The Influence of Technology on the Teaching and Learning of Mathematics in Singapore

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Abstract

In this paper, a brief account on the development of integrating technology in the mathematics curriculum in Singapore over the last decade is first discussed. The impact of such an initiative in the mathematics classroom, on teaching and learning of mathematics in Singapore, and in the training of mathematics teachers is considered. Future directions and projects are also briefly presented.

1 Introduction

Slightly more than a decade ago, the advent of affordable and accessible Information Technology (IT) has brought about significant changes and challenges in many aspects of Singapore's mathematics education. Along with other initiatives such as the Thinking School Learning Nation (TSLN) philosophy and National Education (NE), Singapore's Ministry of Education (MOE) launched the first IT Masterplan for education (MP1) in 1997 [1]. The main objective of MP1 was to provide the necessary infrastructure to all schools, so as to make IT-enriched learning environments accessible to every student by 2002 [2], [3]. This target was well met. By 2002, all schools in Singapore had the necessary IT infrastructure and resources.

Apart from providing the physical infrastructure, MP1 had other objectives. These include training teachers in basic IT skills and equipping teachers with some pedagogical knowledge on integrating IT in their lessons. In addition, curriculum content was reduced (by some 30% across all subjects) to allow for more use of IT in the classrooms.

The second Masterplan for IT (MP2) was launched in July 2002 and is expected to progress to 2008. The main objective of MP2 is to encourage effective, innovative and pervasive use

of IT in an ability-driven education. Access to IT facilities should no longer be an issue; the question now is how these are used effectively to support future initiatives.

In the early 1990s, the use of Computer Assisted Instruction (CAI) in mathematics teaching was introduced. This resulted in the production of a series of CAI titles by the (now defunct) Curriculum Development Institute of Singapore (CDIS). The series consists mainly of drill-and-practice type of courseware. This was followed later by titles such as the *Dynamic Mathematics Series*.

Apart from these courseware titles produced by the CDIS, at the secondary level, teachers were exposed to tools such as *Graphmatica*, *Geometers' Sketchpad* (GSP) and *Microsoft Excel*. Teachers were encouraged to integrate the use of these tools into their mathematics lessons. To help them, many workshops and professional development programmes, including sponsorship to attend international conferences, such as the *Asian Technology Conference in Mathematics* series, were made available. Under the MP2, schools can request for specialized workshops based on the schools' individual needs to be held for their teachers.

2 Impact on mathematics learning and teaching

Against such a backdrop and guided by the vision of these Masterplans, one question that mathematics educators would naturally ask is whether the introduction of IT has had any significant impact in the mathematics classroom. There have been numerous local studies carried out to evaluate the influence and impact of the use of IT on mathematics learning and teaching. However, these studies are often very focused on a specific technology for a specific topic under some specified conditions. Results from these studies, even if valid, may not be entirely applicable across all topics in the mathematics curriculum.

Nevertheless, it is evident that teachers have become more IT-savvy. There is increased confidence in the basic use of IT in the classroom, particularly in terms of using various presentation tools. Very often, open tools or special purpose software are used as "demo tools" to help students visualize or appreciate certain mathematical concepts. In addition, teachers are also more aware of the range of IT tools available (including online resources such as HeyMath) and their possibilities. This growing awareness helps mathematics teachers accept the use of technology in the classroom.

Apart from using IT presentation tools, at elementary and secondary levels, teachers also take advantage of the computer's power and speed in performing computations. The reports in [4], [5] and [6] are but a few examples which illustrate what mathematics teachers in Singapore have been able to do at these levels. At pre-University and tertiary levels, hand-held technology, computer algebra systems and other special purpose software titles are commonly used in various courses. For instance, Ang and Awyong successfully integrated the use of *Maple* in both Algebra and Calculus undergraduate courses [7]. Cheang exploited the freeware "R" in statistics courses [8] while Toh introduced a novel way of using GSP in the teaching of mechanics [9].

3 Curriculum

Has the Singapore mathematics curriculum changed or evolved because we now have powerful IT tools? The content reduction exercise undertaken by the MOE several years ago aims to provide more instructional time to accommodate the various new initiatives, the use of IT being one such initiative. Curriculum content, however, remains somewhat the same over the last ten years despite the availability and accessibility of IT tools.

Textbooks used in schools here remain largely the same. Although there may be more exercises that require the use of some form of technology, the content and approach have not changed much. One reason could be that textbooks are written to help students with their high-stakes examinations, such as the Primary School Leaving Examination (PSLE) and the GCE "O" and "A" level examinations. As long as items in these examinations remain as before, there will be no motivation for textbook writers to deviate too far from the norm or traditional.

At lower levels, the mathematics curriculum emphasizes skills and conceptual understanding. Technology is used to help students learn the skills and concepts. There is little, if any, emphasis on experimental or computational mathematics, though some tools may have been used to perform tedious or routine computations. At the higher levels, although Computer Algebra systems (CAS) may have been used, they are seldom exploited for their full potential in symbolic computations and experimentations. One reason could be that the curriculum does not require it, and neither does the assessment. In other words, despite the advent of powerful computing and technology tools, the Singapore mathematics curriculum has not changed much in the last ten years.

