Promoting Mathematical Thinking in the Malaysian Classroom:

Issues and Challenges

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Overview of this presentation

- What is mathematical thinking (MT)?
- Working definition of MT
- MT as defined in Malaysian mathematics curriculum
- Promoting MT in the classroom teaching
- 3 Issues and 2 challenges in promoting MT
- Some suggestions

What is mathematical thinking (MT)?

- Is mathematical thinking similar to 'think mathematically'?
- No clear defined explanation yet
- Lutfiyya (1998):
  - "mathematical thinking involves using mathematically rich thinking skills to understand **ideas**, discover relationships among the ideas, draw or support conditions about the ideas and their relationships and solve problem involving the ideas." (p. 55).

What is mathematical thinking (MT)? Cont...

- Schoenfeld (1992) proposed:
  - five important aspects of cognition involve in the inquiries of mathematical thinking and problem solving, namely
    - (a) the knowledge base;
    - (b) problem solving strategies;
    - (c) monitoring and control;
    - (d) beliefs and affects; and
    - (e) practices (p.348)

What is mathematical thinking (MT)? Cont...

- OEDC (2000):
  - MT is described as **a process** which involves distinguishing between different kinds of statements, such as definitions, theorem, conjecture, hypothesis, examples, condition assertions; posing of higher order problem; and knowing that the answers sound logic to the problem.
- Suzuki (1998):
  - MT as global concepts that include all the mathematical activities and traditional ways of solving routine mathematical problems

Working definition of MT

- Characteristics:
  - it involves the manipulation of mental skills and strategies
  - it is highly influenced by the tendencies, beliefs or attitudes of a thinker
  - it shows the awareness and control of one's thinking such as metacognition
  - it is a knowledge–dependent activities

Working definition of MT

- *mathematical thinking is a mental operation supported by mathematical knowledge and certain kind of predisposition, toward the attainment of solution to problem.*

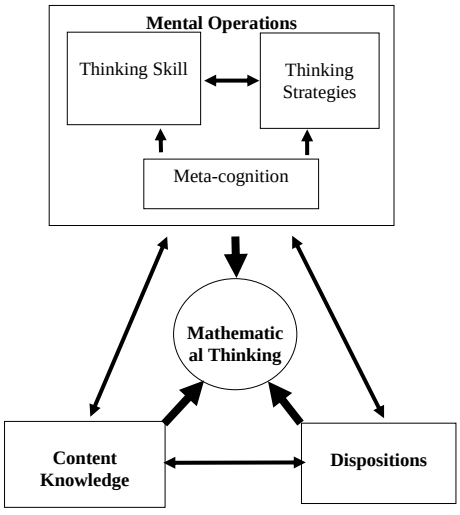

Figure 1: conceptual framework of mathematical thinking

MT as defined in Malaysian mathematics curriculum

- *The Mathematics curriculum for secondary school aims to develop individuals who are able to think mathematically and who can apply mathematical knowledge effectively and responsibly in solving problems and making decision.*
  - *(Ministry of Education Malaysia, 2003b, p.2)*

Table 1: Comparison of Mathematics Objectives between Primary School Curriculum and Secondary School Curriculum

Primary school mathematics*	Secondary school mathematics**
Objective 4: master basic mathematical skills, namely: making estimates and approximates; measuring; handling data; representing information in the form of graphs and charts	**Objective 3:** acquire basic mathematical skills such as: making estimation and rounding; measuring and constructing; collecting and handling data; representing and interpreting data; recognizing and representing relationship mathematically; using algorithm and relationship; solving problem; and making decision.
Objective 5: use mathematical skills and knowledge to solve problems in everyday life effectively and responsibly.	**Objective 5:** apply knowledge and the skills of mathematics in solving problems and making decisions **Objective 8:** cultivate mathematical knowledge and skills effectively and responsibly
Objective 6: use the language of mathematics correctly	**Objective 4:** communicate mathematically
Objective 8: apply the knowledge of mathematics systematically, heuristically, accurately and carefully	**Objective 6:** relate mathematics with other areas of knowledge
Objective 10: appreciate the importance and beauty of mathematics	**Objective 9:** Inculcate positive attitudes towards mathematics **Objective 10:** appreciate the importance and beauty of mathematics

*Ministry of Education Malaysia [MOE] (2003a).
**Ministry of Education Malaysia [MOE] (2003b).

Promoting MT in the classroom teaching

- Local literatures on MT – very limited
- 2 related articles :
  - a) Yudariah and Tall (1995)
    - compared the professors' perceptions of students' mathematical thinking between what they expect and what they prefer
    - MT was inferred from the students' attitudes towards mathematics and problem solving.
    - no clear definition of mathematical thinking.

