Would we teach without technology? A professor’s experience of teaching mathematics education incorporating the internet

Qing Li, Division of Teacher Preparation, Faculty of Education, Education Tower 1302, University of Calgary, 2500 University Drive NW, Calgary, Alberta, Canada T2N 1N4

Summary

The intent of this study is to provide information that can be useful in implementing rational changes to mathematics teacher education. In this paper, I present an approach to teach a graduate mathematics education course incorporating technology, more specifically, discussion forums, i.e. asynchronized threaded discussions via the internet. In this study, both survey of the teachers’ background and transcripts of online discussions are used. However, the main focus is on the analysis of online discourse. The data analysis is concentrated on three areas: the math phobia issue, the equity issue and teachers’ beliefs about the instructional use of technology. Three examples are described of the impact that the use of a discussion forum had on the teaching and learning experiences. Reflection on the experience and the implications for teacher educators are presented.

Keywords: technology, computer-mediated communication, mathematics education, teacher education, equity

The intent of this study is to provide information that can be useful in implementing rational changes to mathematics teacher education: ‘Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students’ learning’ (National Council of Teachers of Mathematics [NCTM], 2000, p. 11). This call to integrate technology into mathematics education challenges not only school mathematics, but also pre-service and in-service mathematics education of teachers. According to Direr,
education have emphasized the importance of learning with technology rather than learning about technology. (2001, p. 170)

Consequently, we, as mathematics educators, need to help pre-service and in-service teachers develop the ability to make use of technology by incorporating it into teacher education. According to Willis (2001), because technology is best learned in context, pre-service and in-service teachers should learn technology through the integration of technology into their course work and field experience. They should also see their professors modelling the use of technology.

Because previous research (Woodruff, Brett and MacD onald, 1998) suggested that the experience of learning online and building an online learning community allows pre-service and in-service teachers to change their attitude towards mathematics and to re-conceptualize mathematics teaching, in spring 2001, I piloted a graduate mathematics methods course integrating the internet. To date, much of the scholarship in learning about mathematics and how to teach mathematics emphasizes face-to-face experiences. Numerous questions remain to be answered for the successful integration of the internet into mathematics education. Can technology play a role in teacher education? How do online interactions support or constrain mathematics education? Is mathematics education of teachers less meaningful when people can communicate using computers? How can online collaboration contribute to teachers' understanding of current trends in mathematics education?

During the semester, I discovered much about online community building, pedagogy and mathematics learning. I saw new aspects in usual topics we face in teacher mathematics education, such as the significance of teachers' own mathematics phobia and their experience with diversity. In this paper, I examine some issues within the new frontier of integrating technology into teacher education and professional development.

I presented an approach to teach mathematics education using technology, more specifically, discussion forums, i.e. asynchronized threaded discussions via the internet. I started this project with the idea that I wanted to find out whether discussion forums are useful in mathematics teacher education and what those uses are. I also wanted to explore teachers' beliefs about the value of instructional technology. In addition, I wanted to provide teachers with the hands-on experiences of incorporating technology into their learning of the pedagogy. I thought that by using the discussion forum I would gain insights about what was going on in the teachers' minds. These insights would help me with my daily assessments and would affect my decisions of what I would do throughout the course. As the initial data and the early experience of the semester began to influence my thoughts about what I was learning, I focused more narrowly on the way in which the discussion forum facilitates the teachers' discussion of sensitive issues. These sensitive issues included mathematics phobia and equity issues which were the most salient topics emerging from the data. In addition, because of my general interest in the investigation of the instructional use of technology, I also designed the course by collecting data regarding teachers' beliefs about the value of instructional technology. This data was analysed and is presented in this paper.

In this study, both survey of the teachers' background and transcripts of online discussions were used. However, the main focus was on the analysis of online discourse, because discourse is the means through which knowledge is created and changed, although discourse is not the sole way to build knowledge (Popper, 1962).
Goals and theoretical background of the course

The course, Mathematics for Elementary Schools, is a graduate course. One of the most important goals of this course is to help the teachers dealing with mathematics phobia. At the very beginning of planning the course, I thought dealing with mathematics phobia a very important issue because mathematics, often thought of as a dreaded area, is something that a 'disturbingly large percentage of the American population fears and loathes' (Burns, 1998, p. x.). Burns (ibid.) argued that mathematics phobia is a serious national problem because it limits people's daily life and their long-term decisions. To help break the 'recurring cycle of math phobia, generation to generation' (ibid., p. x.), we need to start with our teachers. Therefore, I set the foremost goal of the course to deal with the phobia issue. The objectives of the course were

1. to help the teachers overcome their own mathematics phobia;
2. to build the awareness of the mathematics phobia problem and to explore ways of assisting the teachers to increase their confidence in mathematics learning;
3. to enhance teachers' understanding of mathematics teaching, learning and assessment based on the National Council of Teachers of Mathematics' Principles and Standards (NCTM, 2000);
4. to help teachers develop skills in various teaching strategies.

