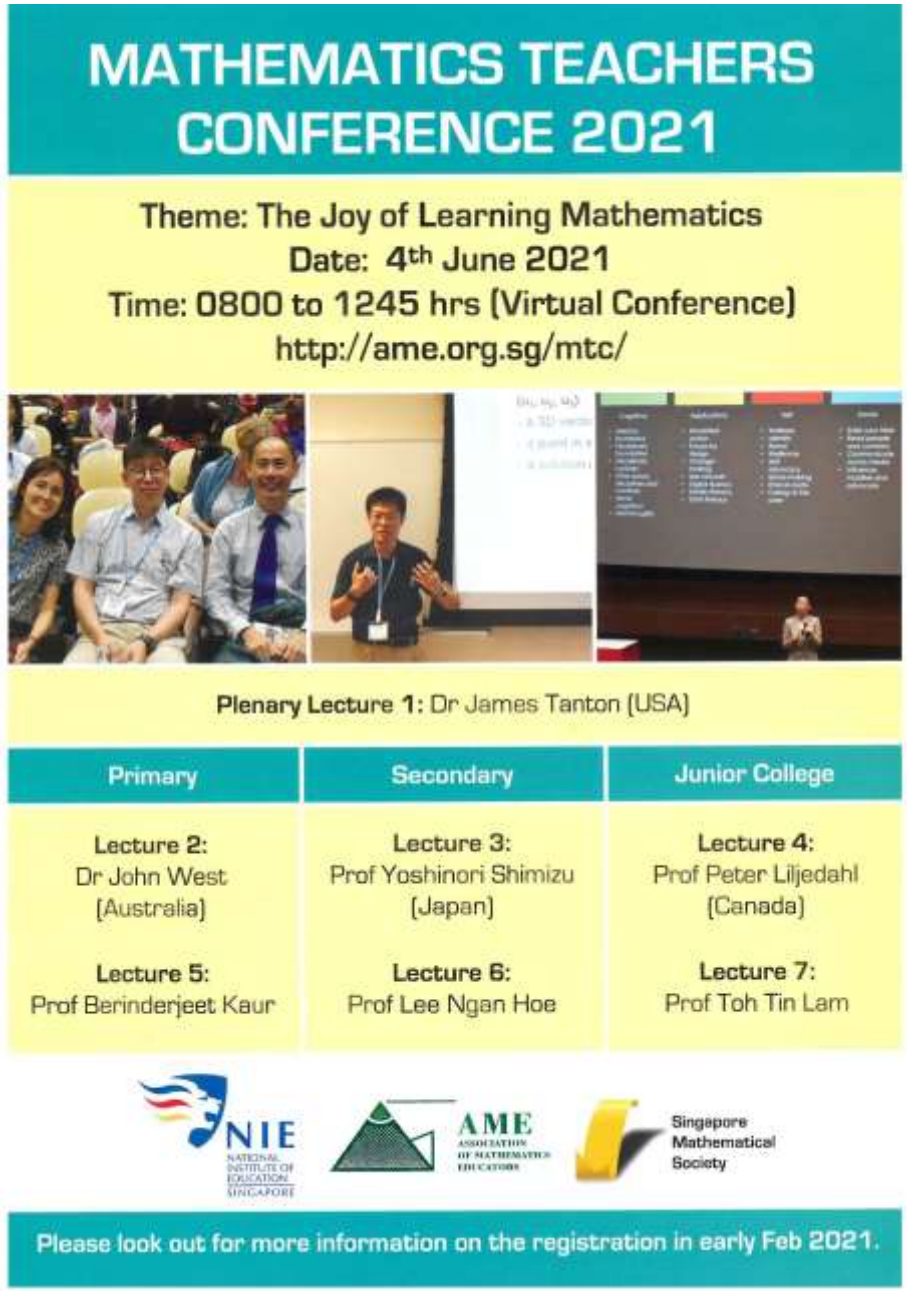

Keynote Lecture 5

The Sum of the Parts is Greater than the Whole

Berinderjeet Kaur
National Institute of Education
Nanyang Technological University
Singapore

