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A Collaborative Teaching Approach: Views of a Cohort of Preservice Teachers in Mathematics and Technology Courses

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A collaborative teaching approach (CTA) between two instructors was implemented to develop more curricular coherence with the intents of reducing fragmentation and of stimulating learning across mathematics methods and instructional technology courses. The CTA was prompted by the need to streamline the learning outcomes, including an e-portfolio exit requirement for their program of study. Utilizing a case study approach to determine preservice teachers' levels of satisfaction, the actual learning effects, and the significant factors in the CTA, we found them to express overall satisfaction with the learning outcomes of the collaboration, and they suggested extended implementation.

In teacher education, the search for more effective forms of delivering instruction is an ongoing effort. Likewise, the integration of technology concepts with subject matter and instructional methodology are continual. There is also widespread agreement that the teachers, not technology, are the drivers that can bring about desired change in mathematics education. Thus, preparing teachers to use technology is a complex issue that must be addressed.

The National Council of Teachers of Mathematics (NCTM, 2000) has published a technology principle which states that "technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (p. 373). Technology integration in teacher education occurs at various levels of engagement with the teacher educator, the prospective teacher, and the student (Garofalo, Drier, Harper, Timmerman, & Shockey, 2000). NCTM challenges teacher preparation programs to provide models of good mathematics teaching to assist teachers in developing their knowledge of mathematics and mathematics-specific pedagogy. They should provide multiple perspectives on students as learners of mathematics along with opportunities for teachers to develop their own identities as teachers of mathematics (Borko et al., 2000).

Our initiatives were informed by mutual acceptance of the benefits of a collaborative approach to teacher training as well as by the evidence found in the literature. The unique contribution of this report is a description of the implementation of the collaborative approach in one mathematics education program at a large southeastern university that prepares prospective and inservice teachers for urban schools. Pertinent literature used to support the research study included several areas in teacher education, including collaborative teaching, development of e-portfolios, and reflective teaching.

In traditional teaching arrangements, students are enrolled in separate courses, and any integration that takes place is often achieved only by their own initiative. Many courses in higher education involve little faculty cooperation, and, in cases where collaboration does occur, instructors engage in team-teaching, addressing various topics under one content area (McDaniel & Colarulli, 1997). In response to instructional needs, creative and powerful models of instructors' collaboration are developed to promote integrative thinking in students. Coming from different disciplines, collaborating instructors integrate instructional content and methodology (McDaniel & Colarulli). Collaboration provides educators with the opportunity to model different ways of teaching, to respond to student needs, and to provide students with the chance to experience two instructors contributing to the instruction (Harris & Harvey, 2000). Therefore, this research was conducted by two instructors who collaborated, based on the need to assist their students make connections within their different courses and to document their progress in the form of electronic portfolios (e-portfolios).

Purpose of the Study

As instructors, we had observed and received consistent feedback from previous students who were faced with an overload in preparing different e-portfolios for different courses within the same program. Putting much thought into the students' concerns and the feasibility of designing a more coherent curriculum for the two courses, we intervened and collaboratively designed the discourse of the objectives of their courses. A collaborative teaching approach with the intent to reduce fragmentation and stimulate learning across two mathematics methods courses and one instructional technology course were implemented. The process of the collaborative approach is discussed further throughout the paper.

In this context, we define CTA as a process where we streamline preservice teachers' learning through

purposeful course design with the intent to reduce fragmentation across courses and to stimulate learning. Our rationale was to guide the preservice teachers' professional growth through the integration of pedagogy and technology. To determine the outcomes of the collaborative approach, the following research questions guided the study: (a) What are the significant factors of the collaborative approach? (b) Are there differing levels of student satisfaction with the collaborative teaching approach? (c) What are the actual learning outcomes of the collaborative teaching approach among students?

Review of Related Literature

The current educational needs consistently pose great challenges to educators and affect significantly the physical and social environments in which they work. The problem of designing learning environments to equip researchers and practitioners with the knowledge and skills they need in their work is real and current. Additionally, traditional teaching models applied in higher education do not always meet new and emerging goals. Collaborative teaching is one way in which educators can embrace the emerging goals of programs that seek to merge technology with pedagogy. This section of the paper explores the literature on the pedagogical aspects of collaborative and reflective teaching approaches enhanced by technology skills through the development of e-portfolios.

Collaborative Teaching

Support and collaboration constitute the guiding principles for improving instructional practice, and specifically teacher support is noted as an important instructional practice. Edwards and Hensien (1999) argue for the strong influence of efforts to support teachers and advocate providing teachers with regular feedback – a voice in curricular decisions in the enhancement of teaching. Moreover, successful implementation requires active and on-going support that is embedded in strong collaboration of effort. In addition, collaboration provides teachers with feedback in order to enhance their reflective teaching practice.

