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Towards a New Normal for Teaching and Learning Mathematics in the Malaysian Classroom: Integrating Thinking, Problem Solving and Technology

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Abstract

The Malaysian curriculum specification highlights mathematical thinking, problem solving and the use of information communication technology (ICT) as its emphases towards developing students' learning of mathematics. This paper suggests a practical teaching approach that integrates these emphases through the use of a dynamic geometry software and spreadsheet to integrate mathematical thinking problem solving and ICT.

Introduction

The phrase "new normal" was first coined by El-Erian (2010) and was written in response to the 2009 world economic crisis. It relates to the things that are likely to happen in the absence of changes in policy and business approaches (El-Erian, 2010) to address the world economic crisis. Applied to the field of mathematics education, the phrase "new normal" appears to have slightly different meanings particularly because in a sense there has been no crisis of such magnitude in mathematics education when compared to the world economic crisis. In addition, calls for reforms have been regularly mooted by mathematics educators to address weaknesses in mathematics education. Over the last half a century, there have been constant calls from the community of mathematics educators to reform school mathematics. The concern is that without reforms school mathematics may degenerate into meaningless application of formulas and rules and subsequently children will not truly appreciate the power of mathematics. Subsequently, there have been constant revisions to the mathematics school curricula. Since the 1990s there have been calls for reform to make mathematics more relevant to the learners, to focus on problem solving and mathematical thinking (National Council of Teachers of Mathematics, 1980, 1991, 2000).

The term "new normal' in this paper, thus can be taken to refer to the norms that would emerge should the global calls for reforms are actualized in the classroom. The new normal connotes the normal practice of teachers and students that promote the learning of mathematics that is relevant to students. Malaysia too has been caught up with this wave of global reforms in mathematics education. Coupled with the global drive towards problem solving and mathematical thinking, there is also the national agenda of making Malaysia globally competitive (National Economic Advisory Council, 2010a, 2010b). In conjunction with this national agenda towards making the country competitive, there have also been many educational initiatives to develop the human capital of the country which is technology savvy. One such initiative was the Smart School Project (SSP) to incorporate technology into education (The Smart School Project Team, 1997; Multimedia Development Corporation, 2005). The Smart School Project aims to incorporate the use of information communication technologies (ICT) into schools to enhance teaching and learning. The SSP was not specifically focused on

mathematics but rather targeted in making the whole school technology-smart. Subsequently, over the last ten years the Ministry of Education in Malaysia (MOE) has put in effort to help teachers use technology in the classroom. Equipment such as notebook computers, desktop computers, LCD computers, computer screens and printers have been supplied to all schools in Malaysia (Muniandy & Mohammad, 2010). Much attention was also given to professional teacher development in the area of ICT both at pre-service and in-service level.

Following the SSP there has also been initiatives to infuse technology into the teaching and learning of mathematics. In particular, the (MOE) also embarked into mathematics-related ICT initiatives by introducing graphing calculators and dynamic geometry softwares into schools. Graphing calculators were supplied to schools and a national license was acquired in 2002, enabling the Geometer's SketchPad (GSP), a dynamic geometry software to be installed into all Malaysian public schools.

The New Normal for the Mathematics Classroom

Curricular Specifications

The inclusion of technology as one of the emphasis in the mathematics classroom has broadened the scope of teaching and learning. The challenge for the introduction of ICT into the mathematics classroom however involves more than just bringing technological equipment into the classroom. The use of ICT needs to fit into the framework of the content and the nature of the subject. In the case of mathematics, there is then a need for ICT to become an enabler for learning mathematics. In the last review of the national mathematics curriculum in 2003, three main foci were incorporated in the curriculum: problem solving, mathematical thinking and the use of technology. These three main emphases are evident in the five areas that form the pillars of the Malaysian mathematics curriculum, namely: a) problem solving in mathematics, b) mathematical communication, c) mathematical reasoning, d) mathematical connections, and e) application of technology (Curriculum Development Centre, 2006). As a consequence, the challenge for the mathematics teacher is thus to find ways how these tools can be used in conjunction with problem solving and at the same time encouraging the student to think mathematically, emphasizing communication and reasoning.

The new curriculum calls for the teacher to become familiar with new ways to teach mathematics, motivating students and making mathematics more interesting. The vision of the new normal for the mathematics classroom thus aims to make students more mathematically literate. Students then should be able to acquire mathematical knowledge and reflectively use it meaningfully in a variety of real world situations. From this perspective teachers need to be mindful that ICT are the means and not the ends of teaching and learning mathematics in the classroom. ICT is thus an enabler towards developing students who is mathematically literate.

