Technology Usage in Mathematics Education in China

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Abstract

In this short note, we give a brief introduction to the status of technology usage in mathematics education in China. We first introduce the government's effort to build the infrastructure for CAI. Then we discuss representative CAI software systems developed in China. Finally we discuss efforts to integrate technology and education in middle schools, and curriculum developments.

1 Infrastructure Development

In the past ten years, the Chinese government has made a great effort to push forward the usage of information technology in education, as the following show [2].

1. *Building technological infrastructure for middle and high school, including computer labs, campus internet, and city-wide educational internet connections.* In the period from 2000 to 2004, the number of computers in the schools increased from 1.1 million to 6 million; the number of schools with school internet increased to fifty thousand; and the educational city-wide internet covered over four hundred cities.

2. *Integration of the curriculum and information technology.* In the government's "tenth five year plan," it was proposed to open information technology courses in high schools, junior high schools, and primary schools by 2005, 2003, and 2001 respectively. This goal has been achieved ahead of schedule.

3. *Two billion Yuan invested by the government in the western part of China to establish remote educational systems for primary and middle schools in order for schools there to share the educational resources in the large cities.*

4. *Training school teachers to increase their ability to use educational information technology.* The Ministry of Education plans to introduce information technology certificates for teachers by 2007. By 2007, each primary and middle school teacher will have at least fifty hours of training on how to use information technology.

In the future, the Ministry of Education proposes to establish internet coverage for 90% of the nation's schools by year 2010 to let the teachers in these schools share the educational resources on the internet. The government has also decided to shift the focus from hardware establishment to software development and the integration of software and hardware in real classroom applications. The goal is to turn the school internet into an intelligent teaching and learning platform.

2 CAI Software Development

A large variety of CAI software packages have been developed in China. Most of the commercial CAI software packages are digitalization of the textbook with multi-media technology. Many teachers have also developed special purpose courseware for their classes. We will mainly introduce two pieces of general purpose CAI software developed in China.

One of the earliest general purposes CAI programs developed in China was Geometry Expert [1], which is based on research results in Chinese schools on automated reasoning. In the late 1970s, Wu's method was proposed by the eminent Chinese mathematician Wen-Tsun Wu. This method can be used to prove hundreds of difficult theorems whose traditional proofs require enormous amounts of human intelligence. Inspired by the success of Wu's method, many other approaches to automated proving of geometry theorems have been proposed.

Geometry Expert was originally developed on the Unix platform around 1994. In 1997, a Windows based version was developed, and recently a Java version was released. Geometry Expert consists of two parts: the proving and reasoning part, and the drawing part. The dynamic nature of its drawing part is comparable to that of Cabri and The Geometer's Sketchpad. As a geometry theorem prover, Geometry Expert implements Wu's method as well as the area method and the deductive basis method which can generate elegant and short proofs (sometimes even shorter than those given by geometry experts).

Another representative general purpose CAI program is Z+Z, developed by Jingzhong Zhang [4]. Z+Z is similar to Geometry Expert in that it is a piece of dynamic geometry software as well as a geometry theorem prover. Besides that, Z+Z has more resources for educational purposes. For instance, it allows the user to propose a proof for a theorem and to check if the proof is correct. It can produce proofs using the theorems from the standard textbooks. Z+Z also has an instruction resource database which consists of much textbook-related courseware.

3 Integration of Technology and Education

After the software and hardware are available for the teachers, there is still the problem of how to use these technologies to improve teaching. The simple or direct usage of technology is presentation. Teachers can design courseware to show text, graphics, images and so on. With the power of the system, teachers can explain the concepts of mathematics more clearly and students can understand the ideas more easily. But teachers do not think that this meets all their needs. They hope that the system can be a tool related to the curriculum and have the power of reasoning and carrying out mathematics operations.

In order to help teachers to use technology in mathematics education, the K12 textbook center of the Ministry of Education initialized a project, "Trial Study of Applying Z+Z to National Mathematics Curriculum Reform." The trial study tried to cover the key issues on technology use in mathematics education. It concerned the selection of appropriate software, training, organization, management and so on. The project consisted of three groups [3].

First, a group was set up to guide teachers. A retired high school mathematics teacher who is also an expert in technology use in mathematics education was the head of this group. This allowed the group to serve as a "bridge" to connect technology and mathematics education.

Second, technology was embedded in mathematics textbooks. A professor from the national mathematics curriculum standard group acts as the head of this project. In the mathematics textbooks written by them, some content is based on the software system.

Third, there was a group to track the study. The members of this group were not members of the project, so that they could treat the trial study neutrally. They collected questionnaires from teachers and students, and interviewed them. They also recorded some classes and applied a video study method to find the teachers' changes, behaviors, management of classes, and so on.

One hundred and seventeen (117) schools participated in this two year trial. Many more teachers and students benefited from the trial. Based on this project, a book was published [3] which consists of two parts: one part is research papers on CAI; another part consists of courseware designed by teachers.

4 Scientific Calculators

Since 1997 scientific calculators have been allowed into mathematics teaching. By 1999 all middle school teachers used calculators in their teaching. Students can use calculators in their study of numbers, expressions, functions, and statistics and probability. Calculators are especially helpful in researching equations, complex numbers, vectors, matrices, and Calculus.

In 2000, scientific calculators were allowed on the university entrance examination for the first time. On the 2000 Shanghai College Entrance Examination, for example, 6% of the total score (nine of 150 questions) depended on calculator use. The entrance examinations include some problems about number operations and function concepts, and also include exploration questions. We have been impressed with the results on problems ranging from simple manipulation to explorations of open questions. Some sample questions follow.

In 2001 the following problem about exploring a function property with the calculator appeared.

Example 1 For $y = \frac{\lg x}{x}$ $(x > 1)$, select the correct statement(s) from the following:

1. $y = \frac{\lg x}{x}$ is monotonically decreasing on $(1, +\infty)$.
2. $y = \frac{\lg x}{x} \in \left(0, \frac{\lg 3}{3}\right]$.
3. $y = \frac{\lg x}{x}$ has a minimal value in $x \in (1, +\infty)$.
4. $\lim_{n\to\infty} \frac{\lg n}{n} = 0$, $n \in \mathbb{N}$.

From the 2005 examination, a problem about exploring the solution of an inequality with a calculator:

Example 2 Suppose that a city has 400 m^2 of new buildings in 2004, and that every year the area of new buildings increases by 8% over the previous year. Besides that, the city builds 500,000 m^2 of new buildings each year. Then, at the end of which year will

1. the accumulated area of all new buildings exceed 47,500,000 m^2?
2. the percentage of the area of new buildings exceed 85%?

Most students in Shanghai middle schools use the CASIO fx82ES calculator. A handbook by teachers on how to integrate the CASIO fx82MS and 82ES with mathematics teaching has been finished.

In 1998 a centre for modern education technology was set up in East China Normal University. It has begun to research how graphing calculators are used in teaching. About fifty high schools are doing special experiments with the help of graphing calculators. The main graphic calculator is TI-83 plus and others.

The eminent Chinese mathematician Wen-Tsun Wu once said: “As a mathematician, I believe that all of us should consider the following question: in this new information age, what kind of role could computers play in mathematics research and education?”

In the Shanghai area, all teachers and students believe that modern information technology must become a valid tool for teachers to teach mathematics, and further that it must become a powerful assistant for students to learn and do mathematics, understand mathematical concepts, and explore mathematical problems.

References

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