There are several advantages to collaborative teaching (Novicevic, Buckley, Harvey, & Keaton, 2003). First, this teaching approach can lead to learners' improved capability to evaluate problems critically, to argue substantively, and to apply effectively learned concepts to new situations or contexts. Second, the process augments the quality of teaching scholarship by transforming it into a participative activity with critical review and quality assurance. Third, collaborative teaching can be viewed as a means to achieve enhanced teaching outcomes because of its peer-reviewed and monitored nature. Additionally, it is structured to address multiple disciplinary perspectives. Fourth, collaborative teaching challenges traditional instructional delivery approaches. Its strength lies in the combined forces applied to address common goals or problems. If faculty goals vary in kind and nature, the outcome of the collaboration can be negative. In particular, if the goals and expected performance levels are not clearly defined at the beginning, team effectiveness can be affected.

E-portfolios

In the teacher education setting, the e-portfolio is defined as a purposeful collection of learner artifacts and reflections saved in an electronic format (e.g., disk, CD-ROM, website) to demonstrate how preservice and inservice teachers are meeting the current established standards for teaching. They are used as assessment tools providing learners with opportunities to showcase their academic work, teaching experiences, and technical expertise (Hewett, 2004). In particular, the e-portfolio is a way to document students' progress over time, identify patterns of growth and competencies in their teaching, develop their self-reflection and self-assessment skills, and improve overall teaching practices (Hewett 2004; Lankes, 1988). "Through portfolios students also come to see their meanings as something socially constructed over time rather than something they were born with but were unable to articulate fully" (Pullman, 2002, p. 151).

E-portfolios are gaining the attention in instructional settings by challenging holistically graded, one-time assignments and projects. Rather, the e-portfolios focus on cumulative growth (Gathercoal, Love, Bryde, & McKean, 2002). Nonetheless, they have been challenged as having setbacks which include cost, hardware and software, technical issues, pedagogical and software incompatibility, and classroom logistics. Despite these setbacks, e-portfolios do offer possibilities and have advantages over non-electronic portfolios, including opportunities for revision, reflection, and collaboration. In addition, e-portfolios are more portable, are easier to share or distribute, and require less physical storage space.

Reflective Teaching

Reflection and self-assessment are important to professional growth. Teachers deal with unique practical problems and manage complexities and nuances daily. They are faced with value judgments that cannot be resolved solely by applying theories or techniques. While research-based knowledge may begin to assist them in identifying solutions to the problems, teachers resort to resolving the context-bound problems

by mentally experimenting and manipulating each situation as it uniquely occurs. This leads to reflective practice, or what Schon (1987) termed "knowledge-in-action." In efforts to think about and react to current situations, Schon considered the notion of reflection-in-action, similarly noted as "thinking on your feet." Reflective practice focuses on the way people think about their experiences and formulate responses as they happen (Krause, 2004; Schon, 1987). Furthermore, when the thinking was about teachers' reflection-in-action, looking to their experiences, connecting with their feelings, and attending to their theories in use, it was termed reflection-on-action.

Reflective practice requires one to make sense of uncertain, unique, or conflicting situations of practice. It occurs at all stages of the teaching process: in planning, action, and evaluation (Moallem, 1997). In the three stages, reflection aids in making choices, monitoring progress and adapting to different situations, and reviewing what works, what does not work, and why. The cyclical action then helps in future planning (Krause, 2004). The process helps teachers to inquire, to further their learning, and to use intuition, insight, and artistry (Hinett, 2002). Thus, a reflective teacher, as noted by Moallem, is one who continuously questions his or her own aims and actions, monitors practice and outcomes, and considers the short-term and long-term effects upon each child. While reflective teaching has frequently been defined and justified in previous studies and models of instruction that have been developed, reflective teaching practice – its nature, function, and potential of reflection – has not yet been fully exploited. In Hart, Najee-ullah, & Schultz's (2004) model of the reflective teaching model, reflection-in-action and reflection-on-action are integral. The reflective teaching model has been employed as the conceptual framework guiding this study.

Conceptual Framework

The conceptual framework guiding this study is embedded in the reflective teaching model (RTM), which is employed in the teacher preparation program under discussion. The RTM is grounded in two theories: constructivism and metacognition. The assumptions are based on the values of modeling, sharing authority, reflecting, and heuristic teaching, which form the guide to the activities and experiences of the model (Hart, et al., 2004). During their course of study, the preservice teachers construct new knowledge about teaching and learning (constructivism), and they monitor their thinking and behavior as they regulate what they do and think while having an experience in teaching (metacognition; Hart et al.).

