Technology and Pedagogy:
Building Techno-Pedagogical Skills in Preservice Teachers

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Learning and teaching with technology is hard, it can be overwhelming, and the field is always changing. (Jacobsen, Clifford, and Friesen 2001, "Oh, easy for Leonardo," ¶ 2)

Although preservice teachers do have a degree of knowledge with regard to information and communication technologies (ICT), "they have little know-how or techno-pedagogical ability with which to integrate those technologies into their teaching practice" (Karsenti 2001, 35). This paper gives an overview of preservice teacher technology integration experiences—including selecting and assessing software, hardware, and peripherals as well as approaches to integrative instructional technology—for students completing a Bachelor of Education at the University of Lethbridge (Alberta, Canada). It outlines an approach that encourages preservice teachers to develop both techno-pedagogical skills and reflective practitioner skills.

Each student entering the Faculty of Education is required to take EDUC 3508: Communications Technology and Education during Professional Semester I (PSI). The primary focus of the course is to provide experiences for the students that will help them effectively infuse technology into their future classrooms. This objective is accomplished by providing students with the opportunity to use a variety of technologies to accomplish tasks and by explicitly exposing them to the process of learning new technologies. This process includes exploring features of various technologies, identifying the appropriateness of using various technologies in teaching and learning, and devising methods to infuse these technologies into their teaching and learning. Students learn to be cognizant of the fact that we live in a culture of constant change—a technology may be appropriate today but not tomorrow. This philosophy underpins the program and encourages students to be reflective in their teaching and learning. As Riel and Becker (2000) state, "the rapid speed of technological development brings new computer mediated tools to the classroom door each year. Teachers have to make continual decisions about how to best utilize these tools in teaching, learning, and assessment" (5). This course attempts to develop the skills as well as the critical and reflective thinking necessary to engage in that process.

Creating an Innovative Online Learning Environment

The Faculty of Education at the University of Lethbridge was successful in creating an innovative learning environment for students to explore technology and devise creative and meaningful approaches to integrate technology into their future classrooms. Technology was used to teach students about technology; the integration was thus practical as well as theoretical in its approach (Clifford, Friesen, and Lock 2004). Through metacognitive teaching—thinking about teaching and planning for instruction in order to meet the specific needs of students—students were able to think about technology integration from the perspective of both the teacher and the learner. Metacognitive teaching includes teacher awareness of the sources and characteristics of the students' misconceptions and subsequent monitoring and evaluating of the extent to which important misconceptions have changed in productive ways (Hartman 2001). Through this approach, the students realized that meaningful teaching with technology does not require the teacher to be a technology or computer expert. Rather, the focus of the course was on the processes of learning—both about tangible technology and the implementation of that technology to improve teaching and student learning. Students learned a structure to learn about technology that could be applied to future learning about any technology; that is, be attentive, intelligent, reasonable, and responsible.

Program Components that Develop Techno-pedagogically Skilled preservice Teachers

As illustrated in Figure 1, there are three components of this program that develop techno-pedagogically skilled teachers: (a) meta-teaching, (b) technology exposure, and (c) critical reflection (Beaudin and Hadden 2004). A discussion of these three components follows.

Meta-Teaching and Process-Oriented Instruction

Preparing teachers to use technology effectively is a major area of concern for teacher education. Effective technology use includes such activities as linking curriculum outcomes with various technologies, establishing a learning context of discovery and process in the use of technology, collaborating with others both face-to-face and virtually to achieve learning outcomes, simulating real-world environments, and assessing outcomes. In turn, faculty modeling of effective technology use has often been emphasized as a key means of illustrating such activities in teacher education programs. "If preservice teacher education is to make a difference in how teachers use technology, then teacher educators must model effective technology use" (Milligan and Robinson 2000, 24; see also Bruder 1989; Fulton 1989; Handler and Marshall 1992; Beisser, Kurth, and Reinhart 1997; Kent and McNergney 1999; Beisser 2000; Topp and Mortenson 2000). While we agree that faculty modeling is a necessary, though often absent, component of preservice teacher preparation, it is only one part of developing techno-pedagogically skilled teachers. We must show preservice teachers how to learn by outlining what process works for combining technology and pedagogy; they need to be exposed to theory and research on technology in order to develop evidence-based instructional strategies and a conceptual framework for integrating and evaluating technology applications. Successful programs must also engage in meta-teaching and process-oriented instruction to foster effective technology use in their students.

