KEMENTERIAN
PENDIDIKAN
MALAYSIA

KURIKULUM STANDARD SEKOLAH MENENGAH

Matematik

Dokumen Standard Kurikulum dan Pentaksiran

Tingkatan 4 dan 5

(EDISI BAHASA INGGERIS)

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Bahagian Pembangunan Kurikulum
MEI 2019

Terbitan 2019

CONTENT

RUKUN NEGARA

BAHAWASANYA Negara kita Malaysia mendukung cita-cita hendak:
Mencapai perpaduan yang lebih erat dalam kalangan seluruh masyarakatnya;
Memelihara satu cara hidup demokratik;
Mencipta satu masyarakat yang adil di mana kemakmuran negara
akan dapat dinikmati bersama secara adil dan saksama;
Menjamin satu cara yang liberal terhadap tradisi-tradisi
kebudayaannya yang kaya dan berbagai corak;
Membina satu masyarakat progresif yang akan menggunakan
sains dan teknologi moden;

MAKA KAMI, rakyat Malaysia, berikrar akan menumpukan seluruh tenaga dan usaha kami untuk mencapai cita-cita tersebut berdasarkan atas prinsip-prinsip yang berikut:

KEPERCAYAAN KEPADA TUHAN
KESETIAAN KEPADA RAJA DAN NEGARA
KELUHURAN PERLEMBAGAAN
KEDAULATAN UNDANG-UNDANG
KESOPANAN DAN KESUSILAAN

FALSAFAH PENDIDIKAN KEBANGSAAN

“Pendidikan di Malaysia adalah suatu usaha berterusan ke arah lebih memperkembangkan potensi individu secara menyeluruh dan bersepadu untuk melahirkan insan yang seimbang dan harmonis dari segi intelek, rohani, emosi dan jasmani, berdasarkan kepercayaan dan kepatuhan kepada Tuhan. Usaha ini adalah bertujuan untuk melahirkan warganegara Malaysia yang berilmu pengetahuan, berketerampilan, berakhlak mulia, bertanggungjawab dan berkeupayaan mencapai kesejahteraan diri serta memberikan sumbangan terhadap keharmonian dan kemakmuran keluarga, masyarakat dan negara”

Sumber: Akta Pendidikan 1996 (Akta 550)

DEFINISI KURIKULUM KEBANGSAAN

3. Kurikulum Kebangsaan

(1) Kurikulum Kebangsaan ialah suatu program pendidikan yang termasuk kurikulum dan kegiatan kokurikulum yang merangkumi semua pengetahuan, kemahiran, norma, nilai, unsur kebudayaan dan kepercayaan untuk membantu perkembangan seseorang murid dengan sepenuhnya dari segi jasmani, rohani, mental dan emosi serta untuk menanam dan mempertingkatkan nilai moral yang diingini dan untuk menyampaikan pengetahuan.

Sumber: Peraturan-Peraturan Pendidikan (Kurikulum Kebangsaan) 1997 [PU(A)531/97.]

KATA PENGANTAR

Kurikulum Standard Sekolah Menengah (KSSM) yang dilaksanakan secara berperingkat mulai tahun 2017 akan menggantikan Kurikulum Bersepadu Sekolah Menengah (KBSM) yang mula dilaksanakan pada tahun 1989. KSSM digubal bagi memenuhi keperluan dasar baharu di bawah Pelan Pembangunan Pendidikan Malaysia (PPPM) 2013-2025 agar kualiti kurikulum yang dilaksanakan di sekolah menengah setanding dengan standard antarabangsa. Kurikulum berasaskan standard yang menjadi amalan antarabangsa telah dijelmakan dalam KSSM menerusi penggubalan Dokumen Standard Kurikulum dan Pentaksiran (DSKP) untuk semua mata pelajaran yang mengandungi Standard Kandungan, Standard Pembelajaran dan Standard Prestasi.

Usaha memasukkan standard pentaksiran dalam dokumen kurikulum telah mengubah lanskap sejarah sejak Kurikulum Kebangsaan dilaksanakan di bawah Sistem Pendidikan Kebangsaan. Menerusinya murid dapat ditaksir secara berterusan untuk mengenal pasti tahap penguasaannya dalam sesuatu mata pelajaran, serta membolehkan guru membuat tindakan susulan bagi mempertingkatkan pencapaian murid.

DSKP yang dihasilkan juga telah menyepadukan enam tunjang Kerangka KSSM, mengintegrasikan pengetahuan, kemahiran dan nilai, serta memasukkan secara eksplisit Kemahiran Abad Ke-21 dan Kemahiran Berfikir Aras Tinggi (KBAT). Penyepaduan tersebut dilakukan untuk melahirkan insan seimbang dan harmonis dari segi intelek, rohani, emosi dan jasmani sebagaimana tuntutan Falsafah Pendidikan Kebangsaan.

Bagi menjayakan pelaksanaan KSSM, pengajaran dan pembelajaran guru perlu memberi penekanan kepada KBAT dengan memberi fokus kepada pendekatan Pembelajaran Berasaskan Inkuiri dan Pembelajaran Berasaskan Projek, supaya murid dapat menguasai kemahiran yang diperlukan dalam abad ke-21.

Kementerian Pendidikan Malaysia merakamkan setinggi-tinggi penghargaan dan ucapan terima kasih kepada semua pihak yang terlibat dalam penggubalan KSSM. Semoga pelaksanaan KSSM akan mencapai hasrat dan matlamat Sistem Pendidikan Kebangsaan.

Dr. MOHAMED BIN ABU BAKAR
Timbalan Pengarah
Bahagian Pembangunan Kurikulum
Kementerian Pendidikan Malaysia

INTRODUCTION

KSSM Mathematics is a core subject that is learned by all pupils under the National Education System. In Malaysia, each pupil gets the opportunity to go through at least six years of basic education in primary school and five years in secondary school. Mathematics programme at secondary school level is divided into three programmes: Mathematics at lower secondary, Mathematics at upper secondary and Additional Mathematics at upper secondary.

The secondary school Mathematics content is essentially a continuation of knowledge and skills learnt at the primary school level. Secondary school Mathematics aims, among others, to develop the knowledge and skills of the people to enable them to solve problems in their daily lives, further their studies to a higher level and thus function as an effective workforce.

The restructring of KSSM Mathematics takes into consideration the continuity from primary to secondary school and onto a higher level. In addition, the benchmarking of Mathematics curriculum in Malaysia has been carried out against high performing countries in the international assessments. This measure is to ensure that Mathematics curriculum in Malaysia is relevant and at par with other countries.

In order to develop individual's potential, intellectual proficiency and human capital, Mathematics is the best medium because of its nature that encourages logical and systematic thinking. Thus, the development of the Mathematics curriculum takes into consideration the needs of developing the country, and factors that contribute to the development of individuals who can think logically, critically, analytically, creatively and innovatively. This is consistent with the need to provide adequate mathematical knowledge and skills to ensure that this country is able to compete internationally and meet the challenges of the 21st century. The different backgrounds and abilities of the pupils are given special attention in determining the knowledge and skills learned in the programme.

AIMS

KSSM Mathematics aims to produce individuals who are mathematically *fikrah*, which means individuals who can think mathematically, creative and innovative as well as competent in applying mathematical knowledge and skills effectively and responsibly to solve problems and make decisions, based on the attitudes and values so that they are able to deal with challenges in their daily lives, in line with the development of science and technology as well as the challenges of the 21st century.

OBJECTIVES

The Form 4 and 5 KSSM Mathematics enables pupils to achieve the following objectives:

1. Develop an understanding of the concepts, laws, principles and theorems related to Number and Operations, Measurement and Geometry, Relationship and Algebra, Statistics and Probability, and Discrete Mathematics.
2. Develop capacity in:
   - formulating situations into mathematical forms.
   - using concepts, facts, procedures and reasoning.
   - interpreting, applying and evaluating mathematical outcomes.
3. Apply the knowledge and skills of mathematics in making reasonable judgments and decisions to solve problems in a variety of contexts.
4. Enhance mathematical skills related to Number and Operations, Measurement and Geometry, Relationship and Algebra, Statistics and Probability, and Discrete Mathematics such as:
   - collecting and handling data.
   - representing and interpreting data.
   - recognising relationship and representing them mathematically.
   - using algorithms and relationship.
   - making estimation and approximation.
   - measuring and constructing.
5. Practise consistently the mathematical process skills which are problem solving, reasoning, mathematical communication, making connection and representation.

6. Cultivate the use of mathematical knowledge and skills in making reasonable judgments and decisions effectively and responsibly in real-life situations.
7. Realise that mathematical ideas are inter-related, comprehensive and integrated body of knowledge, and are able to relate mathematics with other disciplines of knowledge.
8. Use technology in concept building, mastery of skills, investigating and exploring mathematical ideas and solving problems.
9. Foster and practise moral values, positive attitudes towards mathematics and appreciate the importance and the beauty of mathematics.
10. Develop higher-order, critical, creative and innovative thinking.
11. Practise and further develop generic skills to face challenges of the 21st century.

THE FRAMEWORK OF SECONDARY SCHOOL STANDARD-BASED CURRICULUM

KSSM is built on the basis of six fundamental pillars: Communication; Spiritual, Attitude and Values; Humanities; Personal Competence; Physical Development and Aesthetics; and Science and Technology. These six pillars are the main domain that supports one another and are integrated with critical, creative and innovative thinking. The integration aims to produce human capital who appreciates values based on spiritual practices, knowledge, personal competence, critical and creative thinking as well as innovative thinking as shown in Figure 1. The Mathematics curriculum is developed based on the six pillars of the KSSM Framework.