This course was grounded in theories and research from cognitive research (Bruer, 1993; McGilly, 1994), constructivist learning theory (Vygotsky, 1978; Young, 1997) and the development of new learning technologies (Scardamalia et al., 1994). In particular, social constructivism underlies my conception of the course. In this view, knowledge is constructed and advanced through social interactions (Kanuka and Anderson, 1998). Because of my belief that knowledge construction is based on social experiences and that computer-mediated communication (CMC) provides 'an effective means for implementing constructivist strategies that would be difficult to accomplish in other media' (Driscoll, 1994, p. 376), I integrated the internet with sustained educational experiences to help the teachers develop skills and advance knowledge in mathematics education.

Methods

Data

In this study, I used several data collection techniques to ensure triangulation of the data. I maintained a journal recording my actions such as lesson plans and self-reflections of each lesson. I also saved all the transcripts of the threaded discussion. Because I was using discussion forums in the course and looking at technology in terms of its educational value, I conducted an anonymous survey at the beginning of the course. This survey collected data about the teachers' technology background. I did this survey to find out who my teachers were and what they already knew about instructional technology. The survey contained two major components: teachers' demographic information, and their confidence level of both using and teaching with technology. The Appendix contains sample questions used in the survey. I analysed the survey data using descriptive statistics. This provided both the demographic information and technology
background of the teachers. I also coded the transcripts of the threaded discussion and my journal, and identified the emerging themes. This qualitative analysis of the data provided information to answer my research question and the identified themes were explained below.

There were 10 participants – six female and four male in-service teachers – who were enrolled in this graduate course in spring 2001. All the teachers completed the survey. Among the teachers, nine majored in special education and one majored in elementary education. Each of the nine teachers majoring in special education had an educational degree but not an elementary major. Therefore, they were required to have at least one elementary mathematics methods course. Most of the participants indicated that they had never taken a mathematics methods course before.

Structure of the course

The course was structured by combining regular classroom instruction with participation in asynchronous computer conference. The course started with reflective inquiry by the teachers on their experiences with mathematics teaching and learning. Then, the teachers examined theoretical and practical issues in mathematics education. In the final project, the teachers developed ways to apply course content to improve their own teaching and learning of mathematics.

For me, face-to-face interaction was still critical in this course because of the need for rich, hands-on experience of manipulatives. As indicated by Merryfield (2001), online instruction is not helpful with hands-on work. However, I restructured another part of the course using online instruction. The actual software system used was HTMLEz. From the course home page, the teachers clicked on various links to read (and print out if they wanted to) useful information such as the course overview, syllabus, related mathematics educational links, a list of manipulatives, and assignments. The teachers were required to read weekly textbook assignment and to contribute at least one message to the online discussion per week, although a lot of times the teachers posted more messages than required. The teachers could work on their assignments and turn them in online any time of day and night. For privacy and access reasons, I structured the course home page such that only the teachers enrolled in this class and I had access to it. Each week, the teachers went into the course home page and clicked on ‘Class Forum’ to read each other’s messages. Then they could either respond to another’s message to continue the discussion or start a new thread on other topics such as their own reflections on designated reading assignments. They could communicate with one another and me without time and location constraints. Because our university is located in a rural area, a lot of teachers lived 75 miles away from the campus. Integrating part of the course online thus provided more chances for them to interact with one another and me than solely campus instruction.

Technology background

The anonymous survey conducted at the beginning of the course provided information about the teachers’ technology background. The result of the survey indicated that among the 10 teachers, half had completed at least one technology course. In the survey, there were 20 four-point Likert scale questions (where 1 is total lack of confidence and 4 extremely confident) regarding teachers’
confidence of using instructional technologies. I collapsed those results of Likert scale questions into two categories: those who felt confident (3 or 4) and those who lacked confidence (point 1 or 2).