One important and significant shortcoming of faculty modeling is that the methods of integrating technology at the university level—the methods most familiar to the majority of preservice teachers—are quite different than the methods for teaching in a K-12 system. For example, the appropriate and effective use of discussion boards, listservs, and course management software in the university classroom will be different from that in the K-12 classroom. University students can be expected to contribute to class through a variety of asynchronous learning tools outside the classroom while in a K-12 setting, it would be necessary to reserve class time for such activities. The university instructor can more readily assume computer access for students outside the classroom whereas the K-12 instructor may still need to provide computer access for school-based work. A necessary component of teacher education, therefore, would be the act of explaining what we are doing when we integrate technology and a discussion of how to adopt different methods of integration given different educational contexts (Beaudin and Hadden 2004). Faculty modeling must be complemented by meta-teaching in order to prepare preservice teachers for the distinctive settings they will face in their future professions.

Meta-teaching helps prepare techno-pedagogically skilled teachers because it allows them to develop a holistic understanding of the process of teaching with technology. A focus on the process involves the premise that there are different forms of knowledge that can be fostered by (and through) the instructional use of technology. For example, cognitive and developmental psychologists have examined types of knowledge that change as learners advance from being intermediate learners to advanced learners; three major types include declarative knowledge (knowing *that*), procedural knowledge (knowing *how*), and conditional knowledge (knowing *when* and *why*) (Paris, Lipson, and Wixson 1983). Declarative knowledge includes both ideas related to structure and goals as well as information helpful in developing goals and changing task conditions. The following assertion expresses an example of such knowledge: "I know that my comprehension goals differ when reading newspapers and textbooks" (Paris, Lipson, and Wixson 1983, 303). In contrast, procedural knowledge includes ideas related to how certain actions are executed, and conditional knowledge includes strategic ideas about when and why to apply various actions in different contexts (Paris, Lipson, and Wixson 1983, 303; see also Pressley and Harris 1990). A process-oriented focus to technology integration in teacher education encompasses all three forms of knowledge—such that preservice teachers

not only gain substantial exposure to and proficiency with technology but also discover effective and efficient strategies for teaching and learning through technology.

While meta-teaching fosters a full range of key questions for preservice teachers, its greatest impact is that it compels them to think about the *why* questions regarding teaching with technology. Why is this technology appropriate for achieving learning outcomes? Why is this technology likely to improve student learning? Is there a positive change in student learning as a result of the use of technology? Through the use of meta-teaching, preservice teachers become aware that teaching with technology is about learning—both teacher learning and student learning. The approach to meta-teaching that is most fitting to this work is Timpson's description of his running conversation about teaching and learning where "all of us—the instructor, the students, and I—engaged in a collective and complex *metacognitive* task of thinking about instruction and how to make improvements while in the midst of it" (1997, "Teachers and courses," ¶ 5). We continually asked preservice teachers to think about technology and what was happening within their online classroom. In addition, we asked them to consider how the activities would change in their own classroom, and as they did this, they learned how to learn and how to teach with technology as they developed into a community of learners (Brown, Campione, and Day 1981).

Figure 2 highlights the fundamental learning process that was developed within the course. The questions raised within this process are in no way intended to be exhaustive; rather, the process was intended to be a starting point for preservice teachers to begin to think about what they are doing when learning about technology for teaching and learning.

As students were exposed to new technologies, they explored the thinking behind the technology: What is it designed to do? Is the technology simply being applied to an old learning system, or does the technology elicit new, meaningful student learning? Is the technology the most effective for the learning situation? Can the technology be applied to new learning processes and not just existing learning processes? Then the students were asked to think about the ways in which the technology could be used in classrooms and to make informed judgments about its advantages and disadvantages for teaching and learning. They were then expected to use online materials to learn more about the technology as part of becoming informed about its pedagogical possibilities. This process formed the explicit structure of the course. Students were encouraged to see that they could use this structure when they encountered any new technology and to understand that they could use technology to learn about technology.