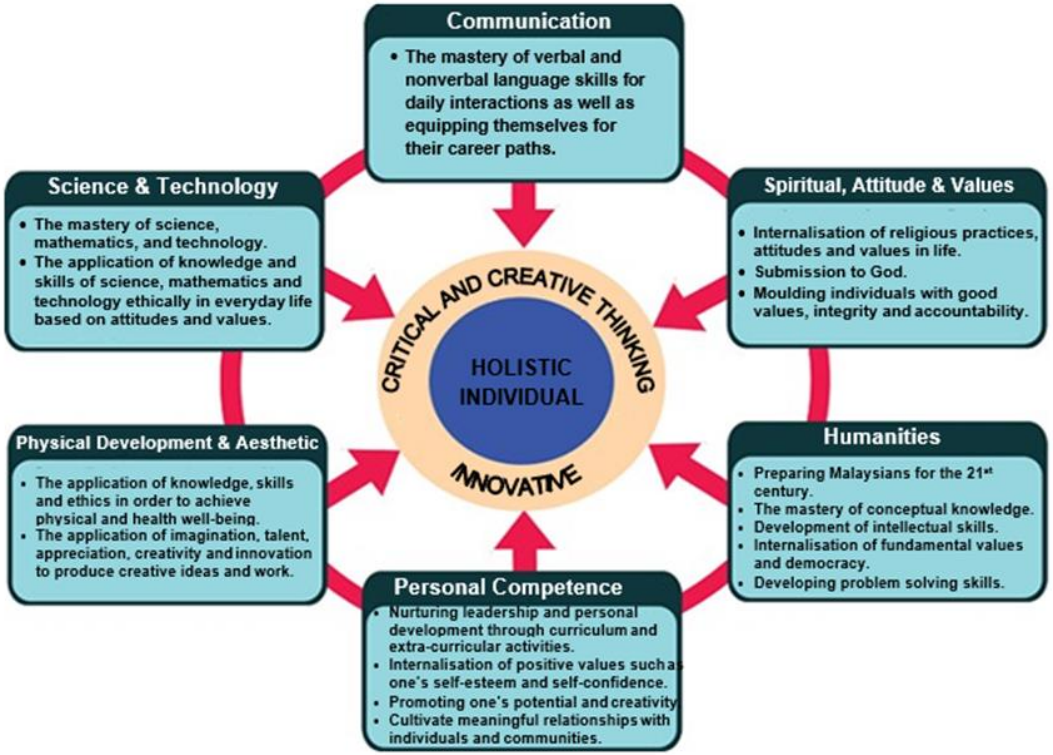


Figure 1: The Framework of Secondary School Standard-Based Curriculum

FOCUS

KSSM Mathematics focuses on developing individuals who internalise and practise mathematical *fikrah*. The Mathematics Curriculum Framework as illustrated in Figure 2, is fundamental to the implementation of the Mathematics curriculum in the classroom.

Four key elements that contribute to the development of individuals possessing mathematical *fikrah* are:

- Learning areas
- Values
- Skills
- Mathematical processes

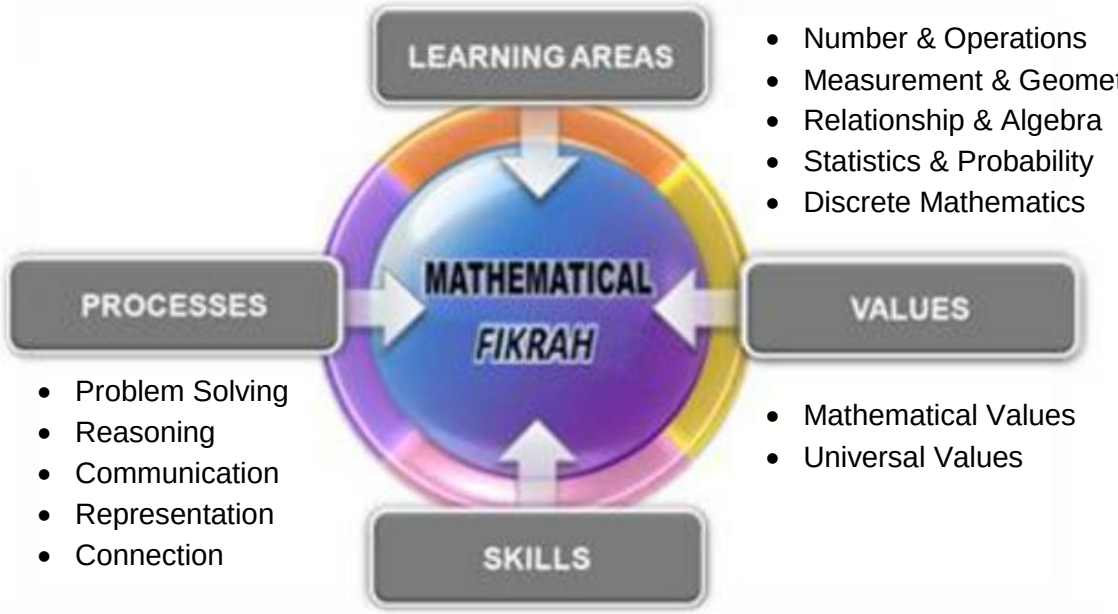


Figure 2: The Mathematics Curriculum Framework for Secondary Schools

Mathematical Fikrah

According to the Fourth Edition of Kamus Dewan (2005), *fikrah* means capability of thinking and thoughts. In the context of mathematics education, mathematical *fikrah* refers to the quality of pupils to be developed through the national mathematics education system. Pupils who acquire mathematical *fikrah* are capable of doing mathematics, understanding mathematical ideas, and applying the knowledge and skills of mathematics responsibly in daily life, guided by good attitudes and values.

Mathematical *fikrah* also intends to produce individuals who are creative, innovative and well-equipped to the needs of the 21st century, as the country is highly dependent on the ability of human capital to think and generate new ideas.

Learning Area

The content of Mathematics covers five main learning areas that are inter-related, namely:

- Number and Operations
- Measurement and Geometry
- Relationship and Algebra
- Statistics and Probability
- Discrete Mathematics

Mathematical Processes

Mathematical processes that support effective and thoughtful teaching and learning are:

- Problem solving;
- Reasoning;
- Mathematical communication;
- Representation; and
- Making connections.

All the five mathematical processes are inter-related and need to be implemented and integrated across the curriculum.

Problem solving is the heart of mathematics. Hence, problem-solving skills need to be developed comprehensively and integrated across the Mathematics curriculum. In accordance with the importance of problem solving, mathematical processes are the backbone of the teaching and learning (T&L) of mathematics and should be able to mould pupils who are capable of using a variety of problem-solving strategies, higher order thinking skills, creative and innovative. Teachers need to design T&L sessions which

focuses on problem solving. Activities carried out should engage pupils actively by posing a diversity of questions and tasks that contain both routine and non-routine questions. Solving problem involving non-routine questions basically needs thinking and reasoning at a higher level. These skills should be consistently cultivated by the teachers to produce pupils who are able to compete globally.

The following problem-solving steps should be emphasised so that pupils can solve problems systematically and effectively:

- Understanding and interpreting problems
- Devising a strategy
- Implementing the strategy
- Doing reflection

The application of various strategies in problem solving, including the steps involved, has to be used widely. Among the strategies commonly used are drawing diagrams, identifying patterns, making tables/charts or systematic lists, using algebra, trying simpler cases, reasoning out logically, using trial and improvement, making simulation, working backwards as well as using analogies.

The following are some of the processes that need to be emphasised through problem solving, that is the development of pupils' capacity in:

- Formulating mathematical situations involving various contexts such as personal, community, scientific and occupation.
- Using and applying concepts, facts, procedures and reasonings in solving problems.
- Interpreting, evaluating and reflecting on the solutions or decisions made and determine whether they are reasonable.

Reflection is an important step in problem solving. Reflection allows pupils to see, understand and appreciate perspectives of others from different angles as well as enables pupils to consolidate their understanding of the concepts learned.

Reasoning is an important basis for understanding mathematics more effectively and meaningfully. The development of mathematical reasoning is closely related to pupils' intellectual development and communication. Reasoning not only develops the capacity of logical thinking but also increases the capacity of critical thinking that is fundamental in understanding mathematics deeply and meaningfully. Therefore, teachers need to provide space and opportunity by designing T&L activities that require pupils to

do mathematics and be actively involved in discussing mathematical ideas.

The element of reasoning in T&L prevents pupil from assuming mathematics as just a set of procedures or algorithms that should be followed to obtain a solution without understanding the mathematical concepts in depth. Reasoning not only changes pupil's paradigm from emphasising on the importance of procedural knowledge but also gives mental and intellectual empowerment when pupils are guided and trained to make and validate conjectures, provide logical explanations, analyse, evaluate and justify the mathematical activities. Such training would build pupils' confidence and courage, in line with the aim of developing powerful mathematical thinkers.

Communication in mathematics is the process of expressing ideas and understanding in verbal, visual or written form using numbers, notations, symbols, diagrams, graphs, pictures or words. Communication is an important process in learning mathematics because mathematical communication helps pupils to clarify and reinforce their understanding of mathematics. Through communication, mathematical ideas can be better expressed and understood. Communication in mathematics, whether verbal, written form or using symbols and visual representations (charts, graphs, diagrams, etc), help pupils to understand and apply mathematics more effectively.

Teachers should be aware of the opportunities that exist during T&L sessions to encourage pupils to express and present their mathematical ideas by using appropriate questioning techniques. Communication that involves a variety of perspectives and points of view helps pupils to better improve their mathematical understanding whilst enhancing their self-confidence.

The significant aspect of mathematical communication is the ability to provide effective explanation as well as to understand and apply the correct mathematical notations. Pupils should use the mathematical language and symbols correctly to ensure that mathematical ideas can be explained precisely.

Effective communication requires an environment that is always sensitive to the needs of pupils so that they feel comfortable while speaking, asking and answering questions, explaining and justifying their views and statements to their classmates and teachers. Pupils should be given the opportunity to communicate actively in a variety of settings, for example while doing activities in pairs, groups or while giving explanation to the whole class.

Representation is an important component of mathematics and often used to represent real-world phenomena. Therefore, there must be a similarity between the aspects of the world that is being represented and the world that it is representing. Representation can be defined as any notations, letters, images or concrete objects that symbolise or represent something else.

At secondary school level, representing ideas and mathematical models generally make use of symbols, geometry, graphs, algebra, diagrams, concrete representations and dynamic software. Pupils must be able to change from one form of representation to another and recognise the relationship between them, and use various representations, which are relevant and required to solve problems.

The use of various representations helps pupils to understand mathematical concepts and relationships, communicate their thinking, reasoning and understanding; recognise the relationship between mathematical concepts and use mathematics to model situations, physical and social phenomena. When pupils are able to represent concepts in different ways, they will be flexible in their thinking and understand that there are variety of ways to represent mathematical ideas that enable problems to be solved easily.

Making connections between areas in mathematics such as counting, geometry, algebra, measurement and statistics is important for pupils to learn concepts and skills integratedly and meaningfully. By recognising how the concept or skills of different areas are related to each other, mathematics will be viewed and studied as a discipline that is comprehensive and connected to each other, thus allowing abstract concepts to be understood easily.

When mathematical ideas are connected to daily life experiences within and outside the classroom, pupils will be more aware of the use, the importance, the strength and the beauty of mathematics. Besides, they are also able to use mathematics contextually in other disciplines and in their daily lives. Mathematical models are used to describe real-life situations mathematically. Pupils will realise that this method can be used to solve problems or to predict the possibility of a situation based on the mathematical models.

In implementing the KSSM Mathematics, the opportunity to make connection should be established so that pupils can relate conceptual knowledge to procedural knowledge and be able to relate topics in Mathematics in particular and relate mathematics to

other fields in general. This will increase pupils' understanding of mathematics, making it clear, more meaningful and interesting.