Tables 1 and 2 provide the results of the survey regarding teachers' confidence about using technologies. Table 1 lists the percentages of the teachers who felt confident in using various instructional technologies. Table 2 records the percentages of the teachers who felt they could use the various technologies effectively with their students. In general, all the teachers were confident about using word processing, web resources and email. Consequently, a higher percentage of them felt comfortable using those technologies effectively with students. A majority of the teachers were familiar with computer games and, therefore, felt confident about using them effectively with students. Around half of the teachers were familiar with presentation software, digital images, computer conference, CD-ROM and multimedia and, therefore, expressed confidence in using those technologies to teach, with one exception. This exception was the use of web resources. Although all the teachers were either confident or extremely confident of locating/identifying web resources, only 60 per cent of these teachers felt they could use the web resources effectively with students. This is not surprising considering that being able to use web resources effectively with students involves much more than simply being able to locate and identify web resources, such as how to evaluate these resources and what teaching approaches they should use. None of the teachers felt that they could use list-serves effectively with their students. Only a small number of the teachers felt they could use chat rooms with students. This may be due to their lack of knowledge and experience concerning these technologies themselves. Or maybe it was because they did not know how to use these technologies to teach. A third possibility was that they might not be familiar with some of the technical terminologies such as list-serves and, therefore, responded negatively despite having unknowingly used them. This was a weakness I did not realize before I conducted the survey. Next time when I conduct a similar survey, I will provide examples of the software, for example 'Presentation Software e.g. PowerPoint' for clarity.

In a nutshell, all the teachers had some instructional technology background such as email, word processing and web. About half of them had a fairly solid knowledge of instructional technology.

**Results**

I started this project with the thought that the incorporation of the internet would enhance the teachers' understanding of issues in mathematics education, but I was
not sure what exactly would happen. I intended that we would discuss a number of
different kinds of topic such as the phobia issue, the NCTM six principles and
teaching strategies. What I found was that the integration of the internet did create
opportunities to discuss things that in previous iterations I had trouble bringing to
class. For instance, I had practically decided to drop the equity/diversity issue in my
initial plan. But it came out automatically with the use of the internet, where it had
not in our in-class discussion. At the beginning of the course, my main objective in
incorporating the internet was to enhance the teachers’ learning of the pedagogy.
However, the insights I gained from the threaded discussion made them as valuable
to my teaching as they were to my students’ learning! For example, as shown below,
the discussion of the statement in one of the textbooks made me refine and revise
my teaching plan which resulted in the teachers’ better understanding and the real-
world application of equity.

Because of these particularly interesting results related to sensitive issues, and
because of my interest in the investigation of instructional use of discussion
forums, I ended up focusing my data analysis on three areas: the phobia issue, the
equity issue and the teachers’ beliefs about the instructional use of technology,
both in their own learning and in their classrooms. Regarding the first two areas,
I described three examples of the impact that the use of a discussion forum had
on the teaching and learning experiences. These examples were explored from
different analytical standpoints. In the discussion on ‘mathematics phobia’, I
concentrated on analysing the content of this debate. The discussion of equity
issue was divided into two topics: ‘students with special needs’ and ‘gender’. In
the ‘students with special need’ section, I demonstrated how the teachers sponta-
neously started a debate which, in turn, led to further actions. While in the
‘gender’ section, I focused on the potential for using a discussion forum to
explore sensitive issues.

Issue 1: Discussion on Mathematics Phobia

A crucial goal of this course was to provide the teachers with opportunities to
explore the phobia issue by building on their awareness of the phenomenon,
identifying the cause of the problem, and exploring appropriate strategies to
overcome the phobia. After analysing the demographic data on the teachers’
background, tackling the phobia issue became an even more important goal for
this course. Most of these teachers had majored in special education with neither
previous course work on mathematics education nor previous experience
teaching mathematics. Hence, it was highly possible that they had mathematics phobia themselves (this was confirmed by the analysis of the transcripts of the threaded discussion and is detailed next). Because of their area of specialization, they were most likely to be teaching and/or would teach students with mathematics phobia. However, I felt reluctant to raise this issue directly and feared that the teachers might feel uneasy admitting that they had the phobia in front of their colleagues. Therefore, as part of the course reading assignment, I gave the teachers the book, *Math: Facing an American Phobia.* In face-to-face meetings, I raised the phobia problem and the teachers were not excited about discussing the issue. I wondered whether they did not care about the topic at all or maybe they just felt prickly discussing it. But surprisingly, in the online discussion the phobia issue became a very hot topic and the teachers shared their feelings about mathematics and expressed their concerns.