Joy of Learning Mathematics

[An example of what this means in a school]

English
Mother Tongue
Mathematics
Mathematics Club
Science
Physical Education (PE)
Aesthetics
ICT
Character and Citizenship Education

Mathematics

Our Vision

Every Child, A Critical Thinker, A Problem Solver and a Math Enthusiast

Our Beliefs

- Every student matters and can achieve a level of mastery of Mathematics that will serve them well in their lives.
- Teaching and Learning of Mathematics should develop students' competencies of thinking critically in an uncertain situation, making decisions in various contexts and collaborating and communicating with others.

Students work in groups and communicate their ideas to one another

Students learn best when working with their peers

Our Guiding Principles

Math Educators in Queenstown Primary School are guided by the following principles:

1. Pedagogical Plurality is Key

Each child is unique and learns differently. As 21st century Math Educators we explore various teaching strategies that are student-centric and seek to better engage and provide the necessary support and stretch for our students.

2. Consistency is the Strategy

We work collaboratively with our colleagues to explore ideas together as a team and continue building our professional expertise to raise the quality of teaching and learning of Mathematics.

3. Reasoning and Communication is our Cornerstone

As we strive to develop our students to be Critical Thinkers and effective Problem Solvers, we continue to provide opportunities for students to explain their reasoning and work with their peers in the classroom.

Designing teaching strategies together

Teachers make Math learning concrete.
The difference between $1m^3$ and $10cm^3$.
Can you spot the cube with a volume of $1cm^3$?

Peer Observations to better understand how students learn

Our teachers facilitate knowledge construction amongst students

Guided by the 3 principles, our Educators instil a ***joy of learning*** in Maths by orchestrating meaningful learning experiences in the classroom that allow students to discover mathematical ideas and co-construct mathematical knowledge with their peer. With sound mathematical knowledge, students are guided to adopt a systematic approach through Polya's Problem Solving process to solve math problems. Teaching of Maths is made accessible for all students through the use of the Concrete-Pictorial-Abstract approach that makes the understanding of key Math concepts accessible for all students.

Joy of Learning Mathematics

Math Trail

We place a premium on enabling our students to apply their mathematical thinking beyond the realms of the Math Classroom. The P4 Math Trail conceptualised and carried out by our P5 and P6 Math Ambassadors is an example of one such initiative.

Applying estimation skills to compare the size of different countries in the World Map

Making use of available resources to calculate the area of the school hall

Let's work on this together!!

FEATURE

The Joy of Learning:

What It Is and How to Achieve It

Professor John Wang
National Institute of Education
Nanyang Technological University

During the Committee of Supply debate in Parliament in March 2017, Education Minister (Schools) Ng Chee Meng suggested nurturing a joy of learning so that students can be intrinsically motivated, will love what they are doing in class, and will enjoy attending school.

When students look for 'interesting' teachers and classrooms, they are in fact looking for an environment that caters to their core needs for autonomy, competence and relatedness. They look for teachers who are able to meet their needs and interests and who can create interesting and challenging lessons that are relevant to their lives.

A classroom where 'joy of learning' exists is one in which students are given appropriate levels of challenges and one in which they are able to make decisions about their learning. When students are faced with difficulties, there should also be a support system in place to help them.

When they experience 'joy of learning', students benefit from a positive learning experience. From the teacher's perspective, it would always be more rewarding if students were motivated and eager to learn. When teachers see motivated students, they too, become more interested to teach.

Joy – A positive emotion

How to trigger it ?

Interesting lesson from students' perspective

Students are intrinsically motivated to learn

Students experience success and look towards the next challenge

FEATURE

The Joy of Learning:

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3. Display patience

When students are developing skills through practice on unfamiliar or complex tasks, teachers should display patience. They can:

- take time to listen
- give encouragement and time for students to complete tasks in their own way
- offer helpful hints when students seem stuck
- praise signs of progress
- postpone advice until they understand the students' goals and perspectives, as well as
- provide scaffolding when it is needed and invited.