Mathematical Process Standards

The following are the mathematical process standards to be achieved by pupils through the implementation of this curriculum.

Table 1: Mathematical Process Standards

PROBLEM SOLVING
• Understand the problems. • Extract relevant information in a given situation and organise information systematically. • Plan various strategies to solve problems. • Implement the strategies according to the plan. • Generate solutions to meet the requirements of the problem. • Interpret the solutions. • Review and reflect upon the solutions and strategies used.
REASONING
• Recognise reasoning and proving as fundamentals to mathematics. • Recognise patterns, structures, and similarities within real-life situations and symbolic representations. • Choose and use various types of reasoning and methods of proving. • Make, investigate and verify mathematical conjectures. • Develop and evaluate mathematical arguments and proofs. • Make decisions and justify the decisions made.
COMMUNICATION IN MATHEMATICS
• Organise and incorporate mathematical thinking through communication to clarify and strengthen the understanding of mathematics. • Communicate mathematical thoughts and ideas clearly and confidently. • Use the language of mathematics to express mathematical ideas precisely. • Analyse and evaluate the mathematical thinking and strategies of others.
REPRESENTATION
• Illustrate mathematical ideas using various types of representations. • Make interpretations from given representations. • Choose the appropriate types of representations. • Use various types of mathematical representations to: i) simplify complex mathematical ideas. ii) assist in problem solving. iii) develop models and interpret mathematical phenomena. iv) make connections between various types of representations.

CONNECTION
• Identify and use the connection between mathematical ideas. • Understand how mathematical ideas are inter-related and form a cohesive unity. • Relate mathematical ideas to daily life and other fields.

Skills in Mathematics Education

The skills that need to be developed and nurtured among pupils through this subject include Mathematical Skills, 21st Century Skills and Higher-Order Thinking Skills (HOTS).

The mathematical skills refer to among others the skills of measuring and constructing, estimating and rounding, collecting and handling data, representing and interpreting data, recognising relationships and representing mathematically, translating real-life situations into mathematical models, using precise language of mathematics, applying logical reasoning, using algorithms and relationships, using mathematical tools, solving problems, making decisions and others. In addition, the curriculum also demands the development of pupils' mathematical skills in aspect related to creativity, the needs for originality in their thinking and the ability to see things around them with new and different perspectives in order to develop creative and innovative individuals. The use of mathematical tools strategically, accurately and effectively is strongly emphasised in the teaching and learning of mathematics. The mathematical tools include papers and pencils, rulers, protractors, compasses, calculators, electronic spreadsheets, dynamic software and others.

The rapid progress of various technologies in todays' life has resulted in the use of technologies as an essential element in the T&L of mathematics. Effective teachers will maximise the potential and technological capabilities so that pupils can build understanding and increase their proficiency and interest in mathematics. Due to the capacity and effectiveness of technology in the T&L of mathematics content, teachers need to embrace the use of technology, particularly scientific and graphing calculators, computer software like Geometer's Sketchpad, Geogebra, electronic spreadsheets, learning software (courseware), the Internet and others.

However, technology need to be used wisely. Scientific calculator for example is not to be used to the extent that the importance of mental calculations and basic computations is neglected. Efficiency in carrying out the calculations is important especially in the lower level and pupils should not totally rely on calculators. For example, although the graphing calculator helps pupils to visualise the nature

of a function and its graph, the use of papers and pencils is still the learning outcome that has to be achieved by all pupils. Similarly, in seeking the roots of the quadratic equations, the basic concept must first be mastered by pupils. Technology should be used wisely to help pupils form concepts, enhance understanding, visualise concepts and others, while enriching pupils learning experiences.

Specifically, the skills in using technology that need to be nurtured in pupils through Mathematics are the ability of pupils in:

- Using technology to explore, carry out research, construct mathematical models hence form deep understanding of the mathematical concepts.
- Using technology to help in calculations to solve problems effectively.
- Using technology, especially electronic and digital technology to find, manage, evaluate and communicate information.
- Using technology responsibly and ethically.

The use of technology such as dynamic software, graphing calculator, the Internet and others need to be integrated into the T&L of mathematics to help pupils form deep understanding of concepts especially abstract concepts.

Values in Mathematics Education

Values are affective qualities intended to be developed through the T&L of mathematics using appropriate contexts. Values are usually taught and learned implicitly through the learning sessions. Moral values being instilled will manifest good attitudes. The application of values and attitudes in the T&L of mathematics are intended to produce individuals who are competent in terms of knowledge and skills as well as having good characters. Embracing moral values will produce virtuous young generation with noble personal qualities and good attitudes.

Values that need to be developed in pupils through the T&L of mathematics are:

- Mathematical values – values within the knowledge of mathematics which include emphasis on the properties of the mathematical knowledge; and
- Universal values - universal noble values that are applied across all subjects.

The development of values through T&L of mathematics should also involve the elements of divinity, faith, interest, appreciation, confidence, competence and tenacity. Belief in the power and greatness of God can basically be nurtured through the content of

the curriculum. The relationship between the content learned and the real world enables pupils to see and validate the greatness and the power of the Creator of the universe.

The elements of history and patriotism should also be inculcated through relevant topics to enable pupils to appreciate mathematics as well as to boost interest and confidence in mathematics. Historical elements such as certain events involving mathematicians or a brief history of a concept or symbol are also emphasised in this curriculum.

21st CENTURY SKILLS

One of the aims of KSSM is to produce pupils who possess the 21st century skills by focussing on thinking skills, living skills and career, guided by the practice of moral values. The 21st Century skills aim to produce pupils who have the characteristics specified in the pupils' profile as in Table 2, so that they are able to compete at a global level. The mastery of the Content Standards and the Learning Standards in the Mathematics curriculum contributes to the acquisition of the 21st Century Skills among the pupils.

Table 2: Pupils' Profile

PUPILS' PROFILE	DESCRIPTION
Resilient	They are able to face and overcome difficulties and challenges with wisdom, confidence, tolerance, and empathy.
Competent Communicator	They voice out and express their thoughts, ideas and information confidently and creatively, in verbal and in written form, using various media and technology.
Thinker	They think critically, creatively and innovatively; able to solve complex problems and make ethical decisions. They think about learning and themselves as learners. They generate questions and be open towards other individual's and communities' perspectives, values, and traditions. They are confident and creative in handling new learning areas.
Team Work	They can co-operate effectively and harmoniously with others. They shoulder responsibilities together as well as respect and appreciate the contributions from each member of the team. They acquire interpersonal skills through collaborative activities, and this makes them better leaders and team members.

PUPILS' PROFILE	DESCRIPTION
Inquisitive	They develop natural inquisitiveness to explore new strategies and ideas. They learn skills that are necessary for inquiry-learning and research, as well as display independent traits in learning. The pupils continuously enjoy life-long learning experiences.
Principled	They have a sense of integrity and sincerity, equality, fairness and respect the dignity of individuals, groups and community. They are responsible for their actions, consequences and decisions.
Informed	They obtain knowledge and develop a broad and balanced understanding across various disciplines of knowledge. They explore knowledge efficiently and effectively in terms of local and global contexts. They understand issues related to ethics or laws regarding information acquired.
Caring	They show empathy, compassion and respect towards the needs and feelings of others. They are committed to serve the society and ensure the sustainability of the environment.
Patriotic	They demonstrate their love, support and respect for the country.

HIGHER ORDER THINKING SKILLS

Higher-Order Thinking Skills (HOTS) are explicitly stated in the curriculum so that teachers are able to translate it into their T&L to promote a structured and focused thinking among pupils. Explanation of HOTS focuses on four levels of thinking as shown in Table 3.

Table 3: Level of Thinking in HOTS

LEVEL OF THINKING	EXPLANATION
Applying	Using knowledge, skills and values in different situations to perform certain tasks.
Analysing	Breaking down information into smaller parts in order to understand and make connections between these parts.
Evaluating	Making considerations and decisions using knowledge, experience, skills, and values as well as providing justification.
Creating	Producing creative and innovative ideas, products or methods.

HOTS is the ability to apply knowledge, skills and values to reason out and make reflection to solve problems, make decisions,

innovative and able to create something. HOTS includes critical and creative thinking, reasoning and thinking strategies.

Critical thinking skills is the ability to evaluate a certain idea logically and rationally in order to make sound judgements using logical reasoning and evidences.

Creative thinking skills is the ability to produce or create something new and worthy using authentic imagination and thinking out of the ordinary.

Reasoning skills is an individual's ability to make logical and rational considerations and evaluations.

Thinking strategies is a structured and focused way of thinking to solve problems.

HOTS can be applied in classrooms through reasoning, inquiry-based learning, problem solving and projects. Teachers and pupils need to use thinking tools such as thinking maps and mind maps as well as high-level questioning techniques to encourage pupils to think.

TEACHING AND LEARNING STRATEGIES

Good T&L of mathematics demands teachers to carefully plan activities and to integrate diversified strategies that enable pupils to not only understand the content in depth, but to challenge them to think at a higher level.

The T&L of mathematics emphasises active pupil participation, which among others, can be achieved through:

- Inquiry-based learning, which includes investigation and exploration of mathematics;
- Problem-based learning; and
- The use of technology in concept buidling.

Inquiry-based is an approach that emphasises learning through experience. Inquiry generally means to seek information, to question and to investigate real-life phenomena. Discovery is a major characteristic of inquiry-based learning. Learning through discovery occurs when the main concepts and principles are investigated and discovered by pupils themselves. Through the activities, pupils will investigate phenomena, analyse patterns thus form their own conclusions. Teachers then guide pupils to discuss and understand the concept of mathematics through the results of the inquiry. KSSM Mathematics emphasises deep

conceptual understanding, efficiency in manipulation, the ability to reason and communicate mathematically. Thus, the T&L that involves inquiry, exploration and investigation of mathematics should be conducted wherever appropriate. Teachers need to design T&L activities that provide space and opportunities for pupils to make conjectures, reason out, ask questions, make reflections and thus form concepts and acquire knowledge on their own.

A variety of opportunities and learning experiences, integrating the use of technology, and problem solving that involves a balance of both routine and non-routine questions, are also emphasised in the T&L of mathematics. Non-routine questions requiring higher-order thinking are emphasised in order to achieve the vision of producing human capital who can think mathematically, creatively and innovatively, are able to compete in the era of globalisation and to meet the challenges of the 21st century.

Mathematics is a discipline of knowledge consisting of concepts, facts, characteristics, rules, patterns and processes. Thus, the strategies used in the T&L of mathematics require diversity and balance. The traditional strategy is sometimes still necessary when teaching a procedural-based content. On the other hand, certain contents require teachers to provide learning activities that enable pupils to discover the concept on their own. Thus, structured questioning techniques are needed to enable pupils to discover the rules, patterns or the properties of mathematical concepts.

