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The Role of Guiding Principles in Pre-service Teachers'

Conceptualization and Utilization of Technology

by

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ABSTRACT

Although research demonstrates the positive impact of technology integration on K-12 student learning, it also indicates a lack of effective teacher preparation in technology. This study examined the efforts of an undergraduate teacher education program to address this inconsistency and improve the technological preparation of its students through the introduction of five guiding principles: Appropriateness, Fluency, Ethics, Evaluation, and Application. A cohort of 13 undergraduate pre-service teachers completed two surveys, a weekly reflection journal, and a curricular unit while student teaching and engaging in ongoing professional development. The guiding principles were found to be a helpful framework within which the pre-service teachers could observe and undertake technology integration in the classroom.

INTRODUCTION

Technology has a significant and growing impact on communication and learning in today's world. Social networking services have exploded, with Facebook experiencing a 105 percent growth in 2009 alone and Twitter gaining 18 million additional visitors over the course of the year (comScore, 2010). Not only has the web become a key source of information, from the 30 million new readers of online newspapers in the last five years to Wikipedia's 13 million articles in 200 languages (XPLANE, 2009), but it is also increasingly becoming a primary source of entertainment, with online video content providers (YouTube, Hulu, etc.) seeing 178 million unique viewers in December 2009 (comScore, 2010). Beyond the internet, smartphone and 3G phone ownership increased by a combined total of 17% from December 2008 to December 2009 (comScore, 2010) and iPhones now support over 65,000 apps (XPLANE, 2009). Given this technology and media-saturated environment, it is natural to consider present-day students' interactions with and expectations of technology.

Data indicates that ninety percent of U.S. children between the ages of five and seventeen use computers (U.S. Department of Commerce, U.S. Department of Education, & NetDay), and that eighty-eight percent of youth

have internet access (Duncan, 2008). Young adults spend more time surfing the internet than consuming any other form of entertainment media (Ipsos MediaCT, 2008), and most teenagers go online daily or several times a day (Lenhart, Arafeh, Smith, & Macgill, 2008). However, 32% of teens never use the internet at school for any reason, despite 99% of public schools having internet access (Rainie, 2005). Given that the majority of use occurs at home (Kelly, 2009), a substantial disconnect has been reported between home and school in terms of internet and technology use (Levin & Arafeh, 2002). Yet significant research conducted in the 1990s and early 2000s indicates that the effective utilization of technology in schools positively impacts content area learning, higher-order thinking skills, scores on standardized tests, and workforce preparation (Kulik, 2003; Cradler, McNabb, Freeman, & Burchett, 2002; Fox, 2009; Schacter, 1999).

Today's students are increasingly comfortable with and often dependent upon a variety of technological tools, from personal laptop computers to readily accessible wireless internet, especially when compared to their parents' generation (Macgill, 2007). Surveys and focus groups have demonstrated that students expect such tools to be a natural part of their education and that they believe they receive a better education when technology is a part of their experience (Rainie, 2005; Spires, Lee, Turner, &

Johnson, 2008; U.S. Department of Commerce, U.S. Department of Education, & NetDay). Corresponding with the student perspective, the federal government as well as other national and international professional associations (including the National Education Association, the National Council for Accreditation of Teacher Education, and the International Society for Technology in Education) and the public at large have increasingly prioritized technological literacy: "the ability to use…a range of technologies…to communicate, to locate and manage information, and, perhaps most importantly, to use these tools effectively to support learning the content of 'the other basics'" (Culp, Honey, & Mandinach, 2005).

Teacher Preparation

With the increased attention given to technology in education, significant research and funding has been directed at teacher preparation programs (Lehman et al., 2003) and their role in promoting and developing teacher competencies around technology integration, defined here as the utilization of technological, pedagogical, and content knowledge to benefit student learning (Pierson, 2001). The most recent U.S. national education technology plan recommends improvement in this area as one of its seven major action steps, claiming that "Teachers have more resources available through technology than ever before, but some have not received sufficient

training in the effective use of technology to enhance learning" (U.S. Department of Education, 2004, p. 40). While forty-six states now have standards for teachers that include technology, only twenty-one of them require candidates to demonstrate technology competence in order to receive a teaching license and only ten states require some form of technology training or professional development for recertification (Hightower, 2009). Less than one-third of teachers report feeling well prepared to integrate technology into their classrooms (Wells & Lewis, 2006; Parsad, Lewis, & Farris, 2001).

In order for technology to become truly integrated into the curriculum at large and have an impact on student learning, teachers must not only recognize the importance of teaching with technology, but must also learn how to effectively incorporate it into their practice. For this to occur, teacher preparation programs will need to infuse their training with technology. Such infusion may include seeking cooperating teachers who utilize technology, offering opportunities to observe examples of technology integration, providing more access to technological tools, and modeling technology-supported teaching (Doering, Hughes, & Huffman, 2003).

Unfortunately, research documents a wide range of barriers to effective technology preparation at the pre-service level. At the program level, these include faculty members' lack of time, training and interest, and weak

existing technology infrastructure and support (Kleiner, Thomas, & Lewis, 2007) as well as unclear expectations and a lack of incentives (Schaffer & Richardson, 2004). Even when program faculty believe in the importance of including technology in their students' course of study, they often encounter difficulties obtaining adequate funding, tools, and technical support. Others have little experience in integrating technology into their own instruction and have minimal opportunities to change this situation. In addition to program elements, a number of individual factors on the part of the pre-service teachers have been associated with the effectiveness of technology preparation. These include positive versus negative emotions experienced during the learning of new technologies (Kay, 2007), attitude towards and perceived ability at learning new technologies (Lambert, Gong, & Cuper, 2008), comfort level with various technologies, frequency of technology use, and feelings of efficacy in relation to technology (Mayo, Kajs, & Tanguma, 2005).

In spite of the challenges, selected teacher preparation programs have demonstrated some degree of success in integrating technology, graduating teachers who continue to infuse their instruction with technology after participating in the program (Franklin & Molebash, 2007; Mayo et al., 2005; Milman & Molebash, 2008). Characteristics of these successful programs include effective faculty modeling (Kim, Jain, Westhoff, & Rezabek, 2008),

strong fieldwork components (Bahr, Shaha, Farnsworth, Lewis, & Benson, 2004), instructor support, peer assistance, and clear guidelines around technology proficiencies (Pratt & Stevenson, 2007). Results are frequently seen after the development and implementation of a single methods course in which the instructor devotes considerable time and effort to purposefully integrate and model the effective use of technology with content standards.