What has changed significantly is the way the content is delivered. Apart from delivery in the classroom, some schools post mathematics problems online and students are to download them from home. As it turned out, this mode of "delivery" became crucial when Singapore was hit by the Severe Acute Respiratory Syndrome (SARS) epidemic in the first half of 2003 and schools were closed for a period of time. Many schools in Singapore switched to an "online distance learning" mode almost instantly, demonstrating the ability of their teachers and students to exploit technology when necessary.

4 Teach Less, Learn More

In one of his speeches[1] to the nation in 2005, the Prime Minister of Singapore appealed to all teachers in the country to "teach less so that our children can learn more". It has long been felt that school children in Singapore have very little time for anything else because of the tremendous amount of homework and schoolwork dished out by their school teachers. There are other ways to teach and to learn, and teaching more does not necessarily lead to more learning. It is perhaps time we took a careful look at what, how and how much ought to be taught in school.

The "Teach Less Learn More" (TLLM) philosophy is essentially about igniting a sense of curiosity and motivating a desire to learn. If children are curious and want to learn, the teacher

[1]Speech was made at the "National Day Rally", an annual event where the Prime Minister would address the nation.

does not need to load them with information in the classroom. Instead, instructional time could be reduced to allow more time for pupils to explore, discover and learn on their own.

This is of course, a very desirable scenario, but the fact is that the idea is neither new nor easy to translate into practice. This is perhaps where technology can play a crucial role. If the intention is to place the major part of learning on the learner, then IT tools may well be one of the main media to facilitate such learning. In other words, the teacher teaches less, but the learner learns more, with the aid of appropriately chosen IT tools and in an IT-driven environment.

5 The Future

Technology will continue to play a major role in education, and particularly in mathematics education [10]. The challenge for us is to move and align our curriculum and assessment in such a way that mathematics is not diluted but in fact enriched because we have the technology. The process may be slow and sometimes painful, but we are surely seeing some encouraging signs.

The curricula for Singapore's junior colleges (Pre-University level) have been revamped. From 2006, teachers and students will have to handle new syllabuses for all subjects, including mathematics. In particular, graphing calculators, or GC, (which hitherto are allowed only in Further Mathematics) will now be used more widely in the mathematics courses. We expect both teachers and students to exploit the potential of GC fully as the curriculum matures. Also calculators will be introduced to primary 5 and primary 6 pupils (Grade 5-6) in due course.

The computer can do things much faster. What was possible but took time, later became possible for the teacher to demonstrate in class. Now, it is possible to the student to do it himself and perhaps engage in computational experiments in mathematics.

All along we are under the impression that technology benefits more the students of higher abilities. In recent years it was found that it also assists the weaker students to by-pass the hurdle of algebraic manipulation so that they may now proceed to learn advanced mathematics without handicap. This is definitely an area with plenty of room to explore.

One area that badly needs attention is assessment. Although the mathematics curricula have undergone many changes, and ways of implementing the curricula and teaching the subject have evolved, assessment modes in mathematics have not changed much over the years. This is likely to remain so in the foreseeable future. As pointed out by Ang [11], until and unless assessment in mathematics is aligned with the innovation, it may be difficult to convince both teachers and pupils to invest time and effort to embrace the innovation.

In December 2006, the MOE announced that together with the Infocomm Development Authority (IDA), 15 new schools under the "FutureSchools@Singapore" Project will be built by 2015. The first of such school is a primary school that will be ready by 2008. The main thrust of the project is that these schools will endeavour to go beyond current curriculum and teaching strategies. These schools will also experiment with different ways of using emergent information and communication technologies (ICT) to facilitate and enhance learning.

In terms of mathematics education, how such an initiative will eventually translate into a better mathematics curriculum, better mathematics instruction, and better mathematics

learning remains to be seen. It is a long road ahead and there will be many factors that will contribute to either the success of failure of the project.

6 Conclusion

There is a general consensus among mathematics educators that applications of technology can be listed under the following four headings.

1. To assist in computation and presentation
2. To integrate into curriculum (for example explaining concepts)
3. To induce changes in teaching content and assessment
4. To overcome handicap in basic mathematical operations

We have reported briefly in this paper the progress of applications of IT in Singapore. In short, items 1 and 2 above have been taken care of whereas items 3 and 4 are in progress.

Mathematics syllabus at all levels (Grades 1-12) has undergone major revamp recently. The new syllabus has been implemented since 2006. There is a genuine reduction of content. Also school leaving examinations may no longer play such a dominant role as before. In other words, their importance has since been downplayed. This is good news for the development of using IT in mathematics in Singapore. In the last decade, we may have been pushed by the technology waves – hopefully, we are now in a better position to ride the waves of technology in future years.

7 References

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