Some teachers’ messages posted at the early stage of the class demonstrated the power of negative feelings about mathematics to strongly affect learning choices and careers of some teachers:

‘I remembered my own mathematics phobia. When I decided to work on my masters degree, I was torn between counselling and special ed. learning disabilities. One of the reasons I chose the path I took was because I didn’t have to take statistics!’ (KA)

‘As I’ve said before I have been math phobic for a long time… all I knew was that it was painful.’ (AM)

They also tried to identify factors that cause this phobia. They spotted three major variables that they strongly believed affected student attitudes toward mathematics. These three variables were family influence, the way mathematics is taught and assessed, and other social factors. First, they realized how parents’ attitudes impact their children’s beliefs about mathematics:

‘Why is it that parents often teach their children to hate a subject before they even go over it in school? I see that at every teacher–parent conference where parents will say something like, “It’s no wonder that Brian hates Algebra, I hated it when I was in high school”. The algebra teacher didn’t have a chance on that kid. It was already over before the game started.’ (L)

The analysis of the online discussion revealed that the teachers realized that how mathematics is taught often influences students’ attitudes toward mathematics. This was the second major factor the teachers identified. They also indicated their appreciation of the current trend in mathematics education that shifts the focus of mathematics teaching from the end-product to the process of learning:

‘If I could have spent more time explaining my ideas and touching the activity I was trying to solve, I would have been a much better math student and may have wanted to continue in my math education. I hated pencil-and-paper work, I think because of the fear of not having the correct answer… we should credit the process more than the product and I truly have to agree as long as the process gets some credit as an end-result to the correct process.’ (A)
The teachers also realized how mathematics learning under pressure could create student anxiety. Some teachers shared their personal experiences and feelings about learning mathematics. These experiences reflected ‘a sense of threat, inadequacy and embarrassment because the experiences were so public’ (Ellsworth and Buss, 2000, p. 14):

‘I hated timed tests and having to go to the board in general. I remember standing at the board and crying in EIGHTH grade because the teacher wouldn’t let me sit down until I finished a problem with a concept I had yet to grasp. I don’t remember anything else about the class, but I do remember the torture I felt.’ (AM)

They also criticized traditional ways of assessing mathematics achievements. They indicated that any single assessment method, particularly timed tests, not only could not fully assess student achievement, but also may create mathematics phobia:

‘I see that same torture on the faces of some of my kids that have to do timed tests.’ (AM)

‘Timed tests are not beneficial for kids and it really wouldn’t be a very accurate measure of their ability … the other issue behind timed tests is kids become fearful of mathematics and then the negative feelings of mathematics come into play. Mathematics should be a positive experience. Wish I would of had that experience, as I am one of those people who is very fearful.’ (MH)

The third factor identified which impacts student mathematics learning was the larger society other than families. The teachers noticed how other social variables could largely affect students’ perspectives on mathematics. For instance, the teachers discussed how public figures’ comments about mathematics really affect the thoughts of the younger generation, and even of society. Beyond the general discussion about this issue, the teachers also took a step further and actively applied the ideas to their daily life. For example, one teacher had captured an incidence and expressed her thoughts about the negative messages that had been sent by those public figures, in this case, by Rosie O’Donnell:

‘As I was reading my Newsweek magazine tonight, the April 9, 2001 issue on the “Perspectives” section on page 19, Rosie O’Donnell argues that there’s no place for mathematics in the curricula. I think “there’s no way they should have to teach [math] now. We have computers. We no longer need to know why 3x = 2y/4”. She has three children. I would be scared for them academically! How many people do you think share that feeling?’ (KK)

At the later stage of the class, the discussion also revealed that those teachers who expressed their mathematics phobia at the beginning of the class had gained confidence in their own ability to do mathematics. As indicated by the teachers:

‘This class has given me confidence in my own mathematics ability and has given me cause to try to be better at math.’ (AM)
For the first time, I felt that I really was good at mathematics. Never before ... I also find myself being more accepting at trying math ... because I see now that I really can and don’t immediately throw up a wall of fear.’ (KA)

In addition, it is evident that those teachers with phobia changed their attitude towards teaching mathematics after the course:

“This class has certainly made me see the importance of expanded mathematics instruction ... beginning in pre-school. Very interesting ... Since enrolling in this class, I am certainly more convinced of the importance of hands-on practical applications in mathematics education.’ (K)

Here, the discussion forum provided a more comfortable environment than a face-to-face setting for the teachers to share their uneasy stories, and these story lines further led to a deeper analysis of the issue in discussions.