Study Context

Given the wealth of research on teacher preparation programs' integration of technology and in response to self-identified areas for improvement, an early childhood and elementary licensure program at a small liberal arts college in western Massachusetts undertook an action research project to investigate ways in which it could improve the technological preparation of its students. A cycle of data collection, interpretation, implications, and action characterizes this approach (Altrichter, Feldman, Posch, & Somekh, 2008), which has at its core the desire to improve practice based upon data. Action research is carried out by those directly involved in the situation with the goal of making effective changes not only at the end of the project but throughout the process as well (Altrichter, et al, 2008). Although not always titled as such, many teacher preparation programs have taken this approach in their efforts to integrate technology (Garcia & Rose,

2007; Doering, et al., 2003; Brush, 1998; Drazdowski, Holodick, & Scappaticci, 1998).

End-of-program evaluations completed by graduating early childhood and elementary licensure candidates collected over a three year period suggested that pre-service teachers in the program felt they lacked adequate conceptual and practical understanding of how technology could be effectively integrated into their teaching and into student learning in the classroom. While organizations such as the National Educational Technology Standards project of the ISTE and the Partnership for 21st Century Skills offered valuable information about standards, student outcomes, and support systems, program faculty found these resources to be insufficient for developing a clear set of guiding principles which would inform pre-service teachers' use of technology in the classroom (Personal communication, Spring 2008). Teacher candidates who read the ISTE teacher and student standards expressed frustration with them, noting that the numerous standards in each document were cumbersome and did not readily map onto their existing state teacher licensure standards or the multiple curriculum frameworks they were using to guide curriculum planning and instruction. Program faculty suggested that a more concise theoretical framework or lens through which teaching and learning with technology could be conceptualized might improve

pre-service students' sense of self-efficacy with regard to the effective use of technology (Personal communication, Spring 2008). From a program viewpoint, what was needed was a set of principles that could be used for both teachers and students and would be concise enough to remember, intuitive enough to make sense, and detailed enough to support implementation.

As a member of the action research team, I used the Performance Indicators from the 2001 Massachusetts Recommended Pre-K-12 Instructional Technology Standards and from the NETS for Students (NETS-S) and for Teachers (NETS-T) as frameworks to develop a set of five guiding principles that combined and organized the big ideas of these indicators into five conceptual and sequential understandings: Appropriateness, Fluency, Ethics, Evaluation, and Application (see Appendix A). At the time of development, the 2008 Massachusetts Technology Literacy Standards and Expectations were not available; however, significant correspondence exists between this document and the guiding principles (see Appendix B). While each of the principles is described briefly below, additional documentation is provided in the appendices. The set is intended to serve as an overarching framework for thinking about technology and thus is appropriate for use at many levels, including for both students and teachers.

Guiding Principles

The first principle, **Appropriateness**, concerns knowing when to use technology as well as which tool to use in order to accomplish one's goal (Performance Indicators 1.59, 1.60, 2.4, & 2.16, MA Instructional Technology Standards, 2001; Performance Indicators 3a & 3c, NETS-S; Performance Indicators 2a, 2c, 4b, & 5b, NETS-T). Whenever there is a desired learning objective or outcome, a primary consideration should be whether or not a technological tool is available which could support the delivery and retention of content. Given that there may be many tools which could help accomplish the objective, thinking about appropriateness also involves considering which technological tool is best suited for the purposes in mind and for the students who will be utilizing it. Thinking through the possibilities ahead of time should always serve to guide and inform the technology's use.

Secondly is **Fluency**, the basic "how to's" of technology use which become necessary once a tool is chosen; it encompasses working knowledge of computer hardware and software as well as of technological resources such as the Internet (Performance Indicators 1.1, 1.37, 1.53, 2.20, 3.1, 3.2, 3.6, 3.7, & 3.12, MA Instructional Technology Standards, 2001; Performance Indicators 3b & 6, NETS-S; Performance Indicators 3a & 3d, NETS-T). While there should be a bigger purpose behind the technology use that is connected

to the learning objective, it is important to consider what skills will be needed, by both the teacher and the student, to effectively use the chosen technology. When teaching technological fluency, the teacher is equipping students to use their knowledge and skills effectively to obtain the best results with the least frustration.

Ethics, knowing the legal and ethical issues surrounding technology and its use, is third and is an important component from the moment the use of technological tools begins. The principle includes understanding of technology's potentials and drawbacks, abiding by legal and ethical constraints, and recognizing consequences for non-ethical behavior, as well as including aspects of cultural understanding and global awareness (Performance Indicators 2.6, 2.7, 2.9, & 2.18, MA Instructional Technology Standards, 2001; Performance Indicators 2c & 5, NETS-S; Performance Indicators 1d, 4a, 4c, 4d, & 5d, NETS-T). Today's world is increasingly globalized, and just because something can be done with technology does not mean that it should: this is where the ethics principle applies.

Fourth, the **Evaluation** principle concerns an evaluation of both the work that is being done and of the information that is being used (Performance Indicators 2.3, 2.12, 2.13, 2.19, & 3.14, MA Instructional Technology Standards, 2001; Performance Indicators 4, NETS-S;

Performance Indicators 1c, 2b, & 5c, NETS-T). Both teachers and students need to be able to not just use the technology, but to know whether or not they have used it effectively for the purpose that was originally identified. This evaluation principle also applies in situations such as internet searches in terms of being able to determine whether or not the results are useful and valid. The metacognitive and critical thinking component of both these aspects is crucial for all activities and particularly for technology due to its wide range of possibilities and information sources.

Finally, **Application** addresses the level to which all technology use should aspire: the meaningful use of technology to make connections and apply one's knowledge to specific contexts or disciplines (Performance Indicators 1.34, 3.3, 3.8, 3.9, 3.10, 3.13, 3.15, 3.16, & 3.19, MA Instructional Technology Standards, 2001; Performance Indicators 1, 2a, 2b, 2d, & 3d, NETS-S; Performance Indicators 1a, 1b, 2d, 3b, 3c, & 5a, NETS-T). Once again, this principle is connected to the original learning objective in that students should be using technology within a larger curriculum to facilitate and enhance their learning of other topics. While application will look different across situations, the goal is for technology to support and enable the creation, integration, and communication of ideas.