For example, if a teacher notices that a student in a Mathematics class is facing difficulty in understanding the concepts taught, instead of providing the answer immediately, the teacher could provide scaffolding in the form of more explicit questioning that could direct the student towards the concept, and give the student time and space to figure it out independently as he or she continues to engage in the lesson with the class.

Time – spend it to gain it!

Teachers often feel they don't have the luxury of time to let students learn at a slower rate. However, when students are able to learn at their own pace, they are better able to accommodate new knowledge, understand conceptual as well as emotional issues, and integrate what they have learned with deeper information processing and understanding. This long-term benefit will outweigh any short-term loss due to time.

The sum of the parts is greater than the whole!

Knowledge generated by a group of individuals often exceed the sum total of the knowledge possessed by the individuals at the onset of an activity.

Why?

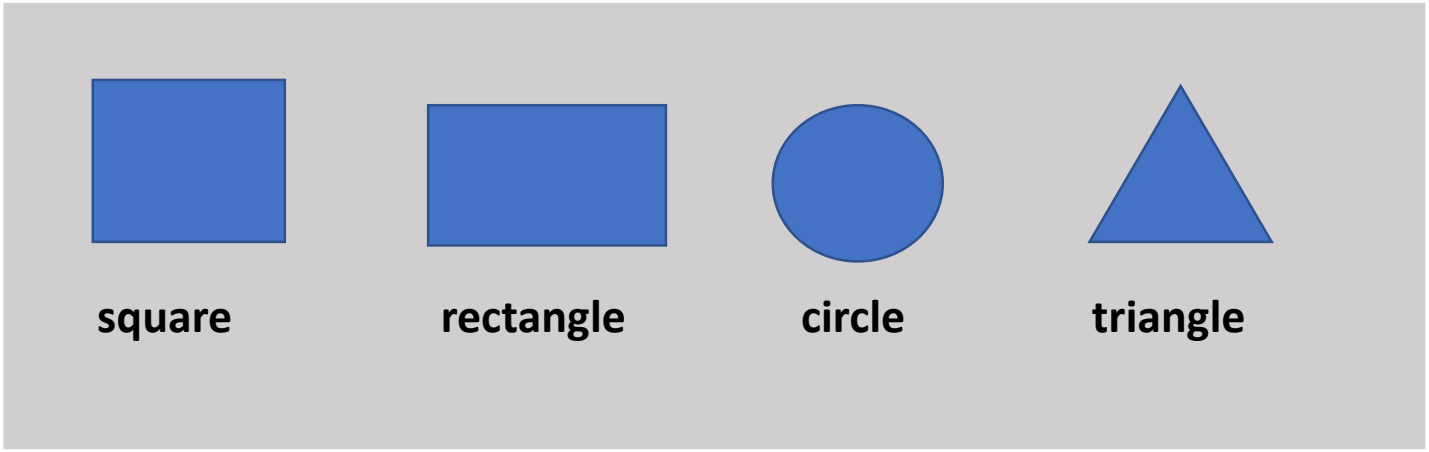
This is so as the rich interactions between individuals generate ‘new’ knowledge.

How?

Meaningful activities are not only fun-filled but also motivating. They go beyond surface learning for pupils and engage them in constructing mathematical knowledge for themselves.