Issue 2: Discussion on equity

In its new ‘Principles and Standards for School Mathematics’ (2000), NCTM posed six principles: equity, curriculum, teaching, learning, assessment and technology. Equity is described as the first and foremost principle for school mathematics. It is clearly stated in the Principles and Standards that:

excellence in mathematics education requires equity - high expectations and strong support for all students ... All students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study - and support to learn - mathematics. (NCTM, p. 12)

In my original design of the course, however, equity was not among the focuses. I thought we needed to cover too many areas in mathematics education. I was afraid the introduction of this sensitive issue, without a thorough discussion due to the time constraints, might create confusion since those teachers were not familiar with mathematics education. I also pondered, would the teachers ever think that the topic was important given that we were located in a very mono-cultural, rural area? To my surprise, the issue naturally evolved in the online exchanges. Two important aspects of equity arose naturally: one was related to special needs and the other to gender. These two issues were the only topics in the whole threaded discussion that had attracted every teacher’s attention.

Students with special needs

The first instance was stimulated from one of the reading assignments. A teacher found a disturbing statement in the textbook. She raised a question and asked for others’ opinions as indicated in the following message:

‘I would like to know if anyone else found the statement Burns [the textbook author] made on page 67 disturbing (“unless we have some mental handicap, all of us are curious and capable of learning many things”). I read that several times, not quite believing that an educator had actually written that, and worse, that it had made it through editing. It seems that she is implying
mental handicaps make children unable to learn and that they are not curious. Regardless of her intent, that is the implication that was made.’ (KI)

Other teachers responded immediately and confirmed negative feelings when reading this statement. One teacher also pointed out how we should rethink our school philosophy of mathematics teaching and learning:

‘I saw that message too and got definite negative feelings from it. With an attitude like that, I’m glad my ADHD son isn’t in her classroom. It made me think of high school and the tracking of the “smart” kids into the higher math and the general math was for those who weren’t expected to do much.’ (KA)

This topic inspired a lot of interest in the online discussion. Although all the teachers shared the same negative feeling about the statement, some teachers offered different explanation of the statement:

‘I don’t think that Burns’s statement was meant to be the put-down that so many people took it to be. It seems to me that Burns meant that to imply that every child can be leaders and that only those with only the most serious handicaps cannot.’ (LL)

Others even took a step further and suggested actions we could take to improve this situation:

‘I think maybe this error in statement should be brought to her attention or the editor’s attention because maybe it has bothered other people too. Maybe the statement could be changed in the next printing edition – just a thought.’ (AS)

Originally, I did not intend to discuss this in class, but because it became an issue and I thought the teachers needed to have opportunities to discuss it in a face-to-face setting, I revised my original teaching plan. In the following week at our campus class, we did take time to revisit this issue. We all agreed that no matter what the intent of the author might be, actions needed to be taken. We decided that I would send Burns an email message, on behalf of the whole class, stating the situation with the attachment of the first teacher’s message. Burns took the suggestion very seriously and responded:

‘Thank you so much for bringing to my attention the statement on page 67. I, too, find it disturbing and inappropriate. Yes, it made it through the editing process, which is unfortunate, but I am ultimately responsible. We will make a correction in the next printing. I’ve been struggling over the past several days to think of how best to reword the sentence, and I’ve come to the conclusion that the best solution is simply to delete the phrase “unless we have some mental handicap.”’

We all feel satisfied with the result. I was really happy to see this rich discussion about an issue related to equity. I was even happier that the teachers did not just sit there reading from abstract theories and books about equity. Instead, they were actively taking up the ideas and applying them to our life, and furthermore,
Technology and mathematics teacher education

they took action to improve our situation. Obviously, the discussion forum was used as a mind tool (Jonassen, 2000) with which the teachers were empowered.

Gender

The second instance related to equity had to do with gender. It all started with exchanges about teaching geometry and how geometry is different from other mathematics topics. One teacher responded to the messages about geometry and added ‘as a female’ on the title of her message. So the title changed from ‘my feeling about geometry’ to ‘my feeling about geometry (as a female)’. This was unusual since the teachers normally tended to just use the “reply” function which would not change the title (for example, a male teacher even ‘replied’ to one of those messages and did not change the title ‘my feeling about geometry as a female’):

‘I have never been a fan of geometry. I have always liked algebra, trigonometry and calculus (all of which work with geometry) but I still don’t like geometry. Maybe it is because most females tend to not care for it. I did like the banquet table problem (page 281). I, too, believe that leaving variables open (such as the hole in the table) can increase critical thinking skills and promote discussion.’ (KI)

Another female teacher responded to this message and clearly indicated the gender issue:

‘Wow KI, I think your acknowledgement about the problem on page 281 shows a lot about the whole male/female issue. Who would be most likely to need to know this type of a problem? I am not trying to stereotype, but girls spend a lot of time thinking about this type of situation.’ (AS)

Then messages flew back and forth about why males and females learn differently, why we (as teachers) should be aware of that and what we could do to accommodate these differences. Both male and female teachers were actively participated in the discussion and shared their observations and thoughts about the issue. One male teacher, although he shared his thoughts on the phenomenon and tried to further explore the cause of the problem, specifically indicated that he did not want to get into this gender issue. He wrote the following message:

‘M aybe part of the problem when it comes to putting geometry into difference between different groups of people can be explained by the toys that we were brought up with. A lot of people who played with Lego when they were younger don’t seem to have an issue with solving geometry problems. They are more able to see what their final outcome of a problem is and able to solve problems logically. I don’t want to get into the female vs male thing, but toys that are meant for boys seem to be more of the building nature than a lot of girl toys that are out on the market.’ (LL)

This teacher (since he is a male) might have just played it safe by indicating that he did not want to get involved in this gender issue. I was reminded of how uncomfortable or resistant people can be with these topics. In our face-to-face discussion, I asked the class how they felt about gender differences. I got blank stares and a few comments like ‘yeah, maybe there are differences, but I don’t
I noticed that male teachers became silent with downcast eyes. Obviously, they did not want to talk about it. This phenomenon made me ponder: why is it that the teachers were reluctant to discuss the sensitive issues in face-to-face settings but exchanged opinions in online discussion? Maybe it was because they felt that an online discussion was less public, which created less pressure. Another possible reason is that they had more time to think about the issue, they could phrase their statements more carefully.

Issue 3: Discussion on Technology

Technology has been an important part of improving the teaching and learning of mathematics. My concern was the degree to which the teachers, by the end of the course, would believe that technology is useful in helping them in their own learning, as well as the potential value of technology in the class that they would be teaching. As the final activity of the course, I set up the online discussion to find out what the teachers would tell me about that. I asked the teachers to present their views about the instructional use of technology. The teachers generally felt that instructional technology could be an effective tool for their own learning if used appropriately. They indicated that the internet used in this course was helpful for their learning because it provided a means to communicate with others and enhanced their understanding of the educational theories through this communication:

'I really enjoyed the online format. At the beginning of class, I must admit that I was a bit sceptical towards using this. However, it worked really well. For the most part, this device worked as a link that kept us all in touch. For me personally, it allowed me to understand everyone's perspective about reading. Another thing that was great about the website was that we always had access to communicating with another student or the instructor.' (M)

The teachers found other advantages of instructional technology for effective learning: it 'gives time for synthesis' (LE), it 'greatly enhances learning by providing visual and interactive experiences for the students to learn with' (KI) and it is 'great because I can do a lot from home and not travel' (AS).

In addition, they realized that they needed to learn more about technology in order to successfully use it: 'I've been learning how to use a computer since last year, still have a lot to learn!' (LE). Another teacher pointed out that the more she learned about instructional technology, the more she felt it is effective for her learning.

Nevertheless, some teachers also realized that technology has its own disadvantages. They indicated that whether instructional technology is effective for their learning depends on what they are trying to accomplish. One teacher stated that:

'sometimes it [instructional technology] is good, but it often makes things appear too simple (i.e. using calculators to do complex problems - you lose the essence).’ (MP)

With respect to the value of instructional technology in K-12 classrooms, the consensus was that technology plays an important, and even increasingly important, role in schools. They claimed, 'today it [the instructional technology] is a must!' (KI). Another teacher commented:
They indicated that technology holds

‘high value considering every job you work at involves some sort of computer applications.’ (A)

Also, technology can ‘provide another medium in which to reach kids’ and help to hold kids’ interests’ (KI), as well as ‘bring students to other places – virtual; students can find information with technology’ (AM).

They also noticed that technology should be used appropriately in classrooms in order to achieve its greatest value:

I think it’s important to ensure kids still know how to use books to find things, do mathematics without a calculator and spell without a spell check.’ (L)

One teacher stated that: ‘[instructional technology] should be used to reinforce skills and ideas and to help promote research and self-starting skills’ (KI). Another teacher wrote that:

‘technology is a classroom tool. It is an aid for the teacher, but no more. It plays an important role in classrooms but is only a resource.’ (LE)

In general, the teachers believed that, on the one hand, instructional technology can be an effective learning tool and it holds a great value for schools. On the other hand, they realized that technology should be used properly and only as a tool.