The use of teaching aids and carrying out tasks in the form of presentations or project work need to be incorporated into the learning experience in order to develop pupils who are competent in applying knowledge and skills of mathematics in solving problems involving everyday situations as well as to develop soft skills among them. Other diversified T&L approaches and strategies such as mastery learning, contextual learning, constructivism, project-based learning, problem-based learning and others should be implemented in accordance to the needs and appropriateness.

The learning of mathematics that embraces *fikrah* needs to be manifested in the T&L. Thus, T&L strategies should be pupil-centred to enable them to interact and acquire the learning skills through their own experiences. Approaches and strategies of learning, such as inquiry-discovery, mathematical exploration and investigation and pupil-centred activities with the aid of mathematical tools that are appropriate, comprehensive and effective can make the learning of mathematics useful and challenging which in turn will form the basis for deep understanding of concepts.

Teachers need to diversify the methods and strategies of T&L to meet the needs of pupils with various abilities, interests and preferences. The active involvement of pupils in meaningful and challenging T&L activities should be designed specifically to cater their needs. Every pupil should have an equal opportunity to form conceptual understanding and procedural competence. Therefore, teachers should be mindful in setting the ecosystem of learning and intellectual discussions that require pupils to collaborate in solving meaningful and challenging tasks.

Creativity and innovation are key elements in the development of a knowledgeable society in the 21st century. Both of these elements will significantly contribute to the social and individual prosperity of a country. Malaysia needs creative and innovative human capital in order to compete in todays' world which is increasingly competitive and dynamic. Education is seen as a means in the formation of creativity and innovation skills among the people.

Creativity and innovation are interrelated. In general, creativity refers to the ability to produce new ideas, approaches or actions. Innovation is the process of generating creative ideas in a certain context. Creativity and innovation capabilities are the skills that can be developed and nurtured among pupils through T&L in the classroom. Mathematics is the science of patterns and relations which has aesthetic values that are closely related to the natural phenomena. Hence, mathematics is the cornerstone and the catalyst for the development of creativity and innovative skills among pupils through suitable tasks and activities.

Teachers need to design T&L activities that encourage and foster creativity and innovation. Among the strategies that can be used is to involve pupils in complex cognitive activities such as:

- The implementation of tasks involving non-routine questions requiring diversified problem-solving strategies and high level of thinking;
- The use of technology to explore, build conceptual understanding and solve problems;
- Fostering a culture in which pupils showcase creativity and innovation in a variety of forms; and
- Design T&L activities that provide space and opportunities for pupils to perform mathematics and build understanding through inquiry-based exploration and investigation.

STEM APPROACH (Science, Technology, Engineering and Mathematics)

STEM approach is the T&L method which applies integrated knowledge, skills and values of STEM through inquiry, problem solving or project in the context of daily life, environment and local as well as global community, as shown in Diagram 3.

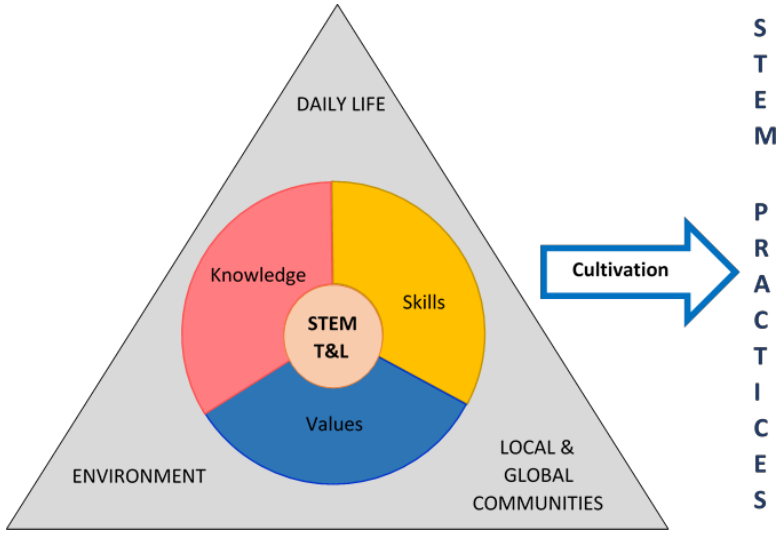


Diagram 3: STEM as Teaching and Learning Approach

STEM teaching and learning which is contextual and authentic is able to encourage in-depth learning among pupils. Pupils can work in groups or individually according to their ability to cultivate the STEM practices, as follows:

1. Questioning and identifying problems.
2. Developing and using models.
3. Planning and carrying out investigations.
4. Analysing and interpreting data.
5. Using mathematical and computational thinking.
6. Developing explanation and designing solutions.
7. Engaging in argument and discussion based on evidence.
8. Acquiring information, evaluating and communicating about the information.

CROSS-CURRICULAR ELEMENTS

Cross-curricular Elements (EMK) is a value-added element applied in the T&L process other than those specified in the Content Standard. These elements are applied to strengthen the skills and competency of the intended human capital who will be capable of dealing with the current and future challenges. The elements in the EMK are as follows:

1. Language

- The use of proper language of instruction should be emphasised in all subjects.
- During the T&L of every subject, aspect of pronunciation, sentence structure, grammar, vocabulary and grammar should be emphasised to help pupils organise ideas and communicate effectively.

2. Environmental Sustainability

- Developing awareness and love for the environment needs to be nurtured through the T&L process in all subjects.
- Knowledge and awareness on the importance of the environment would shape pupils' ethics in appreciating nature.

3. Moral Values

- Moral values are emphasised in all subjects so that pupils are aware of its importance, hence practise good values.
- Moral values include aspects of spirituality, humanity and citizenship that are being practised in daily life.

4. Science and Technology

- Increasing the interest in science and technology can improve literacy in science and technology among pupils.
- The use of technology in teaching can support and contribute to a more efficient and effective learning.
- Integration of science and technology in T&L encompasses four main factors:
  - (i) Knowledge of science and technology (facts, principles, concepts related to science and technology);
  - (ii) Scientific skills (thinking processes and certain manipulative skills);
  - (iii) Scientific attitude (such as accuracy, honesty, safety);
  - (iv) The use of technology in T&L activities.

5. Patriotism

- The spirit of patriotism is to be fostered in all subjects, extra-curricular activities and community services.
- Patriotism develops the spirit of love for the country and instils a sense of pride of being Malaysians amongst pupils.

6. Creativity and Innovation

- Creativity is the ability to use imagination to collect, assimilate and generate ideas or create something new or original by inspiration or combinations of existing ideas.
- Innovation is the application of creativity through modification, correcting and practising the ideas.
- Creativity and innovation go hand in hand and are needed in order to develop human capital that can face the challenges of the 21st century.
- Elements of creativity and innovation should be integrated into the T&L.

7. Entrepreneurship

- The inculcation of entrepreneurial elements aims to establish the characteristics and the practice of entrepreneurship so that it becomes a culture among pupils.
- Features of entrepreneurship can be applied in T&L through activities that could foster attitudes such as diligence, honesty, trustworthy, responsibility and to develop creative and innovative minds to market the idea.

8. Information and Communication Technology (ICT)

- Application of ICT element into the T&L is to ensure that pupils can apply and consolidate the knowledge and skills learned.
- The application of ICT not only encourages pupils to be creative but also makes T&L more interesting and fun as well as improving the quality of learning.
- ICT should be integrated in the lesson based on appropriate topics to be taught to further enhance pupils' understanding of the content.
- One of the emphases in ICT is the computational thinking that can be applied in all subjects. Computational thinking is a skill that applies the concepts of logical reasoning, algorithm, resolution, pattern recognition, scaling and assessment in the process of solving computer assisted problems.

9. Global Sustainability

- Global Sustainability elements aim to produce pupils who have sustainable thinking and are responsive to the environment in their daily lives by applying the knowledge, skills and values acquired through the elements of Sustainable Consumption and Production, Global Citizenship and Unity.
- The Global Sustainability elements are significant in preparing pupils to face the challenges and current issues at different levels; local, national and global.
- These elements are taught directly and indirectly in the relevant subjects.

10. Financial Education

- Application of financial education elements aims at shaping the future generation that is capable of making right financial decisions, ethical practice and financial management skills to manage the financial affairs responsibly.
- Elements of financial education can be applied in T&L directly or indirectly. Direct application is done through the topics that contain explicit financial elements such as the calculation of simple interest and compound interest.

Indirect application is integrated through other topics across the curriculum. Exposure to financial management in real life is important to provide pupils with the knowledge, skills and values that can be applied effectively and meaningfully.

CLASSROOM ASSESSMENT

Classroom assessment is a process to obtain information on pupils' progress which is planned, carried out and reported by the teachers concerned. This process is ongoing to enable teachers to determine the level of pupils' performance.

Teachers can implement formative and summative assessments as classroom assessments. Formative assessments are carried out during the teaching and learning processes, while summative assessments are carried out at the end of a learning unit, term, semester or year. Teachers need to plan, construct items, administer, mark, record and report pupils' performance level in the subjects taught based on the DSKP.

In order to ensure that assessment helps to improve the ability and performance of the pupils, teachers should carry out the assessment that has the following features:

- Using various assessment methods such as observation, oral and writing.
- Taking into account the knowledge, skills and values that are intended in the curriculum.
- Allowing pupils to exhibit various learning capabilities.
- Assessing the level of pupils' performance based on Learning Standards and Performance Standards.
- Taking follow-up actions for improvement and consolidation purposes.
- Holistic, that is taking into account various levels of cognitive, affective and psychomotor.
- Fair to all pupils.

General Performance Level

Performance level is a form of achievement statement that shows the progress of pupils' learning. There are six levels of performance that indicate level of performance that are arranged in hierarchy. This level of performance takes into account the knowledge, skills and mathematical processes specified in the curriculum. The Performance Standards (SPi) for each topic is constructed based on the General Performance Level as in Table 4. The purpose of SPi is to help teachers to make professional judgement in determining the level of performance that needs to be reported in a given duration or time frame.

Table 4: Statements of General Performance Level of KSSM Additional Mathematics

PERFORMANCE LEVEL	INTERPRETATION
1	Demonstrate basic knowledge such as stating a certain mathematical idea either verbally or non-verbally.
2	Demonstrate understanding such as explaining a certain mathematical concept either verbally or non-verbally.
3	Apply understanding such as performing calculations, constructing tables and drawing graphs.
4	Apply suitable knowledge and skills such as using algorithms, formulae, procedures or basic methods in the context of solving simple routine problems.
5	Apply suitable knowledge and skills in new situations such as performing multi-step procedures, using representations based on different sources of information and reason out directly in the context of solving complex routine problems.
6	Apply suitable knowledge and skills such as using information based on investigation and modelling in solving complex problems situations; reason out at a higher level, form new approaches and strategies in the context of solving non-routine problems creatively.

