Integrating Technology into Mathematics Teaching and Learning

Mhairi (Vi) Maeers
University of Regina, Saskatchewan, Canada

Abstract: This paper will address a new initiative in a Faculty of Education. Networked computer mini-labs (4 computers) have been located in teaching classrooms. The author, who teaches mathematics education classes to preservice teachers specializing in teaching at Grades K-5 (elementary) and Grades 6-9 (middle years), has been employing the mini lab located in her classroom to effectively integrate computer technology into the teaching and learning of mathematics. This paper, which discusses one part of a research project funded by the Faculty of Education Professional Development Fund and involving three methods instructors (Mathematics Education, Music Education, and Early Childhood Education), focuses on the experiences with the integration of technology in mathematics education, the challenges, the lessons learned, and the future.

Background Information

A number of years ago the Faculty of Education at the University of Regina was informed by some school boards, in a memo to the Dean, that our graduating students (specializing in Grades K-8) would need to be competent with technology in the classroom to be hired to teach. At the Faculty of Education we were faced with a real dilemma. We had only one optional "computers in the classroom" course for the K-8 preservice teachers and no room in the program for this one course to be mandatory. How could this one optional course meet these hiring needs?

We developed a four-year plan where different "computer in the classroom" concepts would be inserted into each year of the program during classes that students must take—the generic teaching methods or Educational Professional Studies (EPS) classes. The main thrust of this work occurred in year three of the four-year program. Preservice teachers received a number of seminars in many different aspects of technology. At the end of year three these students received a certificate outlining the technology components they had taken. We were getting closer to meeting demands of hiring agencies. For more details of this plan see Maeers, Cooper, & Browne, 1997 and Maeers, Browne, & Cooper, 2000.

However, for me and for my colleagues who taught the same two groups of third year preservice teachers in the same semester, this was simply not sufficient. Having computer skills such as knowing *how to* evaluate web sites, create web sites, design Hyperstudio projects, and create power point presentations is simply a foundation for what really needs to happen, if computers are to be thoughtful supports for curriculum and instruction.

If we are going to enable preservice teachers (and thereafter inservice teachers) to integrate technology into *their* teaching we must demonstrate, through *our* teaching, effective and appropriate ways to integrate technology into our classes. We need to discuss with our students our rationale for integrating technology and help them to see why we are doing it. We need to provide them opportunities, in class, to have hands-on learning experiences using the technology. We must give them assignments which address the integration of technology in the curriculum and give them time to sort through what we have taught them, how we modeled what we taught, and our rationale for teaching that way. Our group of faculty decided to begin a project to try to do these things in our classes (Music Education, Mathematics Education, Early Childhood Education) in the Winter 2001 semester of our Elementary Teacher Education Program.

This paper describes my own experiences as part of the project. I have tried over the years to demonstrate this type of integration of technology in my mathematics methods classes to preservice teachers. I started doing this type of integration partly in response to the memo to the Dean and also because I had helped to create a mathematics website for teachers <see http://mathcentral.uregina.ca> I was beginning to see the potential for using technology effectively in my own teaching.

I do not believe that I should use technology in my teaching if a few blocks or other simple concrete objects would be just as effective (or more effective) to demonstrate a concept.

However, if technology can afford my preservice teachers an opportunity to learn a concept in ways that would be impossible without the technology, or if the technology can provide them with a different perspective on the topic (and thereafter, hopefully, enhance their understanding) then I will use it.

I think we can overuse or abuse the use of technology in teaching. We can get in the habit of using it because it's there. We can also make technology-driven decisions before making pedagogical decisions. What is driving what? We need to be concerned as teacher educators, and as teachers, that we are teaching children, then teaching children the curriculum, and finally, teaching children the curriculum using a variety of resources, one of which MAY be technology.

I am adamant that my preservice teachers go through the following process of resource selection:

1. determine what resources are available for the content to be taught
2. evaluate these resources to ensure that they are suitable
3. discriminate which resource(s) to use (we usually have far too many resources for anything we wish to teach)
4. integrate these resources into a lesson/activity at the most appropriate place.