Present Study

The goal of the current study was to examine and describe pre-service teachers' experience in using these guiding principles to plan for and reflect upon teaching with technology. In particular, the study explored the ways in which participants' conceptualization and utilization of technology developed over the course of their student teaching semester as they were given opportunities to observe and engage with various technology tools in the context of the guiding principles.

METHOD

Participants

A cohort of thirteen seniors participated in this study, selected as a result of their enrollment in the seminar accompaniment to the student teaching practicum. Research has shown that effective preparation with technology at the pre-service level can have lasting effects on participants and their teaching (Milman & Molebash, 2008) and that the student teaching experience can have a large impact on student teachers' intentions to integrate technology (Smarkola, 2007). Seven students were pursuing early childhood education certification and six students were pursuing elementary licensure; three students were of non-traditional age. These students had already completed all other education coursework and were now focused on integrating that knowledge and applying it to their classroom practice. Throughout their practicum semester, they became increasingly responsible for instructional time and content in their respective classrooms, culminating in two weeks of lead teaching and the development of a curricular unit.

Materials

Two surveys were developed for use in this study: one to be given at the start of the practicum experience and one to be given following its

conclusion. The first survey was intended to provide a snapshot of participants' current conceptualization of technology at the time, while the second was designed to explore participants' self-identified changes in their thinking about technology over the course of the semester. To encourage such reflection throughout the practicum experience, participants were provided with a reflection prompt for weekly use concerning their technology use and its connection with the principles.

Survey 1. The first survey assessed participants' views on the use of technology in education, their perception of available support and resources relating to technology, and their own use of technology for personal and instructional purposes. The survey was administered online through FormSite and was available three weeks into the semester; participants were sent the link via email and asked to fill out the survey on their own time. A mixture of open response and scale questions were used, with forty-one items total (see Appendix D). The six open response questions asked participants to provide their thoughts and opinions on technology and its role in teaching and learning as well as to describe the technology that is available to them in their field placements (O'Dwyer, Russell, & Bebell, 2004); one question also inquired about the grade level of the participants' placement. These open-ended questions were designed to provide participants with an opportunity to share

their views in their own words and thus to gain a glimpse into the way that they conceptualized technology prior to structured work with the guiding principles. Fourteen scale questions assessed participants' outlook on technology and student learning by asking them to rate their agreement with a selected set of statements; these questions were used to construct general portraits of participants' attitudes towards and beliefs about technology. The statements were designed to cover a wide range of factors that have been cited in the literature as important components of successful technology use in the classroom, such as constructivist beliefs and ideas about cooperative learning (O'Dwyer et al., 2004). A set of twelve questions investigated the roles of the campus, the teacher licensure program, the placement school, and the cooperating teacher in influencing and supporting participants' use of technology, with three additional questions further exploring the role of the cooperating teacher (Laffey, 2004). This set assessed major influences on participants' use of technology and provided valuable information for the program in thinking about additional areas of technology support. Finally, four questions asked about the observation and utilization of technology in pre-practicum and practicum placements, and two matrix-style questions inquired about comfort level and frequency of use for a variety of specific technologies. These questions illustrated prior technology experience, which

has been shown to be a key factor in teacher use of technology in the classroom (O'Dwyer, et al., 2004; Mayo, Kajs, & Tanguma, 2005), and again provided valuable information on areas needing technology support during the seminar.

Survey 2. The follow-up survey asked participants to reflect on any changes in their thinking about technology, to suggest future changes about technology education in the teacher preparation program, and to evaluate the use of technology in their practicum and in their unit. This survey was also administered online through FormSite: participants were emailed the link following the conclusion of the teacher preparation program and again asked to fill out the survey on their own time. Ten questions were posed, a mixture of open response (four questions) and scale items (six questions) (see Appendix E). Questions in this survey were designed to encourage reflection on the teacher preparation program and the participants' practicum, the first two questions specifically inquiring about changes in thinking and suggestions for the program. One set of three questions asked about the observation and utilization of technology during the practicum, thus allowing comparisons with pre-survey data and with other participant-provided information, and another set of five questions asked about participants' experience with technology in designing and implementing their curricular unit.

Reflection Prompt. A short prompt about technology in the classroom was incorporated in participants' weekly reflection assignment for their seminar course. The prompt asked participants to reflect weekly upon their own uses of technology during their practicum and to consider additional areas of integration either in terms of what they could have done or what they could do (see Appendix F).

Rubric. Participants were also provided with a rubric for the assessment of technology integration in a lesson or unit (see Appendix G). This rubric was designed to help participants self-evaluate their own curriculum planning as well as to be used by the researcher in assessing final curricular units for evidence of technology.

Procedure

All participants were asked to complete an informed consent form during a meeting of their seminar class. At this time, they were given an opportunity to ask questions about the research and their own participation in it. The form asked them to consent to participation in the two surveys and to the release to the researcher of their final curricular unit and instructor-selected reflections. Participants were able to select their level of participation in the study; all chose to participate completely. During this same class meeting, participants took part in an informal introductory discussion about

the study and its goals, having already received copies of the technology guiding principles as part of their coursework.

Three weeks into the semester, participants were emailed the link to Survey 1 and asked to complete it. Throughout the course of the semester, participants were asked to respond to the weekly reflection prompt and were encouraged to think of ways to integrate technology into their instructional practice by means of skills training (Gunter, 2001), discussion of their own efforts (Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003), and instructor modeling (Kim et al., 2008; Adamy & Boulmetis, 2005; Brown & Warschauer, 2006). Participants learned how to upload, download, and embed digital photographs, use a digital camera, and edit video, and they took part in discussions about web resources, ELMO technology, and their observations of technology use in the classroom. Web resources that were introduced included the National Council of Teachers of Mathematics (NCTM) website and its online manipulatives, the FOSS science curriculum site, and an online book site. At some point during the semester, as part of course requirements, each participant was videotaped by a peer and asked to use the video to reflect on her practice. In addition, participants regularly used an electronic course site to obtain class readings, submit papers, and document their practice in portfolio form. Following the conclusion of their practicum, participants were

emailed the link to Survey 2 and asked to complete it. Also at this time, final curricular units and relevant reflections were compiled by the seminar instructor and provided to the researcher.