Teachers can record pupils progress in Teacher's Record Books, exercise books, note books, checklist, tables or others.

Assessment of Values

Elements of attitudes and values that need to be displayed and practised by pupils are assessed continuously through various media such as observations, exercises, presentations, pupils' verbal responses, collaborative activities and others. The achievement report of these elements can be done during mid-year or whenever necessary to observe the progress of pupils and help them improve the practice of good values, based on Table 5.

Table 5: Level of Values Internalisation in Mathematics Education

VALUE IN MATHEMATICS EDUCATION	INTERNALISATION LEVEL
Interested in learning mathematics.	**Low:** 1, 2 or 3 out of all the standards listed are observed
Appreciate the aesthetic values and the importance of mathematics.	
Confident and patient in learning mathematics.	

VALUE IN MATHEMATICS EDUCATION	INTERNALISATION LEVEL
Willing to learn from mistakes.	**Medium** 4, 5 or 6 out of all the standards listed are observed
Work towards accuracy.	
Practise self-access learning.	
Dare to try something new	**High** 7, 8 or 9 out of all the standards listed are observed
Work systematically	
Use mathematical tools accurately and effectively.	

Level of value internalisation in mathematics education is categorised into three levels, which are low, medium and high.

Teachers need to assess these elements holistically and comprehensively through detailed observations as well as using professional judgements to determine the level of internalisation of values that should be given to each pupil.

Overall Performance Level

Overall Performance Level for each subject should be determined at the end of each year. This level comprises the aspects of content, skills and mathematical processes, which are emphasised in the curriculum, including higher-order thinking skills. Thus, teachers need to evaluate pupils collectively, comprehensively and holistically, taking into consideration pupils' activities on a continuous basis through various media such as achievement in examination, topical tests, observations, exercises, presentations, pupils' verbal responses, group work, projects and so on Elements, which are emphasised in the Performance Level According to Learning Areas and Overall Performance Level, should be developed in an integrated manner among the pupils through various tasks. Therefore, teachers have to use their wisdom in making professional judgement to determine pupils' overall performance level as in Table 6.

Table 6: Statements of Overall Performance Level

PERFORMANCE LEVEL	CONTENTS, SKILLS AND MATHEMATICAL PROCESSES
1	Pupils are able to: • answer questions where all related information are given and questions are clearly defined • identify information and carry out routine procedures according to clear instructions.
2	Pupils are able to: • recognise and interpret situations directly • use single representation • use algorithms, formulae, procedures or basic methods • make direct reasoning and interpret the results obtained.
3	Pupils are able to: • perform procedures that are stated clearly, including multi-steps procedures • apply simple problem- solving strategies • interpret and use representations based on different sources of information • make direct reasoning; communicate briefly when giving interpretations, results and reasoning.
4	Pupils are able to: • use explicit models effectively in concrete complex situations, • choose and integrate different representations and relate to real world situations • use skills and reasonings flexibily based on deep understanding and communicate with explanations and arguments based on interpretations, discussions and actions.
5	Pupils are able to: • develop and use models for complex situations • identify constraints and make specific assumptions • apply suitable problem-solving strategies • work strategically using in-depth thinking skills and reasoning • use various suitable representations and display in-depth understanding • reflect on results and actions

PERFORMANCE LEVEL	CONTENTS, SKILLS AND MATHEMATICAL PROCESSES
	• conclude and communicate with explanations and arguments based on interpretations, discussions and actions
6	Pupils are able to: • conceptualise, make generalisations and use information based on investigations and modelling of complex situations • relate information sources and flexibly change one form of representations to another • possess high level of mathematical thinking and reasoning skills • demonstrate in-depth understanding; form new approaches and strategies to handle new situations • conclude and communicate with explanations and arguments based on interpretations, discussions, reflections and actions accurately.

Based on Overall Performance Level, it is clear that teachers should use tasks with various levels of difficulty and complexity which are able to access various elements and pupils' performance level. Holistic assessments are needed in developing pupils with global skills. Content mastery has to be supported by pupils' ability to achieve and apply processes, hence display the ability in solving complex problems especially those involving real-life situations. It is important that teachers carry out comprehensive assessments and provide fair and just report of each pupil's performance level.

CONTENT ORGANISATION

The implementation of KSSM Mathematics is in accordance with the *Surat Pekeliling Ikhtisas* which is being enforced now. The minimum hours per year for the T&L of KSSM Mathematics Form 4 and 5 is 112 hours.

KSSM Mathematics consists of three components: Content Standards (SK), Learning Standards (SP) and Performance Standards (SPi). The interpretation of each part is as in Table 7.

Table 7: Interpretation of Content Standard, Learning Standard and Performance Standard

Content Standard	Learning Standard	Performance Standard
Specific statement on what pupils should know and be able to do in a certain schooling period which encompasses the aspects of knowledge, skills and values.	Criterion set or indicators of the quality of learning and achievement that can be measured for each Content Standard.	Set of general criteria that shows the levels of performance that pupils should display as an indicator that they have mastered a certain matter.

In the content organisation, there is a Note column. This column contains the limitations and scope of SK and SP, suggested activities, information or notes that support teachers' understanding and mathematical processes that need to be implemented to achieve the SP. Teachers can carry out additional activities other than those suggested according to their creativity and the needs to achieve the SP.

The contents of KSSM Mathematics are organised and arranged according to independent and complete subunits based on modular approach. Modular approach in T&L enables teachers to arrange the topics and standards accordingly based on pupils' ability. This approach can be implemented in two ways as follow:

- Linear modular approach - SK or SP delivered sequentially according to the arrangement of the DSKP
- Non-linear modular approach – SK or SP delivered unsequentialy.

The scope of contents for Form 4 and 5 KSSM Mathematics are as shown in Table 8.

Table 8: Form 4 and 5 KSSM Mathematics Contents

LEARNING AREA	TITLE FORM 4	TITLE FORM 5
Number and Operations	• Number Bases • Consumer Mathematics: Financial Management	• Consumer Mathematics: Insurance • Consumer Mathematics: Taxation
Relationship and Algebra	• Quadratic Functions and Equations in One Variable • Linear Inequalities in Two Variables • Graphs of Motion	• Variation • Matrices • Mathematical Modeling
Statistic and Probability	• Measures of Dispersion for Ungrouped Data • Probability of Combined Events	• Measures of Dispersion for Grouped Data
Measurement and Geometry		• Congruency, Enlargement and Combined Transformations • Ratios and Graphs of Trigonometric Functions
Discrete Mathematics	• Logical Reasoning • Operations on Sets • Network in Graph Theory	

Content Standards, Learning Standards and Performance Standards Form 4

LEARNING AREA

RELATIONSHIP AND ALGEBRA

TOPIC

1.0 QUADRATIC FUNCTIONS AND EQUATIONS IN ONE VARIABLE

1.0 QUADRATIC FUNCTIONS AND EQUATIONS IN ONE VARIABLE

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
1.1 Quadratic Functions and Equations	Pupils are able to: 1.1.1 Identify and describe the characteristics of quadratic expressions in one variable.	Suggested Activities: The use of dynamic geometry software is encouraged throughout this topic. Notes: Exploratory activities involving the following cases need to be carried out: (i) The power of the variables is not a whole number; (ii) $b = 0$ or $c = 0$, or $b = c = 0$ in $ax^2 + bx + c$.
	1.1.2 Recognise quadratic function as many-to-one relation, hence, describe the characteristics of quadratic functions.	Notes: Exploratory activities involving graphs of quadratic functions need to be carried out. Characteristics of quadratic functions include: (i) Curved shape of the graph (ii) Maximum or minimum point (iii) The axis of symmetry of the graph is parallel to the y-axis. Suggested Activities: The vertical line test can be used to determine many-to-one relation.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	1.1.3 Investigate and make generalisation about the effect of changing the values of a, b and c on graphs of quadratic functions, $f(x) = ax^2 + bx + c$.	
	1.1.4 Form quadratic functions based on situations, and hence relate to the quadratic equations.	Notes: Real-life situations need to be involved. Quadratic equation in the form of $ax^2 + bx + c = 0$ needs to be involved.
	1.1.5 Explain the meaning of roots of a quadratic equation.	Exploratory activities need to be carried out. Limit to real roots. The position of the roots on the graphs of quadratic equations needs to be discussed.
	1.1.6 Determine the roots of a quadratic equation by factorisation method.	Suggested Activities: Graphical method using dynamic geometry software is encouraged.
	1.1.7 Sketch graphs of quadratic functions.	Notes: For the quadratic functions with no real roots, limit to the cases where the maximum or minimum point lies on the y-axis.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	1.1.8 Solve problems involving quadratic equations.	Notes: Creating situations based on quadratic equations need to be involved. Identifying quadratic graph, given its quadratic function and vice versa, need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of quadratic expressions, functions and equations in one variable.
2	Demonstrate the understanding of quadratic expressions, functions and equations in one variable.
3	Apply the understanding of quadratic functions and equations in one variable to perform simple tasks.
4	Apply appropriate knowledge and skills of quadratic functions and equations in one variable in the context of simple routine problems solving.
5	Apply appropriate knowledge and skills of quadratic functions and equations in one variable in the context of complex routine problems solving.
6	Apply appropriate knowledge and skills of quadratic functions and equations in one variable in the context of non-routine problems solving in a creative manner.

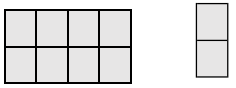
LEARNING AREA

NUMBER AND OPERATIONS

TOPIC

2.0 NUMBER BASES

2.0 NUMBER BASES

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.1 Number Bases	Pupils are able to: 2.1.1 Represent and explain numbers in various bases in terms of numerals, place values, digit values and number values based on the collection process.	Notes: Conversions and calculations involving number bases using calculators are not allowed except for conceptual exploration and checking of answers throughout this topic. Bases are limited to less than 10. Concrete materials and diagrams need to be used in forming the concepts of number bases. Example: The number 12_8  In terms of place value: 8^1 | 8^0 1 | 2 In terms of digit value: $\underline{1} \times 8^1$ and $\underline{2} \times 8^0$ = 8 and 2 In terms of number values: $(1 \times 8^1) + (2 \times 8^0)$ = 8 + 2 = 10_{10}

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	2.1.2 Convert numbers from one base to another using various methods. 2.1.3 Perform calculations involving addition and subtraction of numbers in various bases. 2.1.4 Solve problems involving number bases.	Notes: Various methods include the use of place values and divisions. Suggested Activities: Bases of more than 10 can be explored as enrichment.

PERFOMANCE STANDARDS	
PERFOMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of number bases.
2	Demonstrate the understanding of number bases.
3	Apply the understanding of number bases to perform simple tasks.
4	Apply appropriate knowledge and skills of number bases in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of number bases in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of number bases in the context of non-routine problem solving in a creative manner.