If preservice teachers go through the above process and if they select a technological resource then I feel confident that for that preservice teacher in that lesson the resource is appropriate to the task.

Why a Mini-Lab?

In Saskatchewan, Canada, the political-educational climate encourages corporate partnerships only too willing to invest hardware and connectivity resources into school divisions. Four major school divisions have acquired Sunray appliances and have a four-computer mini-lab in every classroom as well as large labs in every school. Locally, one major school board has a partnership with IBM for a four-computer mini-lab in every classroom. Another school board has a great variety of classroom computer configurations, mostly initiated by interested teachers. What this means for a Faculty of Education is an increasing need and demand to not only teach preservice teachers computer skills, but also to model for them effective ways to use mini-lab technology in regular teaching/learning situations. In other words, preservice teachers need to be shown how to effectively integrate computer-related technologies into the curriculum.

During this past semester I have used a computer mini-lab in my mathematics education classroom, mainly as a station where groups of students could explore mathematics through technology. I have also had one extra computer with a data projector to demonstrate mathematical concepts or direct the class to specific sites or portions of software. I faced a difficult and labour-intensive task this semester to find suitable, appropriate technology that would offer my students both a rich learning experience as learners of mathematics content, and also a rich experience as learners of how to teach mathematics more effectively.

I created a file of excellent interactive websites for almost every topic covered in class. Finding these sites took hours—for every good site there are about 50 dreadful ones. I also acquired some good software that could be used in teaching mathematics. I organized the classroom into learning stations. The mini-lab learning station consisted of a task card that involved my students working on-line or with software. While a group of about 6 students were working at the computer station, the rest of the class was involved in other interactive hands-on activities. The important point in all of this is that all of my students were working with the same set of topics, and working through the same set of issues. The computer station was totally integrated into the work of the class.

I believe that the mini-lab mathematics and technology integration project was very effective. By the end of the semester I could tell that the students were quite relaxed and confident in their use of technology in the teaching of mathematics (technology used as a teaching tool) and in the structuring of learning environments (where technology is used as a learning tool). Their end of semester projects were excellent and their technology logs demonstrated a real desire to grow in their ability to access and use technology. In their field experience almost every student

experimented with some form of technology integration in the teaching of mathematics or music education. I was happy that the project worked. My colleagues were satisfied that the many extra hours of work devoted to this project had paid off. But had it?

Student Feedback

In the log reflections of one of the classes I taught during the Winter 2001 semester, most of the students were quite unhappy with their mathematics education experience. Some said that they had paid to take mathematics education, not technology education, some felt the emphasis on technology was too much (they experienced this emphasis in three of their classes this past semester), some said they wanted me to teach more (I guess they meant talk more or tell more); in general from most of the comments I felt very disappointed that somehow I had failed to meet the students' (perceived) needs. Perhaps in November, when we bring them back for two days during internship, we will hear a different story; perhaps then, after they have been immersed in schools that have mini-lab technology, they will be more appreciative of their mini-lab education experience. I hope so.

Negative student evaluations of teaching (SET) are, however, bothersome. There has been substantial debate on the Society for Teaching and Learning in Higher Education (STLHE) listserv over the years regarding the nature of student evaluations. In our own institution, there is continuous discussion on SET. The Canadian Association of University Teachers (CAUT) states that "it cannot be emphasized strongly enough that the evaluation questionnaires . . . measure only the attitudes of the students towards the class and the instructor. They do not measure the amount of learning taking place" (preamble to CAUT 1998 policy—see http://www.caut.ca). CAUT promotes the main purpose of SET is to provide feedback to teachers to help them improve their instruction and that anonymous student evaluations should never be the sole measure of teaching performance (CAUT Policy Statement 2.4). CAUT also states that qualitative comments written by students on the SET forms should be the sole property of faculty members and not used for administrative purposes.