We have heard the argument that effective technology integration should begin with the curriculum area (such as social studies or science) and move to finding technologies (such as spreadsheets or digital imaging) that are appropriate for the given curriculum. This implies that educators should use technology to assist in effectively and efficiently achieving curriculum objectives. Hadden (2004) attests that technology is best learned within the context of applications—that activities, projects, and problems that replicate real-life situations are among the most effective approaches for learning technology. However, we found it more appropriate in the first semester of the program to begin with the technology and attempt to integrate it into specific PSI course/subject areas, often in a collaborative, project-based approach. In the Language in Education course, for example, students used technology to develop their writing portfolios and photo journals while in the Curriculum and Instruction course, technology was used for collaborative discussion and in collecting teaching materials. Discussions on the validity of their experiences with technology and how these experiences impacted their learning were conducted in the Communication Technology (CT) course. The CT course, in this way, was used as an opportunity for reflection. Students were expected to respond to the following:

- Description of use of technology: *Describe how you used the technology*.
- Response to the activity: *Write a one-paragraph description of how useful you felt the technology was in enhancing your learning*.
- Integration of that technology into your own subject area: *Describe an activity you think your students could do (in a specific subject area) using the specific technology*.

Again, it is important to understand the context of this experience. In no way are the questions intended to be exhaustive. Students in this course are in the introductory semester of their training. This course, in many ways, is setting the stage for further learning and growth. Figure 3 illustrates how the technology topics covered in the Communications Technology course were linked with other Professional Semester I courses. While the figure summarizes how technology components were integrated into other areas, it does little to address what impact the experience had on preservice teachers learning about technology or how the integration of technology enhanced their learning in other courses.

Technology Exposure

We define technology exposure as something far more than just having students develop skills in a particular technology. Technology exposure includes (but is not limited to) all of the following: integration methods, lab protocol, developing technology skills, and learning how to gather tutorials and learning materials from the Internet.

We hoped that virtual field trips would be an effective method to assist in exposing preservice teachers to real-life or real-classroom technology integration. In the virtual field trip component of the course, we intended to present video clips of various technology-rich classroom settings. Questions related to the video clips would be the catalyst for the preservice teachers to reflect and discuss collaboratively what they were watching. Virtual field trips have the potential to target two major areas of common concern in teacher technology preparation. First, they assist in addressing what the best practices are for preparing students to work in a computer lab. Many of the preservice teachers were unaware of the basic classroom issues of working with technology. As a result, the virtual field trip raises questions for current and future consideration: How do I teach in a lab? What is the best way to structure a lab? How can I facilitate collaborative inquiry in a lab? What concerns should I be aware of in the computer lab? How do I handle computer lab protocols? How can I use students as peer teachers? Will this help to improve student learning, and if so, how will it do that? The virtual field trip also has the potential to have students see both exemplary and questionable practices and critically reflect on various applications of technology in the classroom. This leads to the second major benefit of virtual field trips—having preservice teachers develop critical reflection skills. Learning to question what is happening when they see technology being used in the virtual field trip classroom environments forces preservice teachers to engage in active, critical, and collaborative reflection.

Critical Reflection

Critical reflection is thinking about what one does when one teaches with technology, requiring reflection on one's teaching and on the technology used. Reflective instructors might consider questions such as: Is this the best approach? Does this technology enhance teaching and learning? Did student learning improve? How do I know learning occurred or improved because of the use of technology? How was the level of student engagement influenced by the infusion of technology?