LEARNING AREA

DISCRETE MATHEMATICS

TOPIC

3.0 LOGICAL REASONING

3.0 LOGICAL REASONING

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
3.1 Statement	Pupils are able to:	Notes:
	3.1.1 Explain the meaning of a statement and hence determine the truth value of a statement.	The meaning of statements is explained in the context of logical reasoning. Statements include using numerals and mathematical symbols. Statements involving quantifiers which means “all” and “some” need to be involved.
	3.1.2 Negate a statement.	Change the truth value of the statement by using “not” or “no”.
	3.1.3 Determine the truth value of a compound statement.	A compound statement is a combination of two statements using “and” or “or”.
	3.1.4 Construct statement in the form of implication *(i)* If *p* then *q* *(ii)* *p* if and only if *q*	“If *p* then *q*” is an implication which is formed from antecedent, *p* and consequent, *q*.
	3.1.5 Construct and compare the truth value of converse, inverse and contrapositive of an implication.	Mathematical statements need to be emphasised.

<table>
<tr><th>CONTENT STANDARDS</th><th>LEARNING STANDARDS</th><th>NOTES</th></tr>
<tr><td></td><td>3.1.6 Determine a counter-example to negate the truth of a particular statement.</td><td>
<table>
<tr><td>Statement</td><td>If p, then q</td></tr>
<tr><td>Converse</td><td>If q , then p</td></tr>
<tr><td>Inverse</td><td>If not p, then not q</td></tr>
<tr><td>Contrapositive</td><td>If not q, then not p</td></tr>
</table>
Notes:
Statements involving quantities, compound statements, negation and appropriate implications need to be involved.</td></tr>
<tr><td>3.2 Argument</td><td>Pupils are able to:
3.2.1 Explain the meaning of argument and differentiate between deductive and inductive argument.
3.2.2 Determine and justify the validity of a deductive argument hence determine whether the valid argument is sound.</td><td>Notes:
Exploratory activities that involve real-life situations need to be carried out.
The terms premises and conclusions need to be introduced.
Various forms of deductive arguments need to be involved including:</td></tr>
</table>

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		Form I Premise 1: All A are B Premise 2: C is A Conclusion: C is B Form II Premise 1: If p, then q Premise 2: p is true Conclusion : q is true Form III Premise 1: If p, then q Premise 2: Not q is true Conclusion: Not p is true The soundness of an argument needs to be discussed based on premises and conclusion. Example: Premise 1: All prime numbers are odd numbers. Premise 2: 5 is a prime number. Conclusion: 5 is an odd number. The argument is valid but not sound because premise 1 is not true.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	3.2.3 Form valid deductive argument for a situation. 3.2.4 Determine and justify the strength of an inductive argument and hence determine whether the strong argument is cogent. 3.2.5 Form a strong inductive argument of a certain situation. 3.2.6 Solve problems involving logical reasoning.	Notes: The strength of an inductive argument is determined from the probability level of the conclusion is true, assuming that all premises are true. An argument is cogent or not, needs to be discussed based on the truth of the premises. Inductive arguments need to involve inductive generalisations. Example: Premise 1: The chairs in the living room are red. Premise 2: The chairs in the dining room are red. Conclusion: All the chairs in this house are red. This argument is weak because although the premises are true, the conclusion is probably false.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of statements and arguments.
2	Demonstrate the understanding of statements and arguments.
3	Apply the understanding of deductive arguments and inductive arguments to perform simple tasks.
4	Apply appropriate knowledge and skills of logical reasoning in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of logical reasoning in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of logical reasoning in the context of non-routine problem solving in a creative manner.

LEARNING AREA

DISCRETE MATHEMATICS

TOPIC

4.0 OPERATIONS ON SETS

4.0 OPERATIONS ON SETS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.1 Intersection of Sets	Pupils are able to: 4.1.1 Determine and describe the intersection of sets using various representations. 4.1.2 Determine the complement of the intersection of sets. 4.1.3 Solve problems involving the intersection of sets.	Notes: The following representations need to be involved: (i) descriptions (ii) symbolic, including listing and set builder notation (iii) graphical, including Venn diagrams Real-life situations need to be involved. Converting from one representation to another needs to be involved throughout this topic.
4.2 Union of Sets	Pupils are able to: 4.2.1 Determine and describe the union of sets using various representations. 4.2.2 Determine the complement of the union of sets. 4.2.3 Solve problems involving the union of sets.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.3 Combined Operations on Sets	Pupils are able to: 4.3.1 Determine and describe the combined operations on sets using various representations. 4.3.2 Determine the complement of combined operations on sets. 4.3.3 Solve problems involving combined operations on sets.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of the intersection of sets, union of sets and combined operations on sets.
2	Demonstrate the understanding of the intersection of sets, union of sets and combined operations on sets.
3	Apply the understanding of intersection of sets, union of sets and combined operations on sets to perform simple tasks.
4	Apply appropriate knowledge and skills of intersection of sets, union of sets and combined operations on sets in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of intersection of sets, union of sets and combined operations on sets in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of intersection of sets, union of sets and combined operations on sets in the context of non-routine problem solving in a creative manner.

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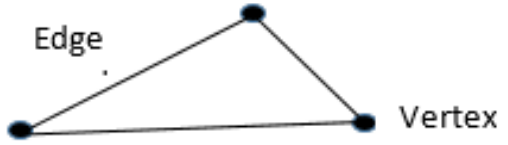
LEARNING AREA

DISCRETE MATHEMATICS

TOPIC

5.0 NETWORK IN GRAPH THEORY

5.0 NETWORK IN GRAPH THEORY

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
5.1 Network	Pupils are able to: 5.1.1 Recognise and explain a network as a graph.	Notes: Real-life situations need to be involved throughout this topic. The following terms need to be involved: (i) Graph is a series of dots either linked or not to each other through lines. (ii) Network is a graph which has at least a pair of related dots. (iii) Point is known as vertex and line as edge. (iv) The degree of a vertex is the number of edges that are connected to other vertices. (v) A simple graph is an undirected graph, without loops or multiple edges. Graphs with loops and multiple edges need to be involved. 

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.1.2 Compare and contrast: (i) directed graphs and undirected graph. (ii) weighted graphs and unweighted graphs. 5.1.3 Identify and draw subgraphs and trees. 5.1.4 Represent information in the form of networks. 5.1.5 Solve problems involving networks.	Notes: Information from various real-life situations including social and transportation networks need to be involved. The following comparisons, including the advantages and disadvantages need to be involved: (i) between various transportation networks (ii) between transportation networks and maps. Optimal cost problems need to be involved. Cost including time, distance and expenses.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of network.
2	Demonstrate the understanding of network.
3	Apply the understanding of network to perform simple tasks.
4	Apply appropriate knowledge and skills of network in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of network in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of network in the context of non-routine problem solving in a creative manner.

LEARNING AREA

RELATIONSHIP AND ALGEBRA

TOPIC

6.0 LINEAR INEQUALITIES IN TWO VARIABLES

6.0 LINEAR INEQUALITIES IN TWO VARIABLES

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
6.1 Linear Inequalities in Two Variables	Pupils are able to: 6.1.1 Represent situations in the form of linear inequalities. 6.1.2 Make and verify the conjecture about the points in the region and the solution of certain linear inequalities. 6.1.3 Determine and shade the region that satisfies a linear inequality.	Notes: Real-life situations need to be involved throughout this topic. Limit to situations which involve one linear inequality.
6.2 Systems of Linear Inequalities in Two Variables	Pupils are able to: 6.2.1 Represent situations in the form of system of linear inequalities. 6.2.2 Make and verify the conjecture about the points in the region and solution of linear inequalities system. 6.2.3 Determine and shade the region that satisfies a linear inequality system.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	6.2.4 Solve problems involving systems of linear inequalities in two variables	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of linear inequalities in two variables.
2	Demonstrate the understanding of linear inequalities in two variables.
3	Apply the understanding of linear inequalities in two variables to perform simple tasks.
4	Apply appropriate knowledge and skills of linear inequalities in two variables in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of linear inequalities in two variables in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of linear inequalities in two variables in the context of non-routine problem solving in a creative manner.

LEARNING AREA

RELATIONSHIP AND ALGEBRA

TOPIC

7.0 GRAPHS OF MOTION

7.0 GRAPHS OF MOTION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
7.1 Distance-Time Graphs	Pupils are able to: 7.1.1 Draw distance-time graphs. 7.1.2 Interpret distance-time graphs and describe the motion based on the graphs. 7.1.3 Solve problems involving distance-time graphs.	Notes: Real-life situations need to be involved throughout this topic. Description of motion needs to involve distance, time and speed.
7.2 Speed-Time Graphs	Pupils are able to: 7.2.1 Draw speed-time graphs. 7.2.2 Make a relationship between the area under speed-time graph and the distance travelled, and hence determine the distance. 7.2.3 Interpret speed-time graphs and describe the movement based on the graphs.	Notes: Exploratory activities need to be involved. Description of motion needs to involve distance, time, speed and acceleration. Acceleration as the change of speed with respect to time, of a motion in the fixed direction, needs to be emphasised.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	7.2.4 Solve problems involving speed-time graphs.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of graphs of motion.
2	Demonstrate the understanding of graphs of motion.
3	Apply the understanding of graphs of motion to perform simple tasks.
4	Apply appropriate knowledge and skills of graphs of motion in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of graphs of motion in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of graphs of motion in the context of non-routine problem solving in a creative manner.

LEARNING AREA

STATISTICS AND PROBABILITY

TOPIC

8.0 MEASURES OF DISPERSION FOR UNGROUPED DATA

8.0 MEASURES OF DISPERSION FOR UNGROUPED DATA

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
8.1 Dispersion	Pupils are able to: 8.1.1 Explain the meaning of dispersion.	Notes: Statistical inquiry approach that involve the following needs to be carried out: (i) The use of digital technology. (ii) Real-life situations. (iii) Collection of data using various methods such as interviews, surveys, experiments and observation. (iv) Interpretation of data representations. (v) The importance of representing data ethically to avoid confusion. (vi) Exploratory activities involving comparison of a few sets of data having the same attributes. Statistical questions are questions that can be answered by collecting data and where there is diversity or variability in the data.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	8.1.2 Compare and interpret dispersion of two or more sets of data based on the stem-and-leaf plots and dot plots, hence make conclusion.	
8.2 Measures of Dispersion	Pupils are able to: 8.2.1 Determine the range, interquartile range, variance and standard deviation as a measure to describe dispersion of an ungrouped data. 8.2.2 Explain the advantages and disadvantages of various measures of dispersion to describe ungrouped data. 8.2.3 Construct and interpret the box plot for a set of ungrouped data. 8.2.4 Determine the effect of data changes on dispersion based on: (i) the value of measure of dispersion (ii) graphical representation	Notes: Variance and standard deviation formula: Variance, $\sigma^2 = \frac{\sum x^2}{N} - (\bar{x})^2$ or $\sigma^2 = \frac{\Sigma(x-\bar{x})^2}{N}$ Standard deviation, $\sigma = \sqrt{\frac{\sum x^2}{N} - (\bar{x})^2}$ or $\sigma = \sqrt{\frac{\Sigma(x-\bar{x})^2}{N}}$ The effect on dispersion of a distribution when (i) each data is changed uniformly (ii) the existance of outlier or extreme values (iii) certain values are added or removed

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	8.2.5 Compare and interpret two or more sets of ungrouped data, based on the appropriate measures of dispersion, hence make conclusion. 8.2.6 Solve problems involving measures of dispersion.	Notes: Measures of central tendency need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of dispersion.
2	Demonstrate the understanding of measures of dispersion for ungrouped data.
3	Apply the understanding of measures of dispersion for ungrouped data to perform simple tasks.
4	Apply appropriate knowledge and skills of measures of dispersion for ungrouped data in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of measures of dispersion for ungrouped data in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of measures of dispersion for ungrouped data in the context of non-routine problem solving in a creative manner.