I have included this section in the paper because I was completely unprepared for the student evaluations that I received from one of my classes (interestingly I got very good comments from the other class). If I was approaching tenure (which thankfully I have) my Associate Dean might choose to use these evaluations against me. Certainly I took a risk, and I was well aware that I was venturing into unmapped territory. I had no idea of how the students would accept the inclusion of technology into all aspects of the class. I felt that everything was going well, but in some students' minds it was not. Perhaps the answer is to return to traditional methodology, where the main strategy is telling the students the information, giving them the facts. Maybe I should be more directive in my teaching, maybe, maybe . . . But I am sure that research into these questions is going to be very important.

Reflections

In discussing some of the student comments with my colleagues involved in this same experiment, of whom all got equally negative comments from this same group of students, I arrived at some tentative conclusions:

1. I pushed the students very hard this semester to explore mathematics in an interactive constructivist manner, AND I pushed technology into that environment. For some students, mathematics is terrifying enough, but with the inclusion of technology, perhaps it simply became too much to handle for the one class. With technology integration as a focus all semester in three of their classes, they were quite overwhelmed, and quite exhausted, by the end of the semester. Certainly, they produced extremely high quality math/technology/curriculum projects and, certainly, they implemented many rich technology-related ideas in the field, but it took its toll. Indeed, some students were quite worn out by the end of the semester.
2. Some students were tired and angry, angry at having to work so hard, angry at having a number of major projects due at the end of the semester, angry because they had to hold down two jobs to keep financially afloat, angry at having no time to party, etc. etc. We became the

vents for their anger and what better place than SET forms. In face-to-face situations not one of these students said anything negative about any of the work they were involved in this semester.

3. Most students in this one section were not used to any form of experiential education. Even in their methods courses there were only a few classes that engaged students in experiential learning and that advocated and employed constructivist methodologies in class. Some students simply cannot be bothered to engage in class activities; they would rather sit passively and take in the information. But, if students do not engage actively, and construct their own understanding of teacher education, and, thereafter, teach children in constructivist ways, we will simply perpetuate the kind of teachers that many of us had 40 years ago. Interestingly, the other section, a group of Early Childhood preservice teachers (K-Grade 5) did have a great deal of coursework in experiential learning. This coursework had been taught experientially. These students did not express any concerns about the nature of the mathematics hands-on interactive component of the class, nor were they concerned about the integration of technology into the teaching and learning of mathematics. This is surprising because these students are generally more likely to have anxieties about learning and teaching mathematics and even more so with the inclusion of technology. But, the interactive, hands-on atmosphere of the class encouraged them to explore mathematical ideas, learn some mathematics, discuss different ways of teaching mathematics, and generally enabled these students to overcome their anxieties and arrive at a place of confidence in their learning and teaching of mathematics, using technology as a teaching or learning tool.

In retrospect, I believe I did push all of the students very hard, mainly because I was pushing myself very hard. I wanted to learn the most effective ways to integrate web technology and software technology into the mathematics topics I was teaching. Technology preparation for each class topic took about 40-50 hours (this was in addition to hours spent on hands-on class activities, overheads, notes, and so on that did not involve technology). I designed the learning environment for the students. Basically all they had to do was explore within this environment. I would teach this way again, but I think I would use this form of technology integration in a senior mathematics education class, where the students are more familiar with the curriculum, and where they have had one complete semester teaching in classrooms, perhaps classrooms with mini-labs. I will also advocate for more experiential teaching in all of our classes.

This form of technology integration is what I believe boards of education should be looking for—rather than separate sets of computer-related skills. But the university course preparation for technology integration may be still a distant hope, due to the extra work for faculty in course planning and implementation, and the risk of having negative student evaluations at the end of the semester and consequent implications for tenure and promotion. Perhaps school boards will have to help Faculties of Education and offer a variety of technology integration inservice opportunities for new teachers. Universities and Faculties of Education can only do so much in teacher preparation.

References

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