Data Analysis

Survey Data. Data from both surveys was exported from the FormSite website into SPSS for statistical analysis. All scale items were recoded from verbal descriptions to representative numbers, where "1" represented the high end of the scale ("Strongly Agree," "To great extent," "Highly supported," etc.) and "5" represented the low end of the scale ("Strongly Disagree, "Not at all," "Not supported," etc.). A number of grouped items were checked for internal consistency reliability by computing Cronbach's alpha and then summated to create overall measures of the following: technology beliefs (questions 4, 5, 7, 8, and 10 from Survey 1; $\alpha = .768$), constructivist teaching and learning beliefs (questions 11-17 from Survey 1; $\alpha = .809$), overall technology comfort level (question 37 from Survey 1; $\alpha = .888$), overall frequency of technology use (question 38 from Survey 1; $\alpha = .807$), and use of technology in curricular unit (questions 6-9 from Survey 2; $\alpha = .986$).

The measures for technology beliefs, overall technology comfort level, and overall frequency of technology use were then used to create relative high and low groups by ordering the cases according to the values for each measure

and splitting them as close to half as possible. This creation of groups enabled comparisons across participants by making it possible to look at the relationship between these variables and the demonstrated use of the principles or actual integration of technology. Participants with a technology belief value less than 2.00 were considered to have a high belief in the importance of technology as an educational tool, while participants with a value of 2.00 or greater were considered to have a low belief in the importance of technology as an educational tool. For comfort level, participants with a value of 2.04 or less were considered highly comfortable with a variety of technologies, while participants with a value of 2.44 or higher were considered only somewhat comfortable with a variety of technologies. In terms of frequency, participants with a value of 3.08 or less were considered frequent users of a variety of technologies, while participants with a value of 3.48 or higher were considered occasional users of a variety of technologies.

Reflection Journals. All reflection journals were read through twice in their entirety, once by the researcher and once by a research assistant, to identify and highlight all mentions of technology. Passages that included such mentions were pulled out to create condensed sets of reflections for each participant and then coded in three different ways. The first coding identified

significant aspects of each selected passage and included codes such as "documentation," "possibilities," "web for content," "communication," and "integration." A second set of codes focused in on the type of technology being discussed: general hardware, general software, video media, internet, overhead/projector, games, presentation software, photographs or visuals, and email. The third coding, completed separately by two members of the research team, assigned one or more guiding principles to each text segment. All assignations were used in order to gain the most complete pictures of the participants' conceptualization of the principles.

Once the coding was complete, journal data was entered at the paragraph level into Narralizer, a qualitative research software program. Three main sections were created for the three sets of coding: "Notes," "Tech Use," and "Principles" (see Appendix H). After each text segment was entered into the program under its appropriate codes, similar categories in the "Notes" section were joined to reflect common or bigger ideas. For example, "communication with parents," "teacher communication," "sharing resources," "collaboration," and "peer communication" were grouped together under "communication." In addition, the coding categories of "hardware" and "software" in the "Tech Used" sections were expanded to include specific notation of the types of hardware and software being discussed, such as

"copier," "calculator," "printer," and "word processing," "games," "powerpoint". Narralizer was used to generate text segment outlines for each participant and for particular codes that were of interest, such as each of the five guiding principles.

Curricular Units. On the first read-through of the curricular units, all evidence and mentions of technology were flagged. Flagged items included explicit rationales or explanations relating to technology, lesson plans which incorporated technology, and physical evidences such as photos or printed power points. A summary sheet was then created for each unit describing the evidence of technology and compiling extractions from the unit that dealt with technology. The researcher and research advisor scored the units separately using the guiding principles rubric, with any discrepancies being resolved through discussion. Each performance characteristic from the rubric was coded either as 0 (No evidence), 1 (Some evidence), or 2 (Strong evidence). The mean score of the four characteristics for each guiding principle then served as a performance indicator score ranging from zero to two for each principle. Finding the mean of the five performance indicator scores created an overall measure, again ranging from zero to two, of the unit's evidence for addressing the guiding principles in its integration of technology.

Data Reporting

Given the range and extent of data collected through the surveys, reflection journals, and curricular units, a case study approach to data reporting was used in order to provide a complete picture of participants' conceptualization and utilization of technology over the course of the semester. Such an approach allowed all of the data to be examined both systematically, so that no pieces were overlooked, and contextually, so that the various data sources could complement each other. The information gleaned from the various case studies was then compiled to report on overall program trends and findings.

RESULTS

Throughout the course of the semester, all 13 participants considered technology and the guiding principles to varying degrees and in varied contexts, often through a combination of explicit reflection in their journals, planned incorporation in their lessons, and applied use during their teaching. Each case description provides background information about the participant, an overview of their technology use during the practicum, the evidence of technology in their unit, an integrated look at their employment of the principles, and any final reflections or recommendations that they made. Important considerations across the cases included participants' experience, attitude, and placement situation.

Amanda

As an early childhood licensure candidate, Amanda split her practicum time between a kindergarten and a first grade classroom. Her response to the first survey indicated that she had a low belief in the importance of technology as an educational tool as well as that she was an occasional user of a variety of technologies with which she was somewhat comfortable. She described technology as "supplemental resources to emphasize a point [or] lesson in another perspective that can be both interactive and informative." Amanda felt

most supported by her cooperating teacher in integrating technology into the classroom, but felt most affected in her classroom use by the licensure program requirements.

Throughout the semester, Amanda both observed and incorporated a variety of technologies in her practicum classroom. One area in which she noticed a particularly effective use of technology was in the publication of student work by means of digital photographs, word processing software, and publishing software, describing how the published works provided a great opportunity for communication with parents and demonstrated to students the meaning and value of their work. Amanda frequently relied upon the internet to support her teaching, using it to get ideas for lessons, to find materials for activities, and to print visuals for her unit on the human body. Throughout her journal entries, she continuously described how these visuals were crucial for student learning and noted that there were many times when she could have had many more to "really cement their understanding and assist in the visualization of the lesson." She also used the internet to extend student learning, discovering a website "that lets you look into classrooms around the world" and sharing that with students when they were comparing Japanese and American classrooms. In addition to these examples, Amanda utilized

email to communicate with her teacher, a digital camera to document student learning, and computers to develop and print worksheets.

In her curricular unit, Amanda planned and implemented a lesson in which students worked collectively with her to create a powerpoint presentation about "Mr. Bones" in order to demonstrate their understanding of the skeleton and its role in the human body. Students came to the computers in pairs, listened to Amanda describe some of the functions of powerpoint, then shared their knowledge about Mr. Bones and discussed how to present it. Amanda developed this activity specifically as a way to incorporate technology and was very positive in her reflection on it: "I felt that students were able to still really get engaged and share their knowledge in a fun and exciting way. I think by creating the power point about the skeleton in our classroom, Mr. Bones, the students felt more comfortable sharing information." Also during her unit, Amanda showed a Magic School Bus video on the digestive system and had students fill out a checklist of each "stop" along the way while they watched. She found this to be an effective way to cover a significant amount of material while retaining student engagement. Other evidence of technology includes the citation of online resources, the use of images and material from the internet, and digital photographs of the classroom.