**Reflection on the experience and implications for teacher educators**

My experiences with teaching mathematics methods courses have convinced me that the appropriate integration of discussion forums into teacher education has the potential to achieve, if not exceed, the same goals of mathematics education. I felt inspired to incorporate the internet into the course as the process made me rethink my assumptions about the pedagogy, the course content and goals, and the technology. Even before the course was over, I was already excited to see that the teachers investigated relationships concerning curriculum, teaching, learning, assessment and equity via computer text messaging. When there were questions, the teachers searched for theories, examined their own experiences and acquired knowledge of the relationship between theory and experience. By learning about mathematics education through literatures and media, and by participating in a learning community, the teachers deconstructed stereotypes and developed relationships among mathematics teaching, learning and assessment, and applied the knowledge to their professional and daily life. I anticipated we would talk about all kinds of issues such as the six *NCTM* principles, mathematics phobia and teaching strategies. In fact, I found that although discussion forums are useful for all
that, the most dramatic areas for communication using discussion forums was in these sensitive issues of phobia and equity.

I personally enjoyed the online part of the course - its flexibility and its richness in discussion about mathematics education. Every week, I was eager to read the messages. I found that the course websites not only maintained the overall flow of the course, but also enhanced the course content via related links and student threaded discussions. The threaded discussion also provided an assessment tool, which gave me instant and ongoing feedback. I gained a broader awareness about the teachers thoughts and beliefs through the threaded discussion. In short, the threaded discussion offered feedback and direction that gave me useful information for changing, refining and enhancing instructional choices. For instance, at the outset of the course, I did not plan to discuss the equity issue at all because I was afraid that we would not have enough material to explore it. Since the issue evolved naturally in the online discussions, I changed my original plan. I not only spent some on-campus meeting time to further the discussions, but also introduced the teachers to some research studies in the area. The changing of my instructional choices made the learning more authentic. The authenticity of the learning experience, in turn, enhanced the teachers motivation and empowered them for learning and practising. In short, I have come to believe that my course is strengthened by threaded discussion on mathematics, sensitive topics and controversial issues.

The results of the survey indicated that all the in-service teachers have some knowledge about instructional technology. This should be taken into consideration for teacher educators who would like to integrate technologies into teacher education. Secondly, there were still a lot of the teachers in this class who did not have a strong background in technology itself. The teachers’ contributions to the online discussions indicated that those teachers still had successful learning experiences with mathematics education in the context of communication using the internet. This implies that it is possible to teach meaningful mathematics education using the internet to in-service teachers with diverse technology backgrounds. When appropriately used, the internet provides an effective means to communicate and interact. It does not require specifically prepared faculty and equipped classrooms.

Thirdly, the comments given at the end of the semester indicated that the teachers all realized the importance of integration of technology in classrooms. They also expressed their desire to learn more about technology and the integrations of technology in education. According to Willis (2001), ‘technology should be introduced and explored in context’ (p. 3). In this mathematics methods course, the teachers were exposed to pervasive modelling of technology in context rather than in laboratory exercises. The results demonstrated that the teachers learned meaningful mathematics education through the use of the internet.

However, there were also several concerns. The first thing that puzzles me is the phenomenon that my participation did not improve the discussion. In nine cases, I found that the teachers started some interesting discussion about certain topics - some related to their previous experiences of learning mathematics, some to sensitive issues. These discussions inspired my desire to be an active participant. I jumped into the discussions and shared my experiences. I tried to stay in a neutral position and minimize the expression of my opinions because I did not want the teachers to think my opinion was the norm. Rather, I wanted to see the discussions flourish. Contrary to what I expected, my participation shut off
further discussion in eight out of the nine cases. Therefore, I decided to stop posting any messages into discussions unless it was something related to course structure and organization. This really made me wonder what the reason was. I have discussed the phenomenon with my colleagues and other teacher educators at different universities. They are all instructors who were exploring the use of this asynchronized communication tool in teacher education. Some of them shared that they had exactly the same experiences and were also pondering what caused this to happen. The only explanation we could come up with is that I was the instructor. The teachers perceived me as a person with power and authority; consequently, they felt uncomfortable talking about my experiences no matter whether it was online or in face-to-face settings. I think a couple of methods could improve the situation. Next time, if I teach similar courses, I will stress, at the beginning of the course, that I want to be an active participant in the online discussion and to be treated as part of the class rather than as the instructor. In addition, I think that changing structures of activity may also be of benefit. For instance, I will structure the courses such that the teachers will take turns to lead each discussion topic and each leader will be responsible for advancing those discussions.