Being critical about technology integration is a time-consuming and difficult task for preservice teachers. Lonergan (1972, 1992) outlines a method that can be used in evaluating a variety of situations. While Lonergan's transcendental method has been examined, a philosophical defense of his work is beyond this paper (see Grace 1996 or Grigg 1995 for discussions on the validity of Lonergan's transcendental method). The present work is an application of his method. Lonergan's model is seen as a valuable tool for decision-making regarding technology integration. His method is transcendental—it transcends the present and the particular. Therefore it can be applied across a variety of situations and is able to address changing technology (Beaudin 2002). Figure 4 illustrates the application of Lonergan's transcendental method during the technology course to offer students a structure that would encourage critical questioning of and reflection on technology. The questions in the table acted as starting points, intending to get students to consider the imperatives: be attentive, intelligent, reasonable, and responsible.

An Illustrative Example of Developing Techno-pedagogical Skills

In our model, preservice teachers follow the process of learning to teach with technology—they learn how we expect them to teach. For example, a three-hour online module directs students to read a few online articles on the use of graphic organizers in the classroom, including articles that support the technology and those that criticize it. This sampling of articles gives the students an idea of what graphic organizers are about. Next, students are asked to download a trial version of Inspiration, a graphic organizer software program. The online module exposes students to various examples as they link to, and view, several completed Inspiration documents. When prompted, students then link to several online resources providing exemplars of various subject specific lessons that have integrated Inspiration to demonstrate understanding of the value of concept mapping software as a cognitive tool for developing structural knowledge. Next, students create a simple Inspiration file to brainstorm uses of technology in their subject area. To complete this task, students need to locate and use online tutorial materials. Finally, students post their document to the class discussion board so that others can view their files with the various technology integration ideas listed.

At this point, meta-teaching comes into play. After the students complete the assignment, they think about what they did: how they learned about a new technology, read about the ways to integrate it in the classroom, viewed lessons using the technology, explored the technology itself, and then shared it with their colleagues. They discuss the outline of the activity and review the results of their work, considering how they learned about a new technology. All of this is completed in a matter of hours. Students, for the most part, find this to be a very liberating discussion. They realize that they have the skills to acquire what they need to teach with technology, and more importantly, they accept the role of learner as an ongoing one—a journey that never ends.

During this process, a critical component comes into play when students are asked if they did, in fact, view their peers' documents. Was the sharing of documents via the class discussion board effective? In this example, the instructor and the students discuss ways of improving the lesson, including changes that would be required for various classrooms, how one might ensure that students benefit from sharing, and how to further expand on the lesson. Simple completion of a task is not enough; we must constantly reflect on the experience, looking toward improving our teaching and learning with technology and assessing the potential and resulting effectiveness toward student learning. In short, we ask our students to be attentive, intelligent, reasonable, and responsible; in other words, we ask that they use Lonergan's transcendental method.

Instruction within the online course is designed to be intensely student-centered, providing personalized learning opportunities oriented to meaningful issues in teaching and learning with technology. Further, the online environment is designed to permit a high degree of interactivity both with content of various kinds (links to databases and information sources) and with people (experts, other students, and the instructors). It also creates a technology culture of use where students must use technology tools and environments to work with one another, arrange their schedules, submit assignments, and meet other course requirements. The students' immersion in a technology-rich learning environment provides further opportunity for teaching and learning using technology. What is crucial here is not only are they learning in a technology-rich environment and therefore gaining technological skills, but they are also coming to appreciate that the technology is enabling the learning because of its implicitness within the learning model.

Through meta-teaching, we require students to make explicit connections about technology both as prospective teachers and as current and future learners. After each lesson, students and instructors critique both what went on in the lesson and why. We encourage students to ask important *why* questions about technology: Why did we ask you to do that activity? How is that activity enhanced with the use of technology? How could you improve the lesson or the technology use? This approach to learning provides a model of how to create a technology-enhanced learning environment, which the preservice teachers experience for themselves—they learn the principles of designing learning environments that can be transferred into their future classrooms.

Conclusion

This article has provided a working definition of techno-pedagogically skilled teachers and exemplified how a hybrid approach of meta-teaching, technology exposure, and critical reflection can be used to enhance instruction. In all of our endeavors to prepare technology-pedagogically skilled teachers, it is crucial that we incorporate an underpinning of technology and pedagogy to prepare our preservice teachers to teach with technology and become learners on a never-ending journey.

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