THREE MATHEMATICAL TASKS

Task 1 – The triangle

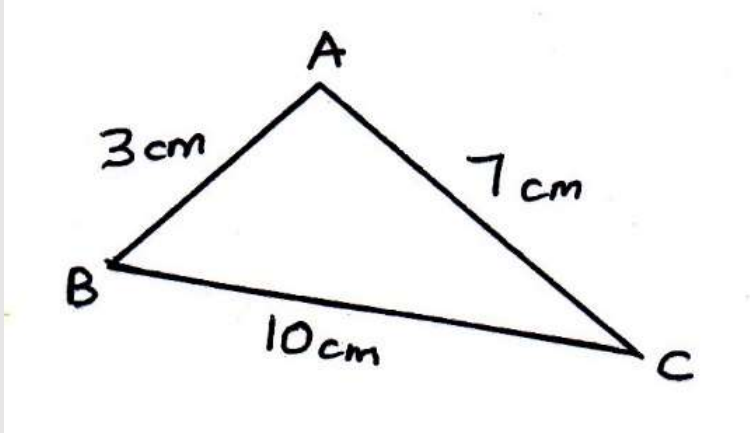


1. Draw a triangle with sides 3 cm, 7 cm and 10 cm

2. Find the area of a triangle with sides 3 cm, 7 cm and 10 cm.

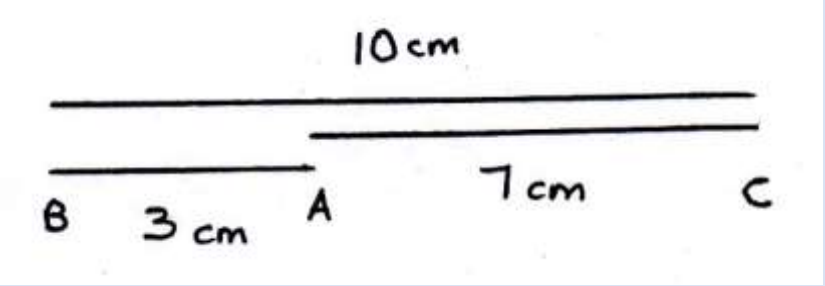
Draw a triangle - Some possibilities

Student will draw a triangle and put the dimensions around it

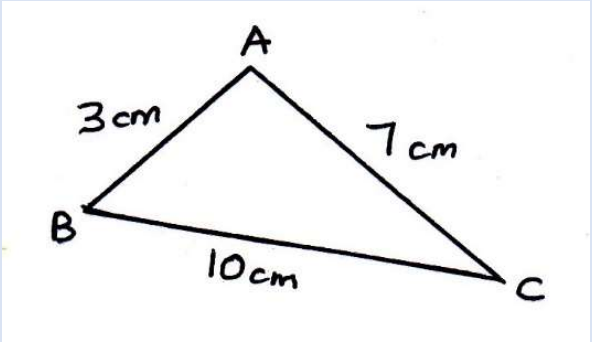


Student will realise that the task is erroneously presented!

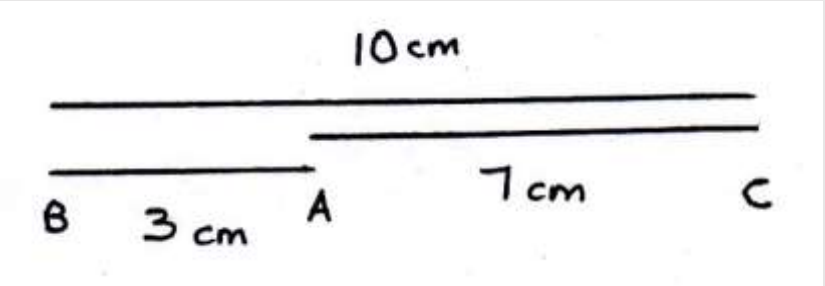
Why? The figure explains.