LEARNING AREA

STATISTICS AND PROBABILITY

TOPIC

9.0 PROBABILITY OF COMBINED EVENTS

9.0 PROBABILITY OF COMBINED EVENTS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
9.1 Combined Events	Pupils are able to: 9.1.1 Describe combined events and list out the possible combined events.	Notes: Real-life situations need to be involved throughout this topic. Combined events are resulted from one or more experiments.
9.2 Dependent Events and Independent Events	Pupils are able to: 9.2.1 Differentiate between dependent and independent events. 9.2.2 Make and verify conjecture about the formula of probability of combined events. 9.2.3 Determine the probability of combined events for dependent and independent events.	Suggested Activities: Listing of the outcomes of an event can be involved. Notes: Determination of the probability of combined events need to involve: (i) Listing of the outcomes of events based on representation, or (ii) Using the formula $P(A \text{ and } B) = P(A \cap B) = P(A) \times P(B)$

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		Representations include tree diagrams, ordered-pairs or tables. Combination of more than two events needs to be involved.
9.3 Mutually Exclusive Events and Non-Mutually Exclusive Events.	Pupils are able to: 9.3.1 Differentiate between mutually exclusive and non-mutually exclusive events. 9.3.2 Verify the formula of probability of combined events for mutually exclusive and non-mutually exclusive events. 9.3.3 Determine the probability of combined events for mutually exclusive and non-mutually exclusive events.	Notes: P(A or B) = P($A \cup B$) = P(A) + P(B) – P($A \cap B$); For mutually exclusive events, P($A \cap B$) = 0 Representations such as Venn Diagrams can be used. Determination of the probability of combined events need to involve: (i) Listing of the outcomes of events based on representation, or (ii) Using the formula

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
		P(A or B) = P($A \cup B$) = P(A) + P(B) – P($A \cap B$) for the following cases: (i) $A \cap B = \emptyset$ (ii) $A \cap B \neq \emptyset$ (iii) $A \cap B = B$ Representations that need to be involved include Venn diagrams, ordered-pairs or tables.
9.4 Application of Probability of Combined Events	Pupils are able to: 9.4.1 Solve problems involving probability of combined events.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of combined events.
2	Demonstrate the understanding of probability of combined events.
3	Apply the understanding of probability of combined events to perform simple tasks.
4	Apply appropriate knowledge and skills of probability of combined events in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of probability of combined events in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of probability of combined events in the context of non routine problem solving in a creative manner.

LEARNING AREA

NUMBER AND OPERATIONS

TOPIC

10.0 CONSUMER MATHEMATICS: FINANCIAL MANAGEMENT

10.0 CONSUMER MATHEMATICS: FINANCIAL MANAGEMENT

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
10.1 Financial Planning and Management	Pupils are able to: 10.1.1 Describe effective financial management process.	Notes: Project-based Learning or Problem-based Learning approaches need to be applied. Financial Management Process: (i) Setting goals. (ii) Evaluating financial status. (iii) Creating financial plan. (iv) Carrying out financial plan. (v) Review and revising the progress.
	10.1.2 Construct and present personal financial plans to achieve short-term and long-term financial goals, hence evaluate the feasibility of the financial plans.	Financial goals set are based on the SMART concept: **S** - Specific **M** - Measurable **A** - Attainable **R** - Realistic **T** – Time-bound The needs and wants in determining financial goals need to be emphasised.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate the basic knowledge of financial management.
2	Demonstrate the understanding of financial management.
3	Apply the understanding of financial management to perform simple tasks.
4	Apply appropriate knowledge and skills of financial management in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of financial management in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of financial management in the context of non- routine problem solving in a creative manner.

Content Standards, Learning Standards and Performance Standards Form 5

LEARNING AREA

RELATIONSHIP AND ALGEBRA

TITLE

1.0 VARIATION

1.0 VARIATION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
1.1 Direct Variation	Pupils are able to: 1.0.1 Explain the meaning of direct variation.	Notes: Real life situations need to be involved throughout the topic. Exploratory activities involving tables and graphs should be carried out throughout the topic.
	1.0.2 Determine the relation between two variables for a direct variation.	Relate the constants of variations to the concept of ratio and gradients of straight lines. The following cases need to be involved: $y \propto x^n, n = 1, 2, 3, \frac{1}{2}, \frac{1}{3}$ The relation between the constant of a variation with the concept of proportion and gradients of straight lines need to be discussed.
	1.0.3 Determine the relation between three or more variables for a given joint variation.	Joint variation is a direct variation in which one variable varies as a product of two or more variables.
	1.0.4 Solve problems involving direct variation.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
1.2 Inverse Variation	Pupils are able to: 1.2.1 Explain the meaning of inverse variation. 1.2.2 Determine the relation between two variables for an inverse variation. 1.2.3 Solve problems involving inverse variation.	Notes: The following cases need to be involved: $y \propto \frac{1}{x^n}, n = 1, 2, 3, \frac{1}{2}, \frac{1}{3}$ The relation between the constant of a variation with the concept of proportion and gradients of straight lines need to be discussed.
1.3 Combined variation	Pupils are able to: 1.3.1 Determine the relation between three or more variables for a combined variation. 1.3.2 Solve problems involving combined variation.	Notes: Combined variation involves a combination of direct variation or joint variation, and inverse variation.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate basic knowledge of variation.
2	Demonstrate understanding of variation.
3	Apply the understanding of variation to carry out simple tasks.
4	Apply appropriate knowledge and skills of variations in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of variation in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of variation in the context of non-routine problem solving.

LEARNING AREA

RELATIONSHIP AND ALGEBRA

TITLE

2.0 MATRICES

2.0 MATRICES

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.1 Matrices	Pupils are able to: 2.1.1 Represent information from real situations in the form of matrices. 2.1.2 Determine the order of a matrix, hence identify certain elements in a matrix. 2.1.3 Determine whether two matrices are equal.	Notes: Real life situations need to be involved throughout this topic. The terms "row matrix", "column matrix", "square matrix" and "rectangular matrix" need to be introduced. Emphasise that a matrix with *m* rows and *n* columns is read as "matrix *m* by *n*". $A = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \vdots & \vdots & \dots & \vdots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{pmatrix}$ The notation of the element a_{ij}, need to be emphasized. Determining the value of elements in equal matrices need to be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
2.2 Basic Operation on Matrices	Pupils are able to: 2.2.1 Add and subtract matrices	Notes: Exploratory activities involving the following laws need to be carried out: (i) Commutative laws (ii) Distributive Laws (iii) Associative Laws Finding the unknown values need to be involved. The conditions for addition and subtraction of matrices need to be discussed. The nature of zero matrix in addition and subtraction need to be discussed.
	2.2.2 Multiply a matrix by a number.	Multiplication of a matrix by a number is known as scalar multiplication. Multiplication of a matrix by a number should be associated with repeated additions: $nA = \underbrace{A + A + A + \ldots + A}_{n \text{ times}}$
	2.2.3 Multiply two matrices.	The conditions for multiplication of two matrices need to be discussed.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	2.2.4 Explain the characteristics of identity matrix.	Exploratory activities involving various multiplication of matrices including identity matrix need to be carried out. The symbol I as identity matrix should be introduced.
	2.2.5 Explain the meaning of inverse matrix and hence determine the inverse matrix for a 2 × 2 matrix.	Exploratory activities involving $AA^{-1} = A^{-1}A = I$ need to be carried out. The symbol A^{-1} and the term determinant need to be introduced. The condition for the existence of an inverse matrix need to be discussed. Suggested activity: Derivation of the formula to determine an inverse matrix may be involved.
	2.2.6 Use the matrix method to solve simultaneous linear equations.	Limit to 2 x 2 matrices.
	2.2.7 Solve problems involving matrices	Representing a situation in the form of basic matrix operations and vice-versa need to be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate basic knowledge about matrices.
2	Demonstrate understanding of matrices.
3	Apply understanding of matrices to carry out simple tasks.
4	Apply appropriate knowledge and skills of matrices in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of matrices in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of matrices in the context of non-routine problem solving in a creative manner.

LEARNING AREA

NUMBERS AND OPERATION

TITLE

3.0 CONSUMER MATHEMATICS: INSURANCE

3.0 CONSUMER MATHEMATICS: INSURANCE

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
3.1 Risk and insurance coverage	Pupils are able to: 3.1.1 Explain the meaning of risk and the importance of insurance coverage, hence determine the types of life insurance and general insurance for protecting a variety of risks. 3.1.2 Investigate, interpret and perform calculations involving insurance rates and premiums. 3.1.3 Solve problems involving insurance including deductible and co-insurance.	Notes: Risk is the possibility of a disaster that cannot be avoided. Insurance aims to transfer risks from individuals to insurance organizations. The importance of insurance is to reduce financial burden in the occurrence of loss or accidents. Emphasise that insurance cannot be used as a mean to gain profit. Premium Rate Schedule and Risk Rate Shedule such as health, travel, accident, robbery and other appropriate risks need to be involved. Co-insurance is also known as joint insurance. Analysing various insurance policies, making wise decision and justifying the choice, should be involved.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate basic knowledge of insurance.
2	Demonstrate understanding of insurance.
3	Apply the understanding of insurance to carry out simple tasks.
4	Apply appropriate knowledge and skills of insurance in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of insurance in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills of insurance in the context of complex non-routine problem solving in a creative manner.