The introduction of ICT into the classroom poses its own set of challenges. First the teacher needs to become familiar with new technology tools, to understand how these tools work and how they can be used as an enabler of learning mathematics. Second, the teacher then has to incorporate these tools into the lesson mindful that the ICT tools are just enablers. The following sections in this paper will look at several ways how this enabling can take place through the use of the GSP.

Creating Meaningful Contexts

In the learning of the topic of parabola and conics, often formulas are just quoted without context. The use of the GSP can enable meaning to be created through the use of vivid visuals

(Kimberling, 2003). Figure 1 shows the task where the perpendicular bisector of two points A and B are traced. B is a point on the circumference of a circle. Depending on the position of A, the trace of the perpendicular bisector can yield different forms of conics.

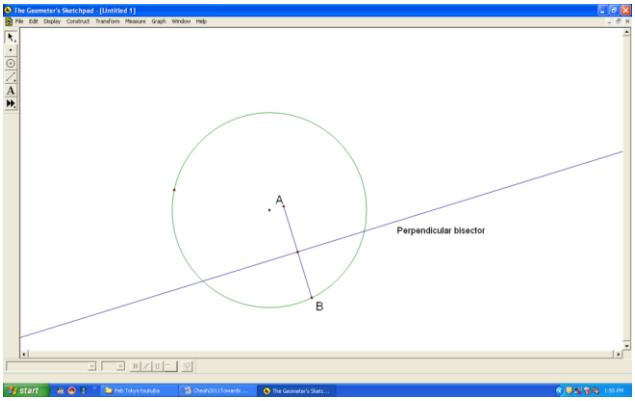

Figure 1. Tracing the perpendicular bisector of AB.

If point A is on the circumference of the circle, the trace is a circle. As shown in Figure 2, if point A in the circle the trace forms an ellipse, and if point A lie outside the circle then the trace forms a hyperbola. Similarly, a parabola is formed by the trace of the perpendicular bisector of a moving point on a fixed line and another fixed point not on the fixed line.

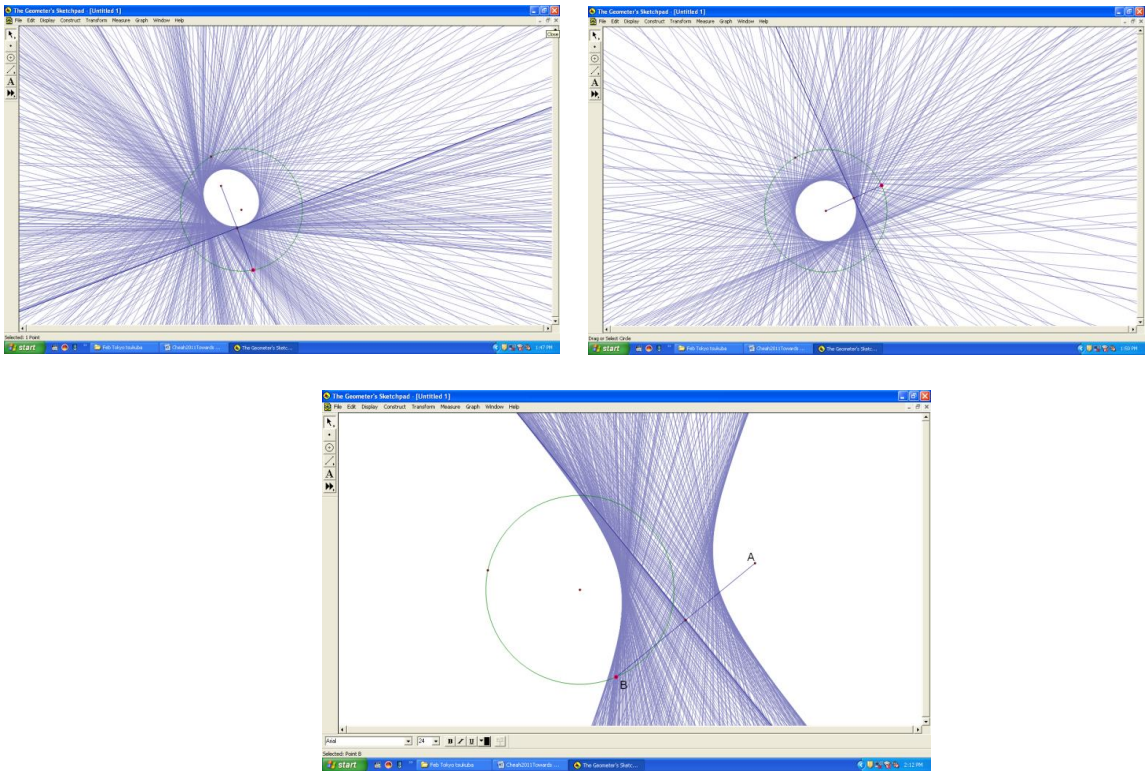

Figure 2. Trace showing an ellipse, circle and hyperbola depending on the position of A.