First, the preservice teachers have the opportunity to experience the Plan-Teach-Debrief sequence, while observing how others think about and teach from a reform perspective (modeling). Next, they are provided with opportunities to explore these concepts in their own classrooms. Collaboratively, preservice teachers model the first phase of the RTM, including planning with peers and a university supervisor (sharing authority). They are exposed to learning experiences and are provided with critiques. In the process, preservice teachers develop strategies for future exercises in "solving" the teaching problem (heuristic teaching). Based on this conceptual framework, the purpose of this research study was to determine the level of satisfaction with the collaborative approach among preservice teachers, the actual learning effects, and the significant factors in the collaborative approach. The instructors for the two courses were instruments in the process, and they were guided by this same conceptual framework.

Context of the Study

As instructors, we focused on addressing two aspects in both the pedagogy and technology courses. First, the preservice teachers were put in the position of reconsidering their ideas about the nature of mathematics instruction and in effect reconstructing more powerful ones through the RTM. Secondly, we worked with the preservice teachers in helping them integrate current research-based knowledge in both pedagogy and technology into mathematics education.

Mathematics Method Courses

In this secondary (6-12 grades) mathematics education intensive program of study, preservice teachers are enrolled in mathematics content and methods courses. The emphasis is on their enrollment in a mathematics methods course (Theory and Pedagogy of Mathematics Instruction) in the Mathematics and Science Division and an instructional technology course (Integrating Technology into School-Based Environments) offered by the Learning Technologies division. Preservice teachers are encouraged to enroll in both courses simultaneously. Previously, these two courses were offered and conducted individually without formal collaborative effort of instructors. As was stated earlier, we had observed and received consistent feedback from previous students who were faced with an overload in preparing different e-portfolios for different courses within the same teacher education program. The mathematics education instructor, collaborating with the instructional technology instructor, redesigned the

curriculum, not to diminish its quality, but to be more effective in providing an interdisciplinary approach to learning and teaching. The preservice teachers had to incorporate their experiences of mathematics teaching and reflections in the e-portfolio. An action research project that looked at a teaching or learning issue in the mathematics classroom was also showcased in the e-portfolio. The technology used in their classrooms, such as PowerPoint, Geometer's Sketchpad, the TI-83+ graphing calculator, and Excel programs, were examples of the experiences of the preservice teachers' involvement in the mathematics content and methods courses and the instructional technology course.

The RTM was implemented in the mathematics methods courses, and the instructor organized a model/experience/reflect format where the preservice teachers were exposed to planning, teaching, and problem-solving activities in their first summer. In addition, they experienced the activity, then reflected on those experiences at the close of the activity. The preservice teachers also followed a Plan-Teach-Debrief sequence in their practicum and student teaching experience where they participated in modeling activities in a classroom and collaborated and critiqued ideas with peers, cooperating teachers, and the methods course instructor.

Instructional Technology Course

The technology course incorporated a problem-centered, activity-based approach anchored in authentic and familiar contexts in which teaching and learning with technology occurs. This course supports the National Educational Technology Standards for Teachers and the Interstate New Teacher Assessment & Support Consortium (INTASC, 1992) Standards. The focus of the course was teaching, planning, introducing, and reinforcing technology integration methods for the K-12 technology-enhanced learning environment. While introducing and reinforcing technology integration skills, the focus of the technology course was teaching and planning methods for the K-12 technology-enhanced learning environment.

Throughout the course, the preservice teachers demonstrated their technology integration skills in a variety of activities that focused simultaneously on what they could do with the technology personally and on their abilities to plan for their students' use of technology to meet curriculum requirements. The preservice teachers developed unit plans, technology-infused lesson plans, and supporting Technology Integration Planning Skills Samples (TIPS), along with supplemental materials that included mathematics worksheets, grading rubrics, and handouts. The TIPS included web pages and webquests, Excel spreadsheets, PowerPoint presentations, Access databases, Inspiration concept maps, and desktop Publisher samples that demonstrated their ability to integrate technology into their selected units and lessons appropriately. Examples of lesson and unit plan content that preservice teachers developed included geometry, algebra, statistics, and calculus appropriate for grade levels 6 through 12. Upon completing the lesson plans, the preservice teachers were required to reflect on the lesson plan development process, the outcome of their microteaching, or the practicum experience upon implementing the lessons if they have had an opportunity to teach the lesson. The capstone project was the e-portfolio in which the preservice teachers documented the design and development of a technology-supported instructional environment that facilitated student learning through student-centered learning activities. The e-portfolio was a culmination of selected TIPS, unit and lesson plans, worksheets, grading rubrics, description of learning environments, and classroom arrangement. In addition, the preservice teachers were required to include their teaching and learning philosophy as well as their professional development plan.