Find the area – some possibilities



Area = ½ (7) (3) = 10.5 cm^2
[making the assumption that AB and AC are perpendicular to each other]

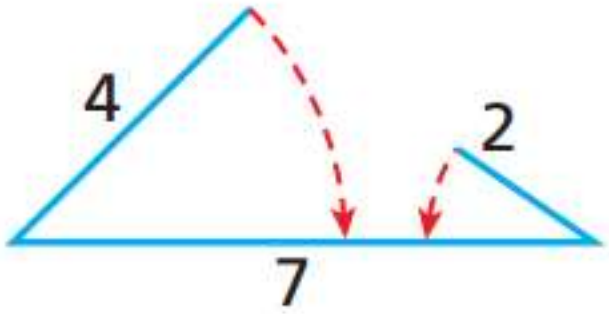


Cannot do the question / the area is zero?
The lengths of the triangle are wrong. We cannot make a triangle with sides 3, 7 and 10.

Teachers may have put off introducing students to the key fundamental property of a triangle to a later time but this is not educationally sound.

Any idea or problem or body of knowledge can be presented in a form simple enough so that any particular learner can understand it in a recognizable form (Bruner, 1966, p. 44).

Can form
a triangle



Cannot form
a triangle

Groupwork activity:
Investigating relationships between the sides of a triangle

- Give students sticks of varying lengths.
- Ask them to make triangles
- Collect all responses
- Guide them to visualise the relationships between the sides of a triangle.

Task 2

My calculator is broken – help me add

1 + 2 + 3 + 4 + 5 + … + 50 = ?

My solution is:

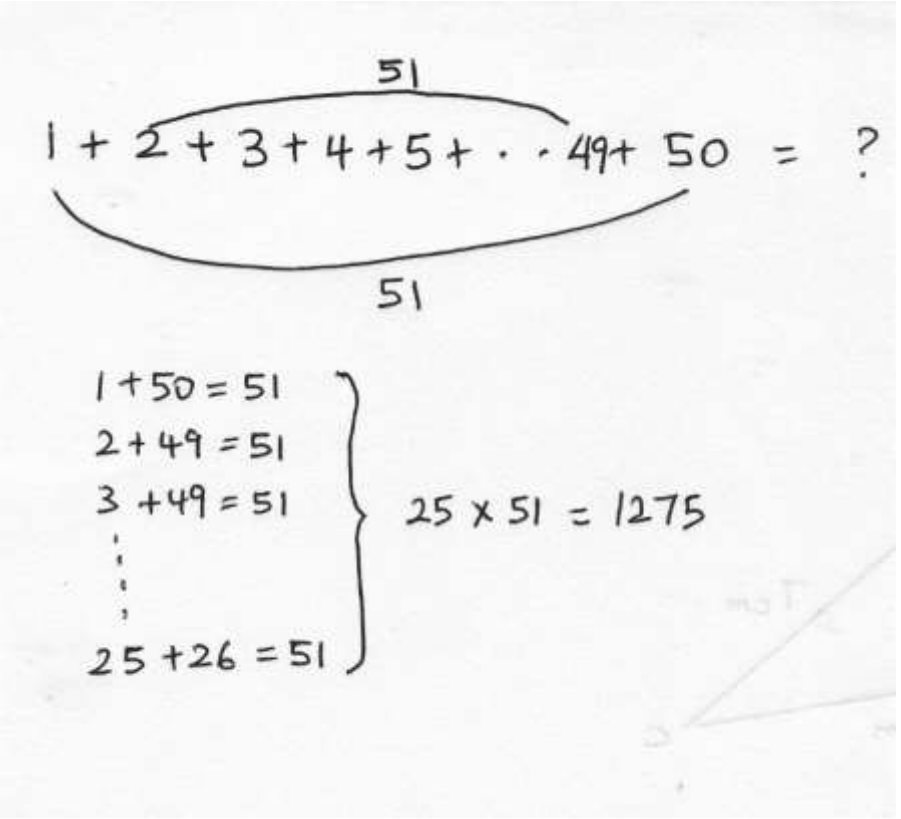
Students work in groups on the task

Solution 1

Students just laboriously added the numbers from 1 to 50 and got an answer. Some after working through long strings of addition arriving at an incorrect answer due to sheer carelessness.