Making Mathematical Connections

One main difficulty of students learning algebra and functions is that often they are unable to visualize the connections between the mapping as is represented by algebra and that characterized by graphs. The example as shown in Figure 3 and Figure 4 illustrates how the Geometer's SketchPad can be used to make connections between algebraic functions and graphical representations (Chanan, Bergosky & Bennet, 2002).

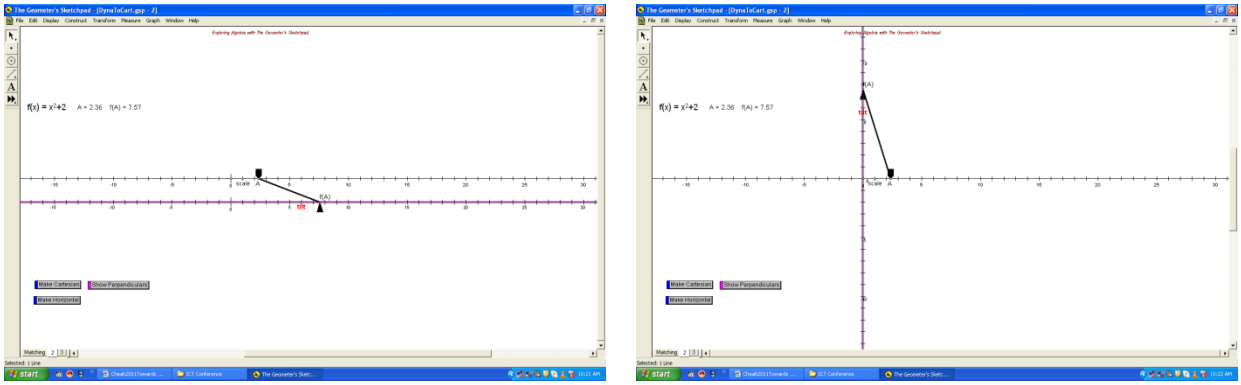

Figure 3. Transforming linear mapping into Cartesian mapping.

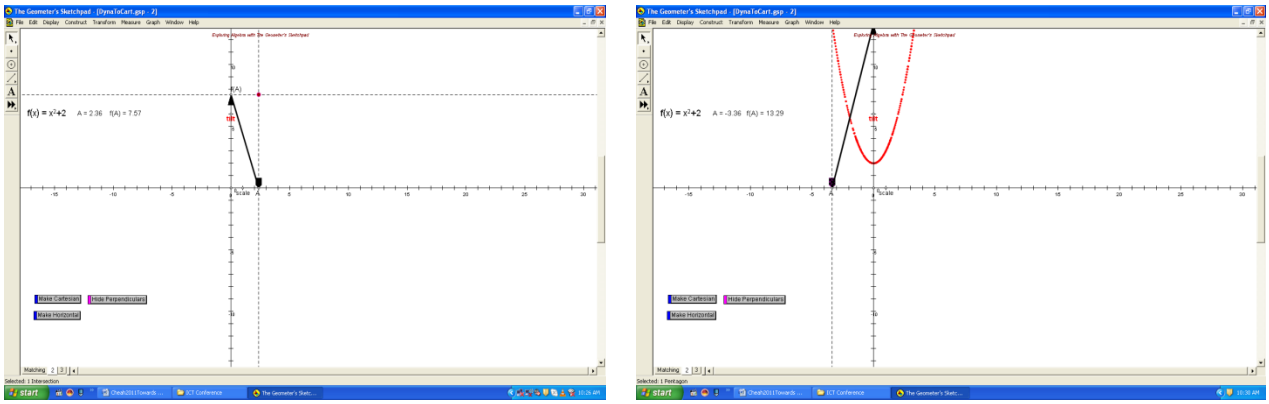

Figure 4. Creating graphs using the trace function.