The preservice teachers responded to three sets of reflections at the beginning, middle, and end of the semester in the technology course. Each of the reflection papers was guided by a set of questions from which they could develop their response. The questions sought to elicit preservice teachers' responses about course expectations, level of technology proficiency, continual growth and self-efficacy in the use of technology in the classroom, their beliefs about technology integration, and their ability to integrate technology into their content areas, as well as issues related to the course itself.

The preservice teachers also analyzed case studies from Roblyer's (2004) *Educational Technology in Action*. The cases selected for analyses focused on general teacher education and mathematics content areas. Expectations for case discussions were provided as follows: first, participants reviewed assigned cases and individually responded to specific questions from the textbook at the end of each case set. Next, they met in teams of three to discuss the assigned cases. Each team then submitted a group report based on their discussions. Finally, each student submitted an individual reflection on each case based on initial responses and group discussions. The goal of the case analyses and reflections was to enable the preservice teachers to begin examining how they might integrate technology and various instructional strategies into their e-portfolios and subsequently into lessons plans for future implementation.

Common Course Elements

Some of these experiences overlapped among two or three courses within the program of study. These experiences were particularly implemented in the student teaching internship using lesson plans developed with the use of technology, classroom management, and the mathematics content. Encouraging a comprehensive output of the students' work was intentional to depict technology integration, reflective teaching, reflective thinking, and collaboration.

The preservice teachers were required to develop e-portfolios in both the mathematics methods and instructional technology courses. A cumulative e-portfolio was also required at the end of the spring semester as an exit requirement for certification and their program. Every year, each outgoing cohort of preservice teachers presents their exit e-portfolios to the incoming cohort. This particular group of preservice teachers had the opportunity to view the outgoing students' presentations and to have their questions answered by the outgoing preservice teachers and instructors at the presentation. During the summer semester, the students presented their cumulative e-portfolios to their instructors. The two main purposes of the e-portfolios in this program of study were (a) to assess ongoing growth of the preservice teachers and (b) to assist students in preparing for the final e-portfolio, the exit requirement for their program of study. Among other items from selected coursework, artifacts in the e-Portfolio included a teaching philosophy, professional goals, technology-infused curriculum units and lessons, teaching resources and materials, a classroom management philosophy, a diversity philosophy and approach, descriptions of teaching and learning environments, evaluations and observations, and journal entries.

Both the mathematics methods courses and the instructional technology course used a blended approach, where instructional content was delivered using both face-to-face and online delivery modes (Govindasamy, 2002). The learning management system for instructional and communication purposes was WebCT Vista. Discussion forums and e-mail were used for communication and feedback within WebCT. Class notes and supplemental electronic resources and articles were also made available via WebCT Vista.

Participants

The preservice teachers enroll in a 45-hour, four-semester intensive program, which is designed to prepare them to teach in high needs schools in urban school districts. Before they can be admitted into the program, the preservice teachers must meet certain requirements. First, they must have an undergraduate degree or the equivalent hours in mathematics or a related field. Second, they must pass a rigorous selection and interview process for admission. These preservice teachers expressed their commitment and willingness to teach in urban schools. In their program of study, they are provided with a 6-week middle grades practicum experience in the fall semester and a 16-week high school student teaching experience in the spring semester. Except for one student teacher, all the participants had some prior formal classroom teaching experience. The participating cohort consisted of seven secondary mathematics education preservice teachers, of whom five were female and two were male; four were White, one was Asian, and two were of African descent. Pseudonyms are used to refer to the five preservice teachers who participated in the focus group interview at the end of the program.

Collaborative Role of the Researchers

Two researchers participated in the study. The first was a mathematics education instructor, who taught the methodology courses. The section researcher was an instructor in instructional technology. The collaboration began with our presence at the new cohort's orientation session to introduce the program of study and requirements. We discussed the criteria and the approaches that were to be taken to ensure the students had a rewarding experience during the courses and an effective e-portfolio at the end of their program. These meetings were an opportunity to clarify the desired instructional outcome early in the semester and in the program. This was also an opportunity for us to identify areas that needed reinforcement. The preservice teachers were provided with opportunities to seek consultation from the mathematics educator while being provided guidance from the instructional technology educator.

Considering the feedback received from previous and current students and our own observations, we met prior to the fall semester and reviewed the requirements for the two courses in mathematics and instructional technology. The information gathered was used to determine overlapping items and instructional content and to develop collaboratively a plan to incorporate common main items and criteria for developing the final product of the e-portfolio.

