such as postage rates and utility rates (water and electricity consumption rates).</p> <p>(b) talk about a situation involving rate and recognise that there are three related quantities (rate, total amount, number of units) and given any two quantities, the third quantity can be calculated.</p> <p>(c) solve problems using proportional reasoning.</p>

MEASUREMENT AND GEOMETRY	
SUB-STRAND: MEASUREMENT	
1. Time	Students should have opportunities to:
1.1 measuring time in hours and minutes 1.2 converting time in hours and minutes to minutes only, and vice versa 1.3 finding the starting time, finishing time or duration given the other two quantities 1.4 24-hour clock 1.5 solving problems involving time in 24-hour clock	(a) practise telling and writing time using everyday examples such as TV programmes, bus schedules, MRT operating hours and exam timetables. (b) represent given information such as starting time, finishing time and duration of activity on a timeline, and use it to solve problems. (c) read and write time in 24-hour clock from flight schedules or train schedules, and give reasons why 24-hour clock is used instead of 12-hour clock. (d) describe everyday events using 24-hour clock, including starting time, finishing time and duration. (e) represent given information such as starting time, finishing time and duration of activity on a timeline and use it to solve problems.
SUB-STRAND: AREA AND VOLUME	
1. Area and Perimeter	Students should have opportunities to:
1.1 concept of area and perimeter of a plane figure 1.2 measuring area in square units, cm^2 and m^2 , excluding conversion between cm^2 and m^2 1.3 area and perimeter of rectangle/square 1.4 finding one dimension of a rectangle given the other dimension and its area/perimeter 1.5 finding the length of one side of a square given its area/perimeter 1.6 finding the area and perimeter of composite figures made up of rectangles and squares	(a) discuss the use of appropriate units of measurement (length, area and perimeter). (b) use real-life examples to explain the concepts of area and perimeter, and compare the sizes of rectangles/squares using area. (c) work in pairs to find the area of rectangles and squares drawn on square grid by counting and by formula. (d) work in groups to make different rectangles and squares using square tiles, study the relationship between the area/perimeter and length(s) of each side, and observe that shapes with same area can have different perimeters, and shapes with same perimeter can have different areas. (e) estimate the area of a figure drawn on square grid by counting whole and partial squares within the figure. (f) apply multiplication and division concepts to find one dimension of a rectangle given its area/perimeter and the other dimension. (g) use square tiles to build squares of different sizes, from 1 cm^2 to 100 cm^2 , and commit to memory the areas of the squares. (h) make a composite figure using cutouts of rectangles and squares or draw the figure on square grid, and calculate its area and perimeter. (i) visualise how a L-shaped figure can be partitioned into rectangles and squares, or can be formed by removing a rectangle/square from a bigger rectangle/square, and calculate the area and perimeter from given lengths.

Content	Learning Experiences
2. Volume of Cube and Cuboid	Students should have opportunities to:
2.1 building solids with unit cubes 2.2 measuring volume in cubic units, cm^3 and m^3 excluding conversion between cm^3 and m^3 2.3 drawing cubes and cuboids on isometric grid	(a) use unit cubes (or connecting cubes) to build different solids (3D figures) and express their volumes in cubic units. (b) compare the sizes of solids in terms of their volumes. (c) make connections between 1 cm^2 and 1 cm^3 , and between 1 m^2 and 1 m^3 e.g. use newspaper and masking tape to make a square of area 1 m^2 and a cube of volume 1 m^3 . (d) work in groups to draw a cube or cuboid taking into consideration size and orientation.
SUB-STRAND: GEOMETRY	
1. Perpendicular and Parallel Lines	Students should have opportunities to:
1.1 perpendicular and parallel lines 1.2 draw perpendicular and parallel lines on square grid	(a) recognise the relationship between two straight lines on a plane that are perpendicular/parallel and give examples of perpendicular/parallel lines from 2D figures and the environment. (b) identify horizontal and vertical lines and explain how to determine if a line is horizontal/vertical e.g. a line is vertical when it is parallel to a plumb line. (c) recognise that two vertical lines are parallel, and that a horizontal line and a vertical line are perpendicular. (d) work in pairs to explore how to construct perpendicular and parallel lines using set squares and protractor, and to check whether two given straight lines are perpendicular or parallel (e) work in pairs to explore how different pairs of perpendicular and parallel lines can be drawn on square grid.
2. Angles	Students should have opportunities to:
2.1 using notation such as $\sphericalangle ABC$ and $\sphericalangle a$ to name angles 2.2 measuring angles in degrees 2.3 drawing an angle of a given size 2.4 angles on a straight line 2.5 angles at a point 2.6 vertically opposite angles 2.7 finding unknown angles	(a) estimate before measuring angles using a protractor. (b) draw angles using a protractor. (c) describe and illustrate the various angle properties. (d) look for examples of different types of angles in the environment. (e) use the angle properties to find unknown angles and explain how they obtain the answers.