LEARNING AREA

NUMBER AND OPERATIONS

TITLE

4.0 CONSUMER MATHEMATICS : TAXATION

4.0 CONSUMER MATHEMATICS: TAXATION

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
4.1 Taxation	Pupils are able to: 4.1.1 Explain the purpose of taxation. 4.1.2 Describe various taxes, hence the consequences of tax evasion from legal and financial aspects. 4.1.3 Investigate, interpret and perform calculations involving various taxes. 4.1.4 Solve problems involving taxation.	Notes: Exploratory activities need to be involved for this topic. Discussion on tax payments from moral and ethical aspects need to be carried out. Taxes that need to be involved are: (i) Income tax (ii) Road tax (iii) Property Assessment tax (iv) Quit tax (v) Sales and service tax Monthly tax deduction, tax relief, separate and joint tax assesment on income tax need to be included. The differences between tax relief and rebate need to be discussed.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demostrate basic knowledge of taxation.
2	Demostrate understanding of taxation.
3	Apply the understanding of taxation to perform simple tasks.
4	Apply appropriate knowledge and skills on taxation in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills on taxation in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills on taxation in the context of non-routine problem solving in a creative manner.

LEARNING AREA

MEASUREMENT AND GEOMETRY

TITLE

5.0 CONGRUENCY, ENLARGEMENT AND COMBINED TRANSFORMATIONS

5.0 CONGRUENCY, ENLARGEMENT AND COMBINED TRANSFORMATIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
5.1 Congruency	Pupils are able to: 5.1.1 Differentiate between congruent and non-congruent shapes based on sides and angles. 5.1.2 Make and verify the conjecture of triangles congruency based on sides and angles. 5.1.3 Solve problems involving congruency.	Suggested Activity: The use of dynamic geometry software is encouraged throughout this topic. Notes : Exploratory activities need to be carried out throughout this topic. Exploratory activities involving the following need to be carried out : (i) *Side-Side-Side* - SSS (ii) *Side-Angle-Side* - SAS (iii) *Angle-Side-Angle* - ASA (iv) *Angle-Angle-Side* - AAS (v) *Angle-Angle-Angle* - AAA (vi) *Side-Side-Angle* - SSA

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
5.2 Enlargement	Pupils are able to: 5.2.1 Explain the meaning of similarity of geometric objects. 5.2.2 Make a connection between similarity and enlargement, hence describe enlargement using various representations. 5.2.3 Determine the image and object of an enlargement. 5.2.4 Make and verify conjecture on the relation between area of the image and area of the object of an enlargement. 5.2.5 Solve problems involving enlargement.	Notes: A complete description of an enlargement need to include the scale factor and the centre of enlargement. Discuss the case when: (i) The scale factor is a fraction (ii) Scale factor < 0
5.3 Combined Transformation	Pupils are able to : 5.3.1 Determine the image and object of a combined transformation.	Notes: The following transformations need to be involved: (i) Translation (ii) Reflection (iii) Rotation (iv) Enlargement

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	5.3.2 Make and verify the conjecture about commutative law in combined transformation. 5.3.3 Describe combined transformation. 5.3.4 Solve problems involving combined transformation.	The description of a single transformation equivalent to a combined transformation needs to be involved.
5.4 Tessellation	Pupils are able to: 5.4.1 Explain the meaning of tessellation. 5.4.2 Design tessellation involving isometric transformation.	Notes: Examples of tessellation in real life need to be involved. Tessellation is a pattern for a recurring shapes that fills a plane without empty spaces or overlapping. Steps to produce tessellation need to be demonstrated. The use of concrete material and dynamic geometry software need to be involved. Escher Tessellation need to be involved. Suggested activity: Project work involving Escher Tessellation.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demostrate the basic knowledge of congruency, enlargement and combined transformation.
2	Demostrate the understanding of congruency, enlargement and combined transformation.
3	Apply the understanding of congruency, enlargement and combined transformation to perform simple tasks.
4	Apply appropriate knowledge and skills on congruency, enlargement and combined transformation in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills on congruency, enlargement and combined transformation in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills on congruency, enlargement and combined transformation in the context of non-routine problem solving in a creative manner.

LEARNING AREA

MEASUREMENT AND GEOMETRY

TITLE

6.0 RATIOS AND GRAPHS OF TRIGONOMETRIC FUNCTIONS

6.0 RATIOS AND GRAPHS OF TRIGONOMETRIC FUNCTIONS

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
6.1 The value of sine, cosine and tangent for angle θ, $0° \leq \theta \leq 360°$.	Pupils are able to: 6.1.1 Make and verify conjecture about the value of sine, cosine and tangent for angles in quadrants II, III and IV with the corresponding reference angle. 6.1.2 Determine the value of sine, cosine and tangent for angles in quadrants II, III and IV based on the corresponding reference angle. 6.1.3 Determine the angle when the value of sine, cosine and tangent are given. 6.1.4 Solve problems involving sine, cosine and tangent.	Notes: The use of dynamic geometry software need to be involved for this topic. Exploratory activities involving unit circle need to be involved. The value of sine, cosine and tangent for angles of 0°, 90°, 180°, 270° and 360° need to be discussed. Finding the values of sine, cosine and tangent for angles in quadrants II, III and IV which correspond to the angles of 30º, 45º and 60º without the use of calculator need to be involved.
6.2 The graphs of sine, cosine and tangent functions.	Pupils are able to: 6.2.1 Draw graphs of trigonometric functions $y = \sin x$, $y = \cos x$ dan $y = \tan x$ for $0° \leq x \leq 360°$, hence compare and contrast the characteristics of the graphs.	Notes: The following characteristics need to be discussed: (i) Maximum value and minimum value. (ii) The shape of the graphs. (iii) The *x*-intercept and the *y*-intercept.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	6.2.2 Investigate and make generalisations about the effects of changes in constants a, b and c on the graphs of trigonometric functions: *(i)* $y = a \sin bx + c$ *(ii)* $y = a \cos bx + c$ *(iii)* $y = a \tan bx + c$ for $a > 0$, $b > 0$. 6.2.3 Solve problems involving graphs of sine, cosine and tangent functions.	

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate basic knowledge of trigonometric ratios and graphs.
2	Demonstrate the understanding of trigonometric ratios and graphs.
3	Apply the understanding of ratios and graphs of trigonometric functions to perform simple tasks.
4	Apply appropriate knowledge and skills about ratios and graphs of trigonometric functions in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills of ratios and graphs of trigonometric functions in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills about ratios and graphs of trigonometric functions in the context of non-routine problem solving in a creative manner.

LEARNING AREA

STATISTICS AND PROBABLITY

TITLE

7.0 MEASURES OF DISPERSION FOR GROUPED DATA

7.0 MEASURES OF DISPERSION FOR GROUPED DATA

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
7.1 Dispersion	Pupils are able to: 7.1.1 Construct histogram and frequency polygon for a set of grouped data.	Notes: Use the statistical inquiry approach for this topic. Digital technology need to be used in this topic. Construction of histogram and cumulative histogram involve only same class interval. Emphasize that histograms and frequency polygons can only be constructed using continuous data. Class interval, lower limit, upper limit, midpoint, lower boundary, upper boundary, size of class interval and cumulative frequency need to be discussed.
	7.1.2 Compare and interpret the dispersions of two or more sets of grouped data based on histogram and frequency polygon, hence make conclusion.	Various forms of data distribution need to be discussed.
	7.1.3 Construct an ogive for a set of grouped data and determine the quartiles.	Construction of ogives need to be related to the cumulative histograms. Percentile need to be involved.

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
7.2 Measures of dispersion	Pupils are able to: 7.2.1 Determine range, interquartile range, variance and standard deviation as a measure to describe dispersion for grouped data	Notes: Interquartile range of grouped data is only determined from ogive. Calculations of variance and standard deviation are based on the formula. Variance and standard deviation formula: Variance, $\sigma^2 = \frac{\sum fx^2}{\sum f} - \bar{x}^2$, where x is the midpoint of the class interval. Standard deviation, $\sigma = \sqrt{\frac{\sum fx^2}{\sum fx} - \bar{x}^2}$
	7.2.2 Construct and interpret a box plot for a set of grouped data.	Ogive and box plots need to be related.
	7.2.3 Compare and interpret two or more sets of grouped data, based on measures of dispersion hence make conclusion.	
	7.2.4 Solve problems involving measures of dispersion for grouped data.	

CONTENT STANDARDS	LEARNING STANDARDS	NOTES
	7.2.5 Design and conduct a mini-project involving statistical investigations based on measures of central tendency and measures of dispersion and hence interpret and communicate research findings.	The report of the mini project need to involve: (i) Statistical questions (ii) Data collection method (iii) Data organisation method (iv) Graphical representations (v) Data analysis (vi) Related description and conclusion. Pupils need to justify the steps in the project implementation. Suggested activity: The mini project may be conducted at the beginning of the topic or be carried out outside the teaching and learning session, using problem-based learning approach.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate basic knowledge of dispersion and measures of dispersion of grouped data.
2	Demonstrate the understanding of dispersion and measures of dispersion of grouped data.
3	Apply the understanding of dispersion and measures of dispersion of grouped data to perform simple tasks.
4	Apply appropriate knowledge and skills about measures of dispersion of grouped data in the context of simple routine problem solving.
5	Apply appropriate knowledge and skills to the measures of dispersion of grouped data in the context of complex routine problem solving.
6	Apply appropriate knowledge and skills to the measures of dispersion of grouped data in the context of non-routine problem solving in a creative manner.

LEARNING AREA

RELATIONSHIP AND ALGEBRA

TITLE

8.0 MATHEMATICAL MODELING

8.0 MATHEMATICAL MODELING

CONTENTS STANDARDS	LEARNING STANDARDS	NOTES
8.1 Mathematical Modeling	Pupils are able to: 8.1.1 Explain Mathematical Modeling.	Notes: Exploratory activities need to be carried out. The explanation should involve the process of: (i) Identifying and defining the problems. (ii) Making assumptions and identifying the variables. (iii) Applying mathematical modeling to solve problems. (iv) Verifying and interpreting solutions in the context of the problem. (v) Refining the mathematical modeling. (vi) Reporting the findings.
	8.1.2 Solve real life problems through mathematical modeling which involves the following functions: (i) Linear (ii) Quadratic (iii) Exponential and communicate the mathematical modeling process implemented.	Communication can involve in written report and presentation.

PERFORMANCE STANDARDS	
PERFORMANCE LEVEL	**DESCRIPTOR**
1	Demonstrate basic knowledge of mathematical modeling.
2	Demonstrate the understanding of mathematical modeling.
3	Apply the understanding of mathematical modeling to perform simple tasks.
4	Apply the knowledge and skills of mathematical modeling in the context of solving real-life problems involving linear functions.
5	Apply the knowledge and skills of mathematical modeling in the context of solving real-life problems involving quadratic and exponential functions.
6	Apply the knowledge and skills of mathematical modeling in the context of solving real-life problems involving quadratic and exponential functions in a creative manner.

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