Several practices and approaches were embraced. We felt it was imperative to revise the syllabi together in order to represent the mutual learning goals. It was also of great importance to plan and synchronize class agendas, coursework, and schedules in a manner that would assist students in integrating their work seamlessly in both courses. Debriefing between the two of us was also pertinent, and we met on average twice a

month for 30-60 minutes in order to determine areas of success and those that needed modification. In addition to teaching the courses, the roles of the researchers included acting as primary instruments for gathering, analyzing, and interpreting the data.

Data Collection Methods

Qualitative methods consisting of classroom observations, instructor notes, course evaluations, students' reflections, examination of course artifacts, e-portfolios, and end–of-course focus group interviews were used to gather and analyze the data within this case study. As suggested by Yin (2003), the case study design is an appropriate way to investigate the causal links and the context relating to an intervention. It is also useful when there is little or no control over the behavioral events. The unit of analysis in this case study was a cohort of mathematics education preservice teachers enrolled in a four-semester teacher preparation program. Focus group interviews were conducted to elicit technology integration in teacher education occurs at various levels of engagement with the teacher educator, the [prospective] teacher, and the student (Garofalo, Drier, Harper, Timmerman, & Shockey, 2000).

Presentation of Data and Analysis

We, the two instructors of the two separate courses, met twice a month during the semesters to discuss course outcomes and emerging data. Each of us was responsible for analyzing the datasets. To manage the data, we used a qualitative data management software tool, Nvivo, to organize and run data reports. Content analysis was used to categorize concepts and ideas that emerged in the two courses (Merriam, 1988).

According to case study methodologies (Miles & Huberman, 1994; Yin, 2003), we used pattern matching in the within and cross-case analyses used to address the research questions. During each analysis phase, we examined the cases for discrepant evidence and rival themes in order to assure the rigor of the analysis. Triangulation within and between data sources provide a holistic picture of the phenomenon and provide corroborating evidence (Creswell, 1998) as findings emerged. Our three research questions were answered by themes that were directly related to the questions, and sometimes there were overlapping themes.

Findings

Data were analyzed and findings taken into account in reviewing strategies and refining the collaborative approach with the incoming cohort. The guiding research questions were intended to determine the significant factors of the collaborative approach, students' satisfaction with the approach, and the students' learning outcomes. A common thread to all three questions was the development of a reflective, constructive view of integrating technology into mathematics education. Based on our data collection, the themes that arose and the meanings that emerged are discussed below.

Impact of Coursework

The preservice teachers expressed that taking the courses concurrently gave them the awareness of what was current and relevant to their future careers. Rose stated that she thought, "being knowledgeable about the technology updates is very helpful even though some might not have a computer at home . . ." Joe echoed this by saying ". . . we did not have the screen and projectors, but I know for a fact that I would not have made any effort to do it without a computer, unless I had taken these classes that had encouraged me to do it." Although particular schools may not have the specific hardware and software, having been made aware of the different options created an awareness of its availability, and thus they could ask for it.

The coursework in both courses went beyond hands-on technology application and included technology integration strategies. As a result of taking the courses together, the preservice teachers began to explore ways in which they could access resources that were not available to them. Annabelle summed this up by talking about the different ways to get access to the resources that they could use in their future classes:

> Read about new technology. . . . If the school does not provide it, see if you can write a grant to get the new technology, but just being aware of new technology helps because they help you to do things in a better way or quicker way or more creative way. Read about them in online magazines, journals . . .

In particular, the preservice teachers stated that they enjoyed working on the assignments as an integrative project. The fact that they could work on different aspects of their coursework and pull it together into a larger project was seen to be beneficial to making interdisciplinary connections. For instance, Joe commented,

> I really appreciated that because I thought the typical college experience would be that I would have these two very similar projects that I would have to keep completely separated, but to the able

> to overlap them and integrated them together in one portfolio it was really – it made it a whole lot more fun.

It was especially important for the preservice teachers to be able to draw connections between the theory course and the instructional technology course. Rose articulated this by noting that in the theory and pedagogy course they learned "what they should be doing as teachers," and in the instructional technology course they learned "how to do it." For example, learning how to write lesson plans in the pedagogy class and then being able to design lessons that integrate technology were very appealing to the students. For this reason, the preservice teachers suggested that taking the courses independently would have been "a different experience."

Cumulative learning was a positive outcome of the learning experience, which aggregated into the e-portfolio, and it was particularly useful for various reasons. First, the e-portfolio was a significant factor in assisting the preservice teachers in keeping records of all their coursework electronically, and then being able to organize it in a singular place, such as a CD-ROM or a website, was beneficial to the students. Second, the e-portfolio was seen to be important to the reflective process as students had all the information relevant to them organized in a meaningful manner. The students submitted work for review and received feedback, which they then incorporated into the samples that they placed in the portfolio. In this way, they were able to keep records and different versions of their assignments and projects and were able to see continual growth throughout their course of study as stated by Rachael:

> I think the e-portfolio is great, I have everything since we started in the program, so anytime that I need something I just go to my e-portfolio and it has my classroom management plan, it has all my philosophy, the RTM, maybe it has the comparison we did from different times we taught and taped so we can always go back and reflect on the learning process, and you can get the feedback.

