Processes Standard for school mathematics

Instruction:

(A) Understand the task and discuss the importance of Mathematical Processes for teachers and the pupils/students.
(B) Make your own note and Provide a video using POWTOON (3-5 minutes).
(C) UPLOAD your video in Elearn (Forum)-Dateline 17 April 2020

TASK

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

1. Problem Solving

Problem solving is the heart of mathematics. Hence, problem-solving skill needs to be developed comprehensively and integrated across 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 creative, innovative and capable of using a variety of problem-solving strategies and higher order thinking skills. Teachers need to design T&L sessions which focus on problem solving in the discussion. Activities carried out should engage the pupils actively by posing a diversity of questions and tasks that contain both routine and non-routine questions. Solving problems involving non-routine questions 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 at a global level.

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 mathematically situations involving various contexts such as personal, community, scientific and occupation.
- Using and applying concepts, facts, procedures and reasoning 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.

2. Reasoning

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 through designing T&L activities that require pupils to do mathematics and be actively involved in discussing mathematical ideas.

The elements of reasoning in the T&L prevent pupils from looking at 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 does not only change pupils' paradigm from emphasising on the importance of procedural knowledge but also gives thinking 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 develop pupils' confidence and courage, in line with the aim of developing powerful mathematical thinkers.

3. Communication in mathematics

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 verbally, in 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 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.

4. Representation

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 varieties of ways to represent mathematical ideas that enable problems to be easily solved.

5. Connections

Making connections among the fields in mathematics such as counting, geometry, algebra, measurement and statistics is important so that pupils are able to learn concepts and skills in an integrated manner. By recognising how the concept or skills in different fields are related to each other, mathematics will be viewed and studied as an integrated discipline, having links between one another and allowing the abstract concepts to be more easily understood.

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 modelling are used to describe real-life situations mathematically. Pupils will find that this method can be used to find solutions to problems or to predict the possibility of a situation based on the mathematical modelling.

In implementing the Mathematics curriculum, the opportunities to make connections 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 enhance pupils' mathematical understanding, making mathematics clearer, meaningful and interesting.

The following are the **mathematical process standards to be achieved by pupils** through the implementation of the curriculum. (KSSM)

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.

General Performance Level (KSSM Mathematics)

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.**

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 • 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.