Promoting MT in the classroom teaching cont…

- (b) Roselainy, Yudariah and Mason (2002):
- aimed to invoke 49 engineering undergraduates' mathematical thinking through the teaching of differentiation.
- by engaging students in 'various kinds of mental activities that signify mathematical thinking (specializing, exemplifying, generalizing, conjecturing and convincing)…'(p.288).
- E.g. teaching of the chain rule,
  - students were given various examples of class of functions that succumb to the Chain Rule.
  - The students' attention were then 'directed towards identifying "what stays the same", "what is different" and "what can be changed" & to "say what they see"' (p.288).
- no report on whether the students' mathematical thinking was enhanced after the study.

Informal communication with mathematics teachers

- Teacher 1: promote mathematical thinking "indirectly and unintentionally through questioning, discussion, problem solving and projects"
- Teacher 2: promote mathematical thinking when teaching students to solve word problems.
  - ask his students to think what the question want; what information given; how are they going to solve it

3 Issues and 2 challenges in promoting MT

- Three issues:
  - ***Issue 1: no clear understanding of mathematical thinking***
  - ***Issue 2: Examination oriented culture and 'finish syllabus syndrome'***
  - ***Issue 3: Lack of appropriate assessment instrument***

Issue 1: no clear understanding of mathematical thinking

- no explicit or clear cut definition of mathematical thinking in the curriculum.
- mentioned more during the orientation course given by the Curriculum Development Centre.
- Mathematical thinking was taught as related to
  - higher order thinking, critical and analytical thinking as well as problem solving.
- Many teachers perceived mathematical thinking to
  - problem solving or higher level of questioning,
  - critical and creative thinking skills

Issue 2: Examination oriented culture and 'finish syllabus syndrome'

- Still prevalent in Malaysian schools, in spite of the government's effort to "humanize" the public assessment system recently.
- Examination results as a yard stick or accountability of school performance.
- Most teachers tended to teach to test.
- anxious to finish the syllabus
- use procedural teaching that is a fast and direct way of information/knowledge transfer.
- stress on "drill and practice" so that students are familiar with the style of examination questions.

Issue 3: Lack of appropriate assessment instrument

- what is not assessed in the examination will not be taught in class.
- Analyses of the past year examination papers shows that there were very few questions that assess mathematical thinking.
- Even items that were categorized as problem solving were set in such a common format that they can be easily solved using a predicted model or procedure.
- school based test papers adopting or adapting those of the commercial publishers, model past year exam questions

Two challenges

- *Challenge 1: lack of resources and know-how in promoting mathematical thinking*
- *Challenge 2: The role of technology in mathematical thinking*

Challenge 1: lack of resources and know-how in promoting mathematical thinking

- **not enough support** of teaching and learning materials, references and professional development training.
- most teachers experienced their school mathematics learning through procedural approach.
  - Many of them tended **to teach as they were taught**.
  - lack the know-how and resources to incorporate mathematical thinking activity in their mathematics lessons
- need extra time and effort in preparation,
  - **time** is the biggest constraint in view of the examination oriented culture and heavy workload of teachers.

Challenge 2: The role of technology in mathematical thinking

- Latest policy change – Teaching mathematics & science in English, 2003
- Malaysian government – provide ICT, software & courseware
- Some Teachers – poor in English & ICT
  - merely exhibit the teaching courseware without much explanation or interaction with the students.
  - just let their students "watch" the teaching program in the absence of the teachers.

Suggestions for promoting MT

1. Equip and enhance mathematics teachers' understanding of mathematical thinking
2. Preparing mathematical thinking lessons through Lesson Study collaboration
3. Redesign assessment framework that focus on mathematics thinking

Equip and enhance mathematics teachers' understanding of mathematical thinking

- Mathematics curriculum document:
  - Need to have a more explicit and comprehensive explanation of MT
- Pre-service and in-service mathematics teachers:
  - need to be made aware of the importance of mathematical thinking.
  - need to be equipped with learning and to experience for themselves in mathematical thinking activities.
  - Expose to various teaching strategies and activities that promote mathematical thinking.
  - through workshops, seminars or conferences.

Preparing mathematical thinking lessons through Lesson Study collaboration

- Lesson Study -- collaborative effort will certainly reduce the workload and time taken in preparing the lesson.
- teachers will gain deeper understanding and more effective strategies through peer support.
- mathematics teachers might be more **confident**
- more **encouraged** to integrate mathematical thinking in their future lessons.

Redesign assessment framework that focus on mathematics thinking

- it is time for the Malaysian Ministry of Education to **redesign the assessment framework** that focus on mathematics thinking.
- With the new framework, mathematics teachers will then **restructure their teaching approach** so that
- promotion of mathematical thinking will become an **essential component** in their mathematics classroom teaching.

Conclusion

- it is pertinent to promote students' mathematics thinking in mathematics classroom.
- To achieve that, there is an urgent need to make significant changes in our mathematics teaching and assessment framework that incorporate attributes of mathematics thinking.

Thank you very much for your attention, please comment.