Amanda demonstrated use of all five of the guiding principles throughout her practicum experience and showed particular strengths in the areas of appropriateness and application. With regard to appropriateness, she was continuously thinking about the possible ways in which technology could be used to support student learning and reflecting on how she could have used technology to improve her lesson delivery. From wondering about a program that a student could use "to write in Chinese and create a dictionary with illustrations for the other students" to recognizing that she probably could have found a website with 3D models to support her lesson on the heart and lungs, Amanda exhibited a clear understanding of what could appropriately be done with technology. Evidence of every appropriateness indicator can be found in her journal entries and her unit score for this principle was 1.25.

In terms of fluency, there is no indication that Amanda struggled with this principle. Her journal entries show clear knowledge of basic skills, common applications, external equipment, and the internet. Although she may be able to, they do not demonstrate that she has the ability to troubleshoot common problems, to find answers to technological issues, or to transfer her knowledge to new technologies. Her unit score for fluency was 1.00 as there was strong evidence for two of the performance characteristics and no evidence for the other two.

Ethics was a weak area for Amanda: she did use the internet once to build global awareness by looking into classrooms from around the world, but did not show evidence of thinking about the ethical ramifications of technology use in either her reflections or her unit (which was scored as 0.50).

Although her unit score for the evaluation principle was 0.25, Amanda's journal entries do reflect her thinking about determining whether or not the use of technology is productive and effective. One experience in particular, when the music teacher was absent and she was asked to show a movie to the students during music time, caused Amanda to recognize that "visuals or video can enhance learning, but you have to put in just as much prep time as for any other lesson if students are really going to learn from it." She also demonstrated the ability to assess websites, finding the world classroom site appropriate to share with the class and realizing that she was having difficulty discriminating among special education sites.

As mentioned before, application was a strength of Amanda's, demonstrated by the many ways in which she used technology throughout the semester and particularly during the implementation of her unit. All of her efforts to integrate technology were connected to content material and learning objectives. Her unit score for this principle was 1.75. Overall, her rubric score for the evidence of technology in her unit was 0.95, just above the

mean for this group of participants. In the second survey, she mentioned that her lack of confidence in using technology caused her to avoid using a great deal of it in her unit, but also described how students were very engaged and eager to participate when she did incorporate it.

In reflecting on the semester, Amanda recommended having pre-service teachers carry out mock lessons that integrated technology in order to "force students who are not as comfortable with using technology in their teaching to see what options they have." She also commented on the importance of prior technological experience and knowledge and said, "Prior to student teaching, I felt that as long as I had the basic understanding of technology I could…be a strong educator. Now I…see it as a priority to learn actively about how I can use technology to teach students in a variety of ways."

Jessica

Another early childhood candidate, Jessica spent her practicum in a kindergarten and a second grade classroom. She did not complete the first survey. During her time in the kindergarten classroom, Jessica set up a penpalship between the students and children she had worked with in Ghana, presumably using technology in the process. Her students were able to view pictures of Ghana and their penpals, read their letters, and then respond to

them. Jessica also used a digital camera to take pictures of her students and a projector to display materials. Evidence of technology in her unit consisted of the use of websites for background information and resources as well as the printing of digital images.

Jessica demonstrated minimal use of the guiding principles over the course of the semester. Her unit showed no evidence of the fluency or ethics principles, but received a score of 0.75 for appropriateness and 0.25 for both evaluation and application. The overall rubric score for her unit was 0.25, the minimum value in this participant group. Through her journal entries, Jessica met the appropriateness indicators of choosing an appropriate technological tool or information source and of planning strategies for the use of technological tools. She also described fluent use of a camera. With regards to ethics, Jessica had a strong focus on developing global awareness through her penpal project, and was also careful to obtain parent permission for photographing. Her journals did not show evidence of the indicators for evaluation or application other than the penpalship likely enhancing a unit of study in the kindergarten classroom.

At the end of the semester, Jessica remarked, “I now feel capable to do things that I thought was virtually impossible, through my experience with it. Previously, I hated technological things, and I felt completely incompetent.”

She recommended that future instruction of teaching candidates include interactive tutorials.

Sasha

Sasha, an early childhood candidate, worked in a kindergarten and a second grade classroom. She expressed a low belief in the importance of technology as an educational tool on the first survey and indicated that she was a frequent user of a variety of technologies but felt only somewhat comfortable with them. For her, the word technology brought to mind "computers, gaming, [and] iPods." Later in the semester, she commented that she was "still not sure what technology is in some ways." Sasha reported feeling most supported in the integration of technology into the classroom by the college campus and most affected in these efforts by her cooperating teacher.

During her placement, Sasha used an overhead projector a number of times, particularly during math, and often utilized the internet for ideas, knowledge, and materials. Examples of this utilization was her implementation of a main idea lesson which she read about on a website and her use of an organization web for writing which she found online. Sasha also found the web helpful in the preparation of her curricular unit, explaining how "[i]t was a great way to look at what other people were doing, and that

includes how they are using technology." On the second survey, she mentioned the use of Google Earth as well as math software that was part of the Investigations curriculum.

One lesson in Sasha's unit asked students to map out a route from Massachusetts to Arizona, and Sasha used the overhead to demonstrate how this could be done, physically modeling for students how they could use their markers to follow the highway lines. During the same lesson, after students finished their mapping, she shared a slideshow with them that included numerous pictures of Hopi pueblos, her goal being to build her students' schema of the Hopi's dwelling places. Another schema-building lesson utilized a National Geographic video on the Hopi, with Sasha introducing the video and also stopping it periodically to discuss the important information that was being presented.

Throughout the semester, Sasha explicitly referenced the guiding principles as she reflected on the technology integration that she was seeing and trying herself. Appropriateness in particular was a big focus for her, and her journal entries show evidence of all the indicators for pre-service teachers. As she was thinking about this principle, she remarked on the relationship between appropriateness and availability in the context of seeing little technology being used: "Sometimes it is about what is appropriate for grade 2,

sometimes it is what is available." Sasha's unit score for this principle was 1.50, again demonstrating the amount of thought she gave to appropriateness.