The second issue I noticed was that the online component of the courses needs to be organized into themes/topics. In this course, I structured the online discussion without any themes and the teachers just threw different messages into one big folder. The discussion of the whole semester was linearly connected within that big folder, although there were a number of threads within the folder. One of the major drawbacks of this was the difficulty of retrieving information. In only several weeks, it was already hard to go back and search for certain messages. This was opposed to my original intent of using the threaded discussion to give the teachers opportunities to revisit, further discuss and rediscover issues, theories and perhaps new applications of the theories. Under the current structure, it was difficult for the teachers to take advantage of having a permanent record of transcripts in online discussion. Recently, in another mathematics methods course for pre-service teachers, I started by asking the teachers to generate their own themes and then organized the threaded discussion by those themes. I also promised them that we would add more themes as issues arise. This worked out very well and the students loved the idea. As an example, after the September 11 tragedy, we discussed the issue in class. The whole class reached a consensus that this event impacts, and will continue to impact, our teaching including mathematics teaching. Thus, we added another theme - the tragedy. The students felt very positive about having this place to discuss the issue whenever they felt the need.

The choices in using technologies such as computers are like other educational resources and methods. We need to consider both the pros and cons of the specific technology. We can use technologies to deal with academic knowledge, and overcome teachers phobia and challenge the whole societies assumptions about mathematics and inequity. My experiences suggest that mathematics educators may benefit the most if we consider how learning mathematics education in face-to-face and online settings can complement each other. In this course, face-to-face meetings provided the best environment for hands-on experiences. Methods of using manipulatives to teach mathematics were easily demonstrated and modelled through face-to-face interactions. When the teachers had questions, I could give them immediate feedback. In addition, I found that the face-to-face meetings allowed the teachers to establish a very warm and
In general, my experience suggests that there are three advantages to incorporate an online discussion forum into teacher education. First of all, the use of the discussion forum provides a more comfortable environment than face-to-face settings for teachers to discuss sensitive issues. Because of missing visual and paralinguistic cues, and because the teachers could take as long as they wanted to think and reflect, some teachers could overcome their usual norms of behaviour that constrain their talk (Merryfield, 2001). The teachers talked frankly in threaded discussions about prickly and uncomfortable topics underlying education that I have never seen in their face-to-face engagements.

Secondly, I found that threaded discussions offer more choices, allow for more diverse points of view and enable deeper analysis of real-world phenomena than do face-to-face discussions because the teachers could select topics that they were interested to respond, and they could initiate a new topic at anytime, anywhere. For instance, immediately after the teacher read Rosie ODonnell's article, she posted her thoughts on the threaded discussions (see ‘Discussion on mathematics phobia’ section) and her post sparkled a lively discussion. If there was no online discussion forum, I could hardly image that she would remember to bring the article to the class six days later. Even if she did remember to bring the article, she would probably have no or little time and chance to bring this issue up. The online forum thus enabled the discussions to develop at a much deeper level and with a broader scope than merely face-to-face interactions.

Thirdly, I noticed that discussions also became a reading and writing task and, therefore, took a much longer time because a five-minute oral conversation takes less time than writing it. Most of us liked to edit our messages before posting them. As an instructor, I found that, with teaching in face-to-face settings, I needed to constantly reflect on the online discussions and make conscious instructional decisions in order to better facilitate the teachers learning.

In the end, I want to state that further research and development on the application of the internet to teaching and learning is needed. We are just starting to understand how students learn using the internet. However, based on these initial studies, the internet will soon become used in a myriad of learning activities.

References


Appendix: Sample questions used in survey

Part I: Your experience with instructional technology

For each item rate your degree of confidence in using the technology as described or to teach its use to someone else. Rate the items from 4 = extremely confident to 1 = a total lack of confidence. Circle NA if the method does not apply to you or is unlikely to apply in the future.

1 Using word processing 1 2 3 4
2 Teaching/showing someone else how to use word processing 1 2 3 4
3 Locating/identifying internet/web resources 1 2 3 4
4 Teaching/showing someone else to locate/identify internet/web resources 1 2 3 4

Part II:

Consider the instructional use of the following media and technologies with students. Circle all technologies and/or media, which you believe you could use effectively with students right now, if called upon to do so. Circle all that apply:

Presentation software computer graphics grading programs
Computer games/simulations email e-journaling
Webquests/internet resources chat rooms list-serves
Computer-aided instruction CD-ROM multimedia
Web pages/including links to other pages