The third outcome was being able to use the contents of their e-portfolios in their own teaching. This could be done in one of two ways. First, they could use the materials they developed such as lesson plans for teaching mathematics content. Second, the preservice teachers could use their own e-portfolios as exemplars and then assist students to create their own projects. Amelia came up with the example to "use e-portfolios for our kids to show how they have gone [grown] during the year from beginning to end." In addition to learning's cumulative aspects, the idea of seamless integration was important to developing the e-portfolio. Hence, duplicating their effort was not seen as an effective way of learning both the pedagogy and technology skills and knowledge.

Reflective Thinking

The preservice teachers were exposed to the reflective teaching model at the beginning of their program. The model was demonstrated to them during a methods course in the summer semester, and subsequently they modeled it in their micro-teaching assignment. In the fall semester, they then modeled it again in their practicum experience at the middle school. In the spring semester, they demonstrated the model in their student teaching experience at the high school. The students reflected on the pedagogy and on technology when it is used. Part of the RTM is to critically reflect on practice. Students developed these skills over the three semesters. Through this model, the preservice teachers developed skills in collaboration, cooperation, reflection, and the ability to accept constructive criticism. In their mid-term and final reflection papers the preservice teachers felt that they had grown professionally as a result of their coursework and their student teaching experiences

In the process, an awareness of reflective thinking was demonstrated in the preservice teachers' e-portfolios. Over time, they moved from looking at the RTM from a theoretical perspective and began to apply aspects of the model in their own coursework and practicum experiences. Reflective thinking is reinforced in the RTM. In the e-portfolios, the preservice teachers demonstrated their development through the RTM process, artifacts, assignments, and their performance as it aligned and met the INTASC standards. The feedback they received from their cooperating teachers during the RTM process was also demonstrated as a motivator to continually revise their practice throughout the program. Annabelle stated,

> I think is [it's] good. We learned a lot about the reflective teaching model, how to reflect, so it is like throughout the program we kept on adding to the E-portfolio, modifying it, refining it, removing one thing and putting another; it helps you to reflect. I think that ['s] the major on[e] for the e-portfolio, that is, if we go back and look at it.

Being able to see the connection between the coursework and the final output was part of reflective process as was exhibited in use of the case studies from Roblyer (2004) that the students were required to analyze and reflect upon. One requirement was for the preservice teachers to draw deeper connections between the scenarios in the case studies and to make them more relevant for their e-portfolios. They felt that the cases

were realistic simulations that they could typically encounter in their own teaching. During the group reflection process, they discussed different ways in which to deal with similar situations. However, they expressed that the pay-off for the reflective process of case study analyses was not as big a payoff as that of working on the e-portfolios. These preservice teachers suggested spending less time analyzing the cases and more time on Mathematics software such as MathLab™ and Maple™.

Collaboration

Explicit and visible collaboration between the two faculty members was a significant factor in the success of the collaborative teaching approach. At the beginning of their program, during orientation, the preservice teachers had been made aware that the two of us were working closely together on curriculum development. Although the collaboration was reiterated often throughout the semester, the preservice teachers really began to see the outcome of the collaboration later in the semester, when they began to apply the concepts learned in the two courses. As the preservice teachers approached the completion of their program, revisiting the skills and knowledge with which they interacted during their course of study, they began to recognize further connections. Joe said,

> . . . they [instructors] did a good job regarding flexibility, breaking things out . . . I mean, truly, there were so many times over the course of the term that [the] two professors only talked to each other to see if . . . they were covering sort of the same thing[s] but they really made those two classes a lot smoother. . . .

Rose stated, "At first I did not realize how much they did and collaborated, but then you realize, 'Oh! It is not just coincidence that this goes together,' so I think they did an excellent job."

Extending the collaboration to other content areas was seen to be important by the preservice teachers. In the particular context of the mathematics students, the students expressed that the approach would have been even more enriching by incorporating more mathematics content, such as mathematics content courses that involve the use of computers. Therefore, the recommendation for collaborating between pedagogy, instructional technology, and content-specific coursework would have helped the students draw the three areas together. Extending collaboration to include other faculty members was recommended. Joe commented, "I know that is impossible to do [collaborate] between all the professors, but two thumbs up for them who did it."