Solution 2:

Students used the heuristic – Look for a pattern and obtained an answer



A young mind's elegant solution

1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 + 9 + 10 = 55

11 + 12 + 13 + 14 + 15 + 16 + 17 + 18 + 19 + 20 =

(10 + 1) + (10 + 2) + (10 + 3) + ……..(10 + 10) = 10 x 10 + 55 = 100 + 55

21 + 22 + 23 + 24 + 25 + 26 + 27 + 28 + 29 + 30 = 20 x 10 + 55 = 200 + 55

31 + 32 + 33 + 34 + 35 + 36 + 37 + 38 + 39 + 40 = 30 x 10 + 55 = 300 + 55

41 + 42 + 43 + 44 + 45 + 46 + 47 + 48 + 49 + 50 = 40 x 10 + 55 = 400 + 55

So the sum of 1 + 2 + 3 + … + 50 = 55 + 100 + 55 + 200 + 55 + 300 + 55 + 400 + 55

= 55 x 5 + 1000

= 275 + 1000

= 1275

Task 3

Always Sometimes Never
(PISA 2021 – Example 3)

Introduction to the nature of the tasks

1. Teacher exposition is needed

2. Teacher should engage students in

- **Comprehending the task**
- **Articulating their thinking**
- **Supporting their thinking with examples**

PISA 2021

Always sometimes never

Question 1/3

For each statement, indicate if it is **always true**, **sometimes true** or **never true**

Statement	Always True	Sometimes True	Never True
A 14-year old girl was at least once in her life half her current height.	○	○	○
A 14-year old girl is taller than a 10-year old girl.	○	○	○

ALWAYS SOMETIMES NEVER

Statements that people make can generally be grouped into three different categories:

Statements that are **ALWAYS** true;
Statements that are **SOMETIMES** true; and
Statements that are **NEVER** true.

The statement:
"*A number that is divisible by 4 is also divisible by 2*"

is **ALWAYS** true because 2 is a factor of 4.

The statement:
"*A number that is divisible by 9 is also divisible by 6*"

is **SOMETIMES** true. For example, 36 is divisible by 9 and by 6, but 27 is divisible by 9, but not divisible by 6.

The statement:
"*The sum of two odd numbers is odd*"

is **NEVER** true because the sum of two odd numbers is always even.

Students to discuss in their groups the statements

Teacher to engage them with a statement at a time

After students have examined a statement teacher to engage everyone in whole class discussion, collecting as many example as possible

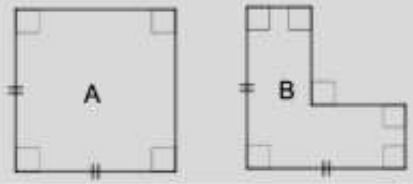
In this way some students who may be "lost" at the beginning will soon come aboard.

PISA 2021

Always sometimes never

Question 2/3

For each statement, indicate if it is **always true**, **sometimes true** or **never true**

Statement	Always True	Sometimes True	Never True
When a whole number is multiplied by itself the answer is even.	○	○	○
Doubling a whole number produces an even number.	○	○	○
Halving an odd whole number produces a whole number	○	○	○
$3x + 1 = \frac{6x + 2}{2}$	○	○	○
 The perimeter of figure A is greater than the perimeter of figure B.	○	○	○
If a coin is flipped 50 times it will land heads up 25 times.	○	○	○