Content	Learning Experiences
3. Rectangle and Square	Students should have opportunities to:
3.1 properties of rectangle and square, excluding diagonal properties 3.2 drawing rectangle and square on square grid	(a) describe the properties of rectangles and squares in terms of perpendicular and parallel lines, e.g. two pairs of parallel sides, and discuss how rectangles and squares are related, e.g. a square is a special rectangle. (b) work in pairs to explore how to draw different squares and rectangles on square grid. (c) observe the different orientations of a rectangle (or a square) when it is rotated through 90° (quarter turn), 180° (half turn), 270° (three-quarter turn) and 360° (a complete turn), clockwise or anti-clockwise. (d) sketch and draw rectangles and squares according to given length(s) using ruler, protractor and set squares.
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Tables, Bar Graphs and Line Graphs	Students should have opportunities to:
1.1 reading and interpreting data from tables/graphs 1.2 completing a table from given data 1.3 solving 1-step problems using data from tables/graphs	(a) work in groups to discuss how to collect data e.g. through interview or survey, and how to represent the data in a table/bar graph. (b) relate the data represented in a table to the corresponding bar graph and explain why the data is presented in a graph instead of a table. (c) discuss examples of data presented in bar graphs found in newspapers and magazines, and how the data was collected and displayed in graphical form. (d) construct a bar graph/line graph using a spreadsheet, e.g. Excel, and make connections between bar and line graphs, and explain which type of graph should be used or both can be used. (e) discuss examples of inappropriate representations of data from newspapers e.g. whether certain representations are misleading.

Content	Learning Experiences
PRIMARY SIX (FOUNDATION)	
NUMBER AND ALGEBRA	
SUB-STRAND: FRACTIONS	
1. Fraction and Division	Students should have opportunities to:
1.1 dividing a whole number by a whole number with quotient as a fraction 1.2 converting fractions to decimals	(a) divide a whole number by a 1-digit whole number and write the answer as a fraction, instead of as quotient and remainder, or as a decimal. (b) explain how fraction and division are related e.g. $\frac{3}{5}$ is 3 divided by 5; when 3 pies are shared equally among 5 children, each child gets $\frac{3}{5}$ of a pie. (c) use the part-whole model to illustrate the concepts of fraction and division, and their relationship e.g. draw a model to show $12 \div 3$ as a whole divided into 3 equal parts which is also $\frac{1}{3}$ of 12. (d) work in groups to discuss the methods of converting fractions to decimals by division and by making the denominators into 10/100.
2. Four Operations	Students should have opportunities to:
2.1 dividing a proper fraction by a whole number 2.2 dividing a whole number/proper fraction by a proper fraction 2.3 solving up to 3-step word problems involving the 4 operations	(a) use fraction discs or digital manipulatives to illustrate the concepts of and algorithms for <ul style="list-style-type: none"> - division of a proper fraction by a whole number. - division of a whole number by a proper fraction. - division of a proper fraction by a proper fraction. (b) use calculator to do the 4 operations on fractions (including mixed numbers). (c) solve problems using the part-whole and comparison models.

Content	Learning Experiences
SUB-STRAND: DECIMALS	
1. Multiplication and Division	Students should have opportunities to:
1.1 multiplying and dividing decimals 1.2 dividing a whole number by a whole number with quotient as a decimal without calculator 1.3 rounding answers to a specified degree of accuracy 1.4 solving up to 3-step word problems involving the 4 operations (including problems involving money)	(a) use number discs or digital manipulatives to illustrate the multiplication and division algorithms. (b) estimate the product and quotient using multiplication and division within the multiplication tables and use the estimation to check the reasonableness of the calculated answer.
SUB-STRAND: PERCENTAGE	
1. Percentage	Students should have opportunities to:
1.1 expressing a part of a whole as a percentage 1.2 use of % 1.3 finding a percentage part of a whole 1.4 finding discount, GST and annual interest 1.5 solving up to 2-step word problems involving percentage	(a) look for examples where percentages are used in real life e.g. newspaper cuttings showing discounts, bank brochures showing interest rates, and discuss their usage. (b) discuss different ways of expressing a part of a whole e.g. the number of squares shaded to show 30% on 100-square and 200-square grids. (c) use a percentage scale to illustrate the part-whole concept of percentage, and to show the relationship between percentage and fraction, e.g. $30\% = \frac{3}{10}$, <div style="text-align: center;">  </div> (d) use a linear scale to show the relationship between percentage and decimal <div style="text-align: center;">  </div> (e) play card games/online games involving equivalent fractions, decimals and percentages, e.g. 20% is equivalent to $\frac{1}{5}$ or 0.2. (f) use the part-whole model to represent and solve percentage problems.