As part of their orientation into the program, the incoming students met and interacted with the outgoing group. During the process, they received the opportunity to view the previous group's e-portfolios, and this helped them to form expectations of what would be required of them during their program of study. Rachel stated,

> I actually looked for that IT class because before the course started, when we were seeing other senior portfolios and I was kind of impressed by that, and they told me that had learned all that in that IT class, so I was looking forward to it.

Beliefs and Attitudes

Students appreciated the assistance they received from both courses. They stated that they were excited about using technology in the classroom and were comfortable using various hardware and software. These preservice teachers expressed the general feeling that technology is relevant and good and that more technology is needed in the schools now than ever before. Being knowledgeable about the technology and the updates is very helpful because even though some students might not have a computer at home, they are often around computers, and they know a great deal about the technology. Therefore, as a teacher, it becomes important to be aware of the current trends in order to incorporate pedagogical aspects of the process.

Initially, the preservice teachers were not sure that they would get much out of the course because they assumed that teachers just use overheads and computers, and many of them already knew how to do so. Amelia stated, ". . . [I]nitially when I saw the syllabus I thought it was going to be a lot of basic work, but I think the projects and assignments really helped to kind of simmer in what we were learning in class." However, it turned out that the preservice teachers were motivated to find new and creative ways of integrating technology, such as graphing calculators and Geometer's Sketchpad software, into their own coursework and as instructional tools. The preservice teachers also expressed growth and reduced anxiety using technology. They expressed satisfaction from the experience of having a class that directly addressed the development of an e-Portfolio. Joe commented,

> I really, honestly, could not have done my E-portfolio without the IT class; I mean, not even close, for me it would have been a tremendous amount of time and energy, and I would have died trying to do it. That IT class was absolutely essential to getting any kind of good portfolio.

Learning Outcomes

One significant outcome of the coursework was increased integrated technological and pedagogical skills and knowledge. The preservice teachers noted that during their program of study, they began using technologies that they were already familiar with in more innovative ways beyond the basic use. These innovative uses of technology were also demonstrated the following spring semester when preservice teachers enrolled in the practicum experience. For instance, Joe noted that he now viewed PowerPoint® as a "tool that captures students' attention whilst transforming information." In addition the preservice teachers indicated an increased comfort level when incorporating different technologies in the classroom. They reported this as being able to incorporate different technologies that they had explored in the technology course. As noted earlier, they were developing lesson plans that used technology integration for use during their practicum. These lesson plans that they created were subsequently incorporated into their e-portfolios. The preservice teachers indicated they were more likely to use technology in instruction, as they felt more comfortable exploring different ways in which they could incorporate the new tools that they were being exposed to in their coursework. For instance, they came up with examples of how they could incorporate software such as Geometry SketchPad® into lessons.

Another significant output was learning how to develop the e-portfolio itself. This included learning how to use the different software packages and then incorporating mathematics content in the technology course. The process also involved problem-solving skills to develop an organized and comprehensive final product. Being able to use the e-portfolio as a way to showcase their work was an added advantage. Further, the preservice teachers could provide samples of current projects to indicate their currency with various skills and standards. For instance, Annabelle suggested,

> It is good for when you are seeking employment, to show whoever is going to be your future employer what you have done and actually to go through and say, okay, you did this, and with all we have learned to do and actually did it and putting dates it will look rich to anybody, so those are the two advantages of it.

Annabelle's comment stimulated further discussion on the ways in which exchange of information occurs. The preservice teachers began to compare their own presentation formats with what was currently being used in the schools. Joe stated,

> I have to turn in our portfolios in February at the school for our department head. I am just going to take some stuff I did this semester and shift around the structure of what I got and turn that in, which might really freak them out because I think they got all big huge binders, because these teachers have been keeping them like for ten years.

Technology Issues

The issue of access and availability of technology was raised by the preservice teachers. They expressed concern that having access to technology resources at their future schools would be important to their success as teachers. Joe expressed that ". . . the availability to get it [the technology] is an issue." The preservice teachers also recognized the options and possibilities that were available to them to use in their future classrooms, in the form of physical resources, software, and electronic online resources. They talked about accessing resources, such as lesson plans, online and adapting them to their individual classes. One of the concerns expressed was the realization that many of the public schools did not have everything that they would need to maximize on the advantages of having electronic resources. Annabelle stated that "if it is there, it will be good!!! Because most of the public schools do not have everything you need."

Discussion

The CTA was geared toward providing support and facilitating the preservice teachers' personal growth of knowledge about teaching. We, the instructors of these courses, believe Harris and Harvey's (2002) assertions that facilitating critical thinking, providing teaching and learning opportunities, and reflecting on knowledge is important to our students' professional growth. Another belief is that engaging in professional collaboration can be influential in effecting change in instructional practices (Edwards & Hensien, 1999).