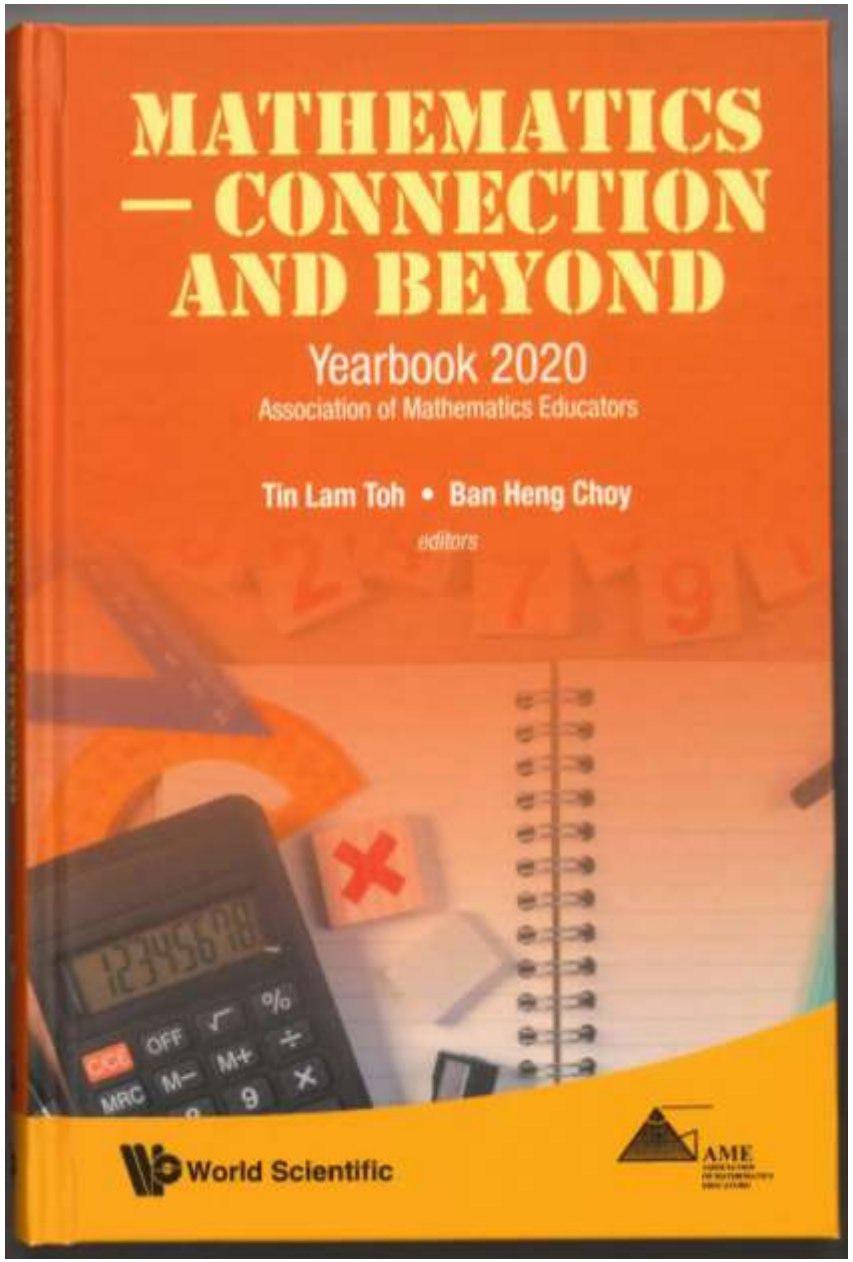
Always sometimes never

Question 3/3

Each of the following statement is **SOMETIMES TRUE**.

For each statement provide an example of when the statement is true and when the statement is not true.

Statement	Example of when the statement is true	Example of when the statement is not true
The person with the largest number of coins has the largest amount of money.	*Enter your example here*	*Enter your example here*
A – B = B – A	*Enter your example here*	*Enter your example here*
If you add the same number to the numerator (top) and the denominator (bottom) of a fraction, the fraction value increases.	*Enter your example here*	*Enter your example here*



Helpful Reading ....

Chapter 8:
Student-centred learning mathematics

5 E Instructional Model for Mathematics

1 **Engage (provide rationale / arouse interest)**

2. Explore (student activity – preferably peer or group)

3. Expain (student talk)

4. Elaborate (practice skills and behaviours)

5. Evaluate (peer and self)

THANK YOU

Wish everyone a good conference!

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