Creating Real-Life Problems

One way of making mathematical ideas relevant to students is to create mathematical problems that can help the students connect to real-life situations. An example of a mathematical problem that uses the GSP helps students visualize the problem is shown in Figure 5 (Cheah, 2008).

The problem. Grandfather has a goat farm. He is afraid that the wolf may harm or eat his goats. So he uses all his money to buy fences to protect them. However, as he is poor, he can only afford to buy 24 pieces of fences of 1 metre length each. He wants to build a rectangular fence in a way not only to protect his goats from the wolf, but also to provide as much space for them. What should the dimensions of the fence be?

Use of ICT. The use of ICT to help students appreciate and visualize the problem better is done both through the use of the EXCEL spreadsheet and the Geometer's SketchPad. The EXCEL file shown in Figure 6 enables students to fill in different values for the length of the

rectangle and see how this affects the value of the area while the click-and-drag feature in the GSP enables students to see how the area of the rectangle changes with different values of lengths of the rectangle.

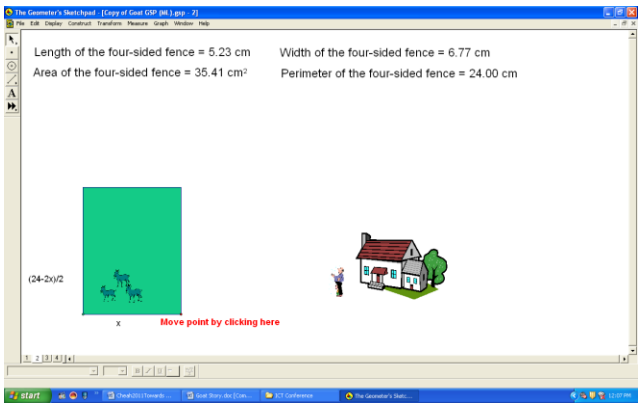

Figure 5. Using ICT to help students understand the problem.

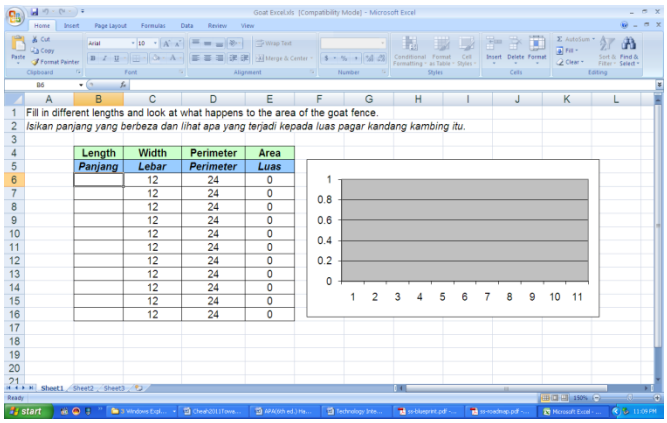

Figure 6. A spreadsheet enabling students to test different variable values.

Conclusion

ICT is a powerful media and if used appropriately in conjunction with problem solving and mathematical thinking creates new ways that can facilitate the learning of mathematics. The click- and-drag feature in GSP provides not only vivid imageries but also helps students visualize the meaning of changing variable values. The prime advantage in the use of ICT is that it allows repetitive calculations to be done quickly and accurately thus freeing up time for mathematical discourse and thinking. The use of ICT seems to be able to open up new and exciting ways for teachers to teach mathematics.

The examples shown in this paper shows how the GSP and EXCEL spreadsheet can be used meaningfully in problem solving and to visualize mathematical concepts that would be difficult to do in a traditional mathematics without the aid of ICT.

However for ICT to be sustainably used in the mathematics classroom as envisioned in the mathematics curriculum in Malaysia, many challenges need to be overcome. Teachers need to be trained and exposed to new technologies. Further, the roles of the teachers in the classroom

need to be reviewed, mindful that the expectations of students and teachers will change through the use of ICT. What then is the new normal for the mathematics classroom? What will the new norms of the classroom be and how can this be integrated with the existing norms of the classroom? What aspects of the curriculum need to be emphasized and what needs to be de-emphasized? A host of questions will arise. Yet there needs to be the courage to create a new normal for the mathematics classroom. It is therefore critical that teacher professional development and teacher support be given due prominence, to constantly encourage teachers to use these new ideas, and to cultivate reflective practice while using these new technologies. This would then enable the teachers to constantly improve their teaching skills and deepen their knowledge in the subject. Sustaining this new normal of teaching and learning mathematics can then become a reality.

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