Throughout the activities of this study, the reflective teaching model, a pedagogical tool for us to plan, teach, and reflect (debrief) was the guiding framework for both instructors and preservice secondary mathematics teachers. The instructors planned the collaboration, then taught the preservice teachers to collaborate throughout the course and allowed them to reflect in class, through assignments and through a focus group activity. Hence, both instructors and preservice teachers were guided by the model. As noted, the group discussions were important to providing our students with a context to practice reflection-on-action (Schon, 1987), looking back on an incident, as well as reflection-for-practice, what they would do differently. We believe that reflective practice

leads to reflective teaching, and thus we emphasized this in both courses. The preservice teachers expressed their views about the RTM, their overall experience in reflecting on the cases, receiving peer input, gauging their own professional growth and development, and making connections to other coursework and practicum experiences culminated into an overall reflective process.

Several outcomes were expected. First, we hoped that when the preservice teachers observed the collaboration between the two instructors, they too would begin to explore avenues of collaboration with their peers and future colleagues. As indicated in the outcome of the study, the preservice teachers in this study acknowledged the collaborative efforts that were put in place to assist them in integrating course content. Second, the preservice teachers were provided with opportunities to seek consultation from the mathematics education instructor while being provided technical guidance from the instructional technology instructor. Third, we envisioned that sharing the outcomes of the collaborative approach with other colleagues across the department would open additional avenues of collaboration and encourage further activity with other colleagues across the department and in other content areas.

Increasingly, teacher education programs are recognizing the need for preservice teachers to be able to solve ill-structured problems and then to incorporate instructional experiences into their curriculum. Hence, the mutual interaction between learners and instructors and among learners themselves seems to have special importance to high-quality learning. Learning seems to occur when the social context provides opportunities for authentic just-in-time learning, incentives, and support. This social interaction seems to enhance problem-solving and development of metacognitive skills through reflective dialogue (Enkenberg, 2001).

The collaborative approach was designed to develop more curricular coherence for students with the intent of reducing fragmentation of the curriculum and to stimulate learning across mathematics and instructional technology courses. Outcomes of the collaborative approach can be used to determine needs in curricula and options for aligning common goals (Novicevic, 2003). In addition, the instructors wanted to model collaboration not only at the student level, but at all levels. It was therefore intended that refinement of the collaborative approach would be further developed into a model that instructors can adapt to other content areas within their programs. Students get the opportunity to document their personal educational development as well as learn and practice their technical skills. As noted by Rodgers (2002), a community of practice is a place where reflection should ideally occur through interacting with others in the community. Hence, reflective knowledge requires one to make sense of uncertain, unique, or conflicting situations of practice. Teachers who reflect and consider the affordances and constraints of a technology and its alignment with their own teaching philosophy are more likely to integrate technology (Zhao, Pugh, Stephen, & Byers, 2002).

Reflection is emphasized in this alternative teacher preparation program under study. We believe that reflective practice leads to reflective teaching. We also believe that the development from novice to expert occurs from instruction, professional maturation, and personal experiences (Hart et al, 2004; Schon, 1987). The importance of teacher reflection to the process of change in instructional practice is not limited to teachers of mathematics but extends to other areas as well. In instances where collaboration does occur, faculty members usually engage in team teaching (McDaniel & Colarulli, 1997). However, as noted, many courses in higher education involve little faculty collaboration and often rather engage one faculty member teaching students in his or her course alone.

Conclusion

Overall, the preservice teachers expressed satisfaction with the learning outcomes of the instructors' collaborating. They provided commendations about what worked well and recommendations for improvement. These comments were incorporated with the subsequent cohort of preservice teachers who joined the program the following academic year. The preservice teachers indicated that they were excited about learning different aspects of technology integration, although the technology course was viewed as "busy." However, they acknowledged that the projects and assignments helped to "simmer in" the content from their coursework. As collaboration continues to be used in educational research and teaching, it is important to pay close attention to the nuances and intricacies of the relationships that are formed (Rodgers, 2002).

As technology continues to be infused into curricula, educators should continue to seek ways in which technology tools and resources, including e-portfolios, can best meet learning goals and objectives (Zhao, et al, 2002). As identified in this study, there are overlaps in content areas that can be addressed when instructors come together to share skills and knowledge in their different content areas for the mutual benefit of enhanced student learning. Thus, the use of e-portfolios is one such forum for presenting pertinent information in a manner that is convenient and accessible to both the students and their instructors. When students go through their programs of study, the e-portfolio is a useful tool for depicting professional growth over time

as it can accommodate multiple documents and artifacts. Finally, when the students experience different instructors and take a variety of courses, it is a convenient way for them to make connections within their coursework in their program of study. If instructors can seek ways to bring content and processes together, then the process is further streamlined.

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