Content	Learning Experiences
	(g) collect receipts that show discounts, GST, service charges etc., and use calculator to check how these values are calculated. (h) work in groups to plan a shopping list with a given budget using newspaper advertisements and promotion pamphlets.
MEASUREMENT AND GEOMETRY	
SUB-STRAND: AREA AND VOLUME	
1. Area of Triangle	Students should have opportunities to:
1.1 concepts of base and height of a triangle 1.2 area of triangle 1.3 finding the area and perimeter of composite figures made up of squares, rectangles and triangles	(a) associate the base and height of a triangle with the length and breadth of its related rectangle, and recognise the relationship between the area of the triangle and its related rectangle. (b) draw different triangles on square grid and identify the height of a triangle corresponding to a given base. (c) work in groups to determine the basic shapes (rectangle, square and triangle) that make up a composite figure, or use basic shape cutouts to form different composite figures.
2. Volume of cube and cuboid	Students should have opportunities to:
2.1 volume of a cube/cuboid 2.2 finding the volume of liquid in a rectangular tank excluding conversion between cm^3 and m^3 2.3 relationship between ℓ (or ml) with cm^3	(a) build cube and cuboids layer by layer using unit cubes (or connecting cubes) to establish the formula for the volume of a cube/cuboid. (b) build cubes of $1 \times 1 \times 1$, $2 \times 2 \times 2$, $3 \times 3 \times 3$, ... using unit cubes (or connecting cubes) and find the volumes of the cubes by counting and by formula. (c) pour 1 litre of water into a container measuring $10 \text{ cm} \times 10 \text{ cm} \times 10 \text{ cm}$ to establish the equivalence of 1 litre (1000 ml) and 1000 cm^3 .
SUB-STRAND: GEOMETRY	
1. Rectangle, square and triangle	Students should have opportunities to:
1.1 properties of <ul style="list-style-type: none"> • isosceles triangle • equilateral triangle • right-angled triangle 1.2 angle sum of a triangle	(a) sort a set of different triangles into groups by their angles/lengths, and explain how it is done and use terms such as 'acute-angled triangle', 'obtuse-angled triangle', 'right-angled triangle', 'isosceles triangle' and 'equilateral triangle' to describe the triangles. (b) look for the various types of triangles in the environment. (c) investigate and discover that the angle sum of any triangle is 180° using triangle cutouts or ICT applets. (d) identify and justify the angle properties of triangles, e.g. fold an isosceles triangle cutout to show that the base angles are equal.

Content	Learning Experiences
1.3 finding unknown angles, without additional construction of lines, in composite geometric figures involving <ul style="list-style-type: none"> • square • rectangle • triangle 	(e) draw special triangles on square grid. (f) use the angle properties of triangles to find unknown angles and explain how they obtain the answers. (g) use the properties of square, rectangle and triangle to find unknown angles and explain how they obtain the answers. (h) sketch and draw different triangles according to given angles and lengths using ruler, protractor and set squares.
STATISTICS	
SUB-STRAND: DATA REPRESENTATION AND INTERPRETATION	
1. Pie Charts	Students should have the opportunities to:
1.1 reading and interpreting data from pie charts 1.2 solving 1-step problems using data from tables/graphs	(a) discuss examples of data presented in pie charts, and make connections between pie charts and other graphic representations of data. (b) use the concept of proportionality to interpret data presented in pie charts in terms of percentages or fractions. (c) construct a pie chart using a spreadsheet e.g. Excel.
SUB-STRAND: DATA ANALYSIS	
1. Average of a set of data	Students should have opportunities to:
1.1 average as 'total value \div number of data' 1.2 relationship between average, total value and number of data 1.3 solving up to 2-step problems involving average	(a) discuss the meaning of average in real-life situations such as average height, average load in a lift, average temperature in a day or month. (b) recognise that there are three related quantities in a set of data (average, total value and number of data) and given any two quantities, the third quantity can be calculated.