Her journal entries also show some evidence for fluency, describing the use of an ELMO document camera as well as her use of the web to find materials and content understanding. She thus meets the indicators for basic computer skills, external equipment, and internet use, but does not explicitly demonstrate that she can utilize various applications, troubleshoot common problems, or transfer her knowledge to new technology. Her unit score for fluency was 0.75. She showed no evidence of thinking about ethics in either her journals or her unit.

The evaluation principle was another one that Sasha focused on explicitly, describing the need to "keep figuring out if information…on the web is valid." She also evaluated the technology use of others, finding an internet safety program that utilized powerpoint and the internet to be above the grade level of her students and mentioning both positive and negative things about the activities her students did during their computer lab. In reflecting on these things, she met all of the indicators. Despite this thinking about and use of evaluation throughout the practicum, Sasha's unit received a score of only 0.25 due to its lack of evidence of this principle.

Sasha's observations of technology use also led to her stated belief about application that "[t]he whole idea of enhancing understanding is important." She found that without a connection to their learning in the classroom, it was more difficult for students to focus and avoid being overwhelmed. Her journals showed evidence of all the application indicators except for the use of technology to communicate results or outcomes to others. Sasha's unit score for this principle was 1.00. Her overall unit score was 0.70, putting her just below the participant mean. She described her unit as being more "hands-on" than technology-rich.

Sasha felt that her thinking about technology "changed slightly" over the course of the practicum, and remarked that she finds technology to be "a crucial element that helps connect the students to their learning because it is ever so present in the lives of the students." She also mentioned that there was less technology available in her school than she thought there would be. Her recommendations for teacher preparation in technology centered around having discussions about practical applications in all subject areas and units of study as well as seeing "actual examples of how to infuse learning with different technology."

Karen

An elementary licensure candidate, Karen spent her entire practicum in a third grade classroom. Her response to the first survey showed a low belief in the importance of technology as an educational tool but also indicated that she was a highly comfortable and frequent user of a variety of technologies herself. At the beginning of the semester, Karen described technology as "anything that helps communicate or process information more efficiently and effectively." She felt most supported and most affected by her cooperating teacher in her integration of technology into the classroom.

Karen's classroom used laptops daily, with some students working on a phonics program and all students given twenty-minute blocks of research time a couple of times a week. When students were working on internet research, they utilized a website called portaportal through which they could access pre-selected websites. Karen also used her own laptop frequently for teaching and learning purposes, despite experiencing "a little resistance because it is kind of not Montessori in their eyes" at the beginning of the semester. Thinking "This is the news hands-on!" she continued bringing her laptop and, at various times, demonstrated for students how she was searching for information, showed them slideshows she had created which were related to topics they were studying, and displayed graphs from popular news sites to

small groups for a math lesson. Karen also relied upon the internet for visual images from a digital library to support English language learners, for help with big ideas about the Revolution, for a video version of *Charlotte's Web* to show the class, for math worksheets, and much more. On one day, she used the overhead with clear shapes to teach geometry concepts, finding that "the overhead meant everyone could see and I didn't have to deal with 'miss, miss! I can't see!'"

Karen designed her unit such that its culminating activity relied upon technology: "a video in which each student presents their biography poster on an important person from the American Revolution." She did the actual videotaping for this project, but spent time prior to this helping the students become used to seeing themselves and each other on video. Throughout the unit, Karen also asked students to complete online research for their biographies and incorporated two explicit lessons in which she modeled this process for them. In the first such lesson, Karen's goal was to "work on modeling care of materials and establishing a protocol for how students treat laptops so that they will be able to use the laptops individually throughout this unit." It included an introduction of the questions they were expected to answer, a review of how to access the portaportal website, a think-aloud modeling of how to choose websites, and a demonstration of how to carefully

and safely carry a laptop. Karen's reflection on her instruction indicated that the lesson went well, with students respecting the laptops and handling transitions well. She did find that students became frustrated when they couldn't find the information they needed right away, and decided that in her next lesson, she would spend more of her introduction emphasizing the research process and the time it takes. In addition to doing this during the next research lesson, Karen modeled how to select important information in order to answer questions which required students to synthesize, congratulated students on "their appropriate use of laptops from the day before," and staggered student dismissal to the laptops to avoid traffic jams.

Karen demonstrated strong use of the guiding principles throughout the semester. Her overall rubric score for the evidence of the principles in her unit was 1.55, the highest in the cohort. Despite this, her response to the second survey included the comment that "At first…I didn't think I used technology that much in my unit." After thinking about it some more, she decided that she had utilized technology, but felt strongly that "it's always a question of what is the right material for each moment, each lesson, and each student."

In addition to that explicit consideration of appropriateness, Karen's subscore for the principle was 2.00, and her journal entries have a

preponderance of examples in which she considered when to use what technology. Evidence exists for each appropriateness indicator, with particular strength shown in the areas of planning strategies for the use of technological tools and using technology to support learning. When thinking about this principle, Karen mentioned that her school environment and its implied resistance to technology was a big factor in her consideration of its use.

Fluency was also well-documented in Karen's journals: using her laptop to search for information for students, linking the computer and TV for a movie, and making a short slide show. The majority of indicators were thus evidenced, although no explicit mention was made of using multiple platforms or troubleshooting problems. Karen's unit score for fluency was 1.75, the one missing piece being evidence of helping students to troubleshoot.

Although ethics was not referenced at all in her journals, Karen's unit received a score of 0.50 for this principle. She had students use technology safely and responsibly and encouraged them to think about technological possibilities, but did not show evidence of engaging them in a consideration of other ethical issues such as collaborative work and global engagement.

With regard to evaluation, Karen frequently demonstrated the indicators of determining whether or not the use of technology is productive and effective and reflecting meaningfully on the impact of technology use,

both in terms of her own practice and others'. Her journals include many moments of evaluating the outcome of technology integration in terms of student learning. Karen also showed evidence of assessing the trustworthiness of information based upon its source, but did not mention issues of information distortion, needing to discriminate between sources, or using available resources to make informed decisions. Her unit score for the evaluation principle was 1.50.

Application was a great strength of Karen's, with her unit receiving a score of 2.00 and her journals describing many uses of technology to support content learning. All of the indicators were present in her reflections through a variety of examples. At one point, Karen commented that her students viewed the use of computers "as a sign that they are 'real' students," causing her and her cooperating teacher to make a greater effort to integrate computer research into their social studies time. This realization was a key factor in her choice to facilitate online research and produce videos during the course of her unit.

Susan

As an early childhood candidate, Susan split her practicum time between a kindergarten and a first grade classroom. She expressed a high belief in the importance of technology as an educational tool on the first survey and also identified herself as a highly comfortable and frequent user of

a variety of technologies. When asked about what she viewed as technology, Susan responded with a variety of examples: “computers, overhead projectors, smartboards, ELMO, t.v., radio, CDs, DVDs.” With regard to her integration of technology into the classroom, Susan reported feeling most supported and most affected by her cooperating teacher.

Overall, Susan found that “[m]ost everything we do [in my classroom] is done with paper and pencil.” Her room did have one computer that was used by students during their center time as well as an overhead machine occasionally used by the teacher, and her students attended computer class as a special once a week. Over the course of the practicum, Susan used a scanner and a digital camera to document student work, creating a folder for each student and giving it to them and their parents at parent-teacher conferences. She also relied on the internet for a variety of things: content, ideas, and visuals to support her unit on rocks, materials such as math problems for various lessons, and information and knowledge to answer students’ questions related to read-alouds. Particularly with regard to this last example, Susan realized that she was modeling effective use of technology for her students by demonstrating to them where she often went for information and how she knew what to look for. In terms of her own use of technology, Susan spent a

number of hours at the end of the semester learning and working to edit video clips of her own teaching for use in her professional performance assessment.

During her unit on rocks, sand, and silt, Susan had multiple opportunities to use an ELMO to "project a live video on the wall to show every single child what I was doing when examining or sorting rocks." She found this technology tool particularly helpful when sharing rocks loaned to her by the geology department and when teaching a lesson on sorting and classifying. Describing the impact of using the ELMO, Susan reflected, "students did not have to crowd around me and block others' view – they could all easily see the image on the screen. The students would get very excited about the ELMO and were very engaged in every lesson in which I included it." In addition to the ELMO, Susan utilized a digital camera during her unit to document student learning as well as computers in her classroom and on campus to develop lessons and materials, mentioning them as especially helpful for revision purposes.

With regard to the standards, Susan's journals show evidence of all the indicators for appropriateness. Her particular strength was in identifying the ways in which she observed technology being used and thinking about how she could adapt or modify those methods for her own purpose. Susan received

a 1.50 for this principle in her unit, with the missing piece coming from a lack of helping students to think about the use of technology in their own lives.

Fluency is also well-demonstrated in Susan's journals, with mention of using the ELMO, finding information online, searching the web for resources, and utilizing a scanner. Indicators such as understanding different file types and troubleshooting common problems were not present. Her unit score for fluency was 0.75, again showing a weakness in helping students to engage with this principle. For ethics, Susan's unit was given a score of 0.50, as she required students to use technology safely and responsibly. However, her journal entries contain no reference to the principle.

Evaluation was particularly meaningful to Susan in terms of needing standards by which to evaluate websites. She frequently mentioned needing to think about whether or not a site was high quality as well as whether or not its approach was limited in scope or understanding. Susan also did a great deal of reflecting on the technology use she saw around her, from the use of computers during centers to finding worksheets online. Her unit score for this principle was 0.25, as she did not model or explain any of these ideas to her students during her unit.

Despite not observing a great deal of technology use at her grade level, Susan showed evidence in her journals of all the application indicators. She

consistently looked for ways to use technology for content enhancement and enrichment as well as integrating its use into routine projects such as documenting student work. Her unit score, 1.75, also reflects this commitment to application. Overall, Susan's unit received a total technology score of 0.90, which situates her right at the mean of the participant pool.

Citing exposure and experience gained over the course of the semester, Susan remarked that by the end she was "much more willing to use a variety of forms of technology in my classroom." Looking towards the future, she felt that seeing or experiencing the use of an ELMO or Smartboard would be very beneficial to student teachers, both in terms of their instruction and their mindset. Although recognizing that these tools are not always available, she felt that the exposure to them would play a big role in pre-service teachers' conceptualization of technology integration.

Hannah

A candidate for elementary licensure, Hannah worked in a fifth grade classroom for the duration of her practicum. She did not complete either of the two surveys, but described herself in her journal entries as "good at using technology to find what I need to teach, especially to learn new content and get ideas for lessons." Hannah found it more difficult to actually implement technology use in the classroom due to issues of access. However, she did

observe “a rather amazing integration of all sorts of technology” during a grade-wide “lemur day” in which regular classes were cancelled in order for students to try and gather over two hundred facts about lemurs. Students rotated among learning stations that included a documentary, a speaker, library time, and computer time, and were responsible at each one to take notes on lemur facts, then add these facts to a giant poster in the hallway. In addition to the use of technology in the learning stations, the collectively generated chart was typed up and distributed to each student. At other times during her practicum, Hannah used the copier to create and duplicate student materials as well as the internet to research lesson ideas and to review and learn content she needed to teach. Her unit was “designed to prepare fifth grade students for the state [MCAS science] test” and included a list of annotated website resources as well as evidence of a computer being used to create student assignments and materials.

This minimal documented use of technology in her unit is reflected in her overall unit score of 0.30. Appropriateness and application were Hannah’s strongest subscores for the unit, at 0.50, with fluency and evaluation right behind at 0.25. No evidence was present for the fluency principle. Areas of effective technology use included using it for enhancement of content and doing so fluently.

Despite this low level of technology evidence in her unit, Hannah's journals reflect a great deal of thought about the topic. All appropriateness indicators were demonstrated, with particular attention given to the identification of the ways in which technology was being used around her. Hannah also made a connection between appropriateness and availability, noting that it was difficult to use technology when access was so lacking. She found herself confused by the difference between this principle and that of evaluation, saying, "I think these [appropriateness and evaluation] have a lot of overlapping."

In terms of fluency, Hannah did describe technology as "not always reliable," but went on to mention a variety of tools such as the copier, internet, word processing, and videos in light of what she was observing or teaching in the classroom. These examples show that she met many of the fluency indicators, but do not demonstrate her ability to use various platforms, troubleshoot, or transfer knowledge.

Hannah mentioned evaluation mostly in the context of the internet, sharing an instance in which her cooperating teacher presented students with two conflicting sources of information and reflecting on the use of online resources such as Wikipedia and librarian-selected material. Her journals do

not show evidence of her using this principle to think about whether or not the uses of technology that she observed were productive and effective.

Finally, Hannah's journal entries about application certainly revealed her utilization of technology being connected to content areas, but did not talk about how this utilization enhanced student's understanding or helped them to communicate their work with others. They also did not show evidence of indicators such as organizing a variety of information to connect ideas and themes, analyzing retrieved data within a disciplinary context, and applying existing knowledge to solve new problems.

Pamela

Another early childhood candidate, Pamela spent her practicum in a kindergarten and a first grade classroom. Her response to the first survey indicated that she had a high belief in the importance of technology as an educational tool but that she was only an occasional user of a variety of technologies with which she was somewhat comfortable. To her, technology meant "frustration, migraines, [and] piles of unopened instructional manuals." Pamela expressed feeling most supported in her integration of technology into the classroom by her cooperating teacher and most affected in these efforts by both the school in which she was placed and by her cooperating teacher.

At various times throughout her placement, Pamela observed her first grade cooperating teacher using a digital camera to take pictures and video for incorporation into learning activities as well as to send home to sick students. As Pamela took on more teaching responsibilities, she also used a camera to document student learning in the lessons that she taught. Her classroom had the ability to project images onto a pull-down screen, and Pamela utilized this technology a few times, showing students pictures she found on the internet of the new pennies being released and sharing an online video of a baby giraffe standing up for the first time. Although initially hesitant about "slogging through good and not-so-good online resources and lessons," she did find the web particularly helpful in finding teaching resources related to the development of her unit on the human body. Other technology incorporated by Pamela in her practicum included her laptop to organize teaching-related materials, computers to display slides and math information, and CDs for children to listen to audio books.

Although Pamela's journals only contained minimal information related to the principles, she did touch upon a number of the indicators. In terms of appropriateness, Pamela had a particular strength in understanding what could and couldn't be done with technology, realizing for example that she could keep a series of folders on her laptop that were organized around

different important classroom topics. She knew that she could keep her own notes and reflections there as well as materials or handouts from seminar or previous semesters. Pamela also identified ways in which her cooperating teacher used technology. Her unit score for this principle was 0.50.

Throughout the semester, Pamela experienced great difficulty with her own technological fluency. She frequently found her laptop to be uncooperative and also described an incident in which she had a great deal of difficulty getting a video to play for her class. Her response to this event was to view it as "all the more reason for me to make sure I know that something is working properly ahead of time" and to dig out the guiding principles for help in thinking about technology. This low level of fluency was also reflected in Pamela's unit score of 0.25.

Although her unit showed no evidence of either ethics or evaluation, Pamela's journal entries showed that she was cognizant of the need to send home permission slips for videotaping as well of the need to sift through online resources. Describing it as a process, Pamela felt like she improved at "slogging through good and not-so-good online resources and lessons" as time went on.

Application was another relative strength of Pamela's, her unit score for this principle being 0.50 for embedding technology and enhancing

students' content understanding. Her journal frequently mentions effective applications that she observed, and she was very consistent in connecting what she saw with student learning. Overall, Pamela's unit rubric score was 0.25, at the minimum of this cohort's range.

Her experience over the course of the semester in trying out different technologies helped her realize a "need to be more pro-active in learning and utilizing technology." She felt that if she herself had had more access to technology throughout the practicum experience, especially at home, then she would have been more inclined and better able to plan and use technology effectively in her classroom. Pamela expressed great hope for finding "many more ways and reasons" to use technology in her future jobs.

Gina

Gina, an elementary candidate, completed her practicum in a sixth grade classroom. She expressed a high belief in the importance of technology as an educational tool on the first survey and also identified herself as a highly comfortable and frequent user of a variety of technologies. The word technology made her think of "computers, digital cameras, and video." Gina felt equally supported and affected by the college campus, the teacher preparation program, the school in which she was placed, and her cooperating teacher in the integration of technology into the classroom.

Her curricular unit on the Revolutionary Era cited the use of technology for background knowledge, particularly in terms of websites that she found with helpful information for herself and her students. Gina also showed a video on Job Shattuck, a leader in Shays' Rebellion, during the implementation of her unit. She prefaced the video with a discussion of the rebellion and followed it by comparing Job Shattuck with Daniel Shays and anarchy with rebellion. Other evidence of technology in Gina's unit was the use of material (photographs and background information) printed from the internet and digital photos of student work and the classroom. In reflecting on the unit's overall implementation, Gina commented, "regardless of how confident I felt about my preparation and content knowledge, someone would ask a question that I could not answer. I can't begin to count how many times I responded by saying, 'Let's look it up,' or 'Why don't you see if you can find the answer online and let me know what you find.'"

Gina's journal entries were not available for data analysis, but her unit received an overall rubric score of 0.70 for evidence of the technology principles, just below the mean of the participant cohort. Appropriateness was a particular strength for Gina, her unit showing at least some evidence for every performance indicator and being scored as 1.50 for this principle. Her evidence for fluency (with 0.50 as a score) included demonstrations of fluent

technology use and encouraging students to develop electronic research skills. Gina's unit showed no evidence of the ethics principle and received a 0.25 for evaluation as minimal evidence existed for using and modeling a validation process for technologies and resources. Application was another relative strength for Gina, the unit score being 1.25 due to the embedding of technology, its use for content enhancement, and the purposeful mindset with which it was approached. When considering technology integration overall, Gina felt that it was important "to use [technology tools] as much as possible to gain experience" and thus become comfortable with its use.

Ellen

Another elementary candidate, Ellen spent her practicum time in a second grade classroom. She expressed a high belief in the importance of technology as an educational tool on the first survey and indicated that she was a highly comfortable and frequent user of a variety of technologies herself. Ellen's definition of technology was "[m]an-made electronics—things that have been invented to compute or complete more lengthy tasks quickly (computers, calculators, digital cameras)." She reported feeling most supported by her cooperating teacher in the integration of technology into the classroom and most affected in these efforts by the school in which she was placed.

Throughout the semester, Ellen incorporated a wide variety of technologies into her classroom, despite feeling that her school system was "a little under-resourced" in this area. In terms of her own use, she created an organizational grid to document the amount of instruction that she was providing compared to her cooperating teacher and spent time online reading about different classroom management approaches and researching academic content for which she was responsible. Ellen also found that technology, especially her new phone camera, made it easy for her to document student learning and use that documentation to reflect on her own practice, to communicate with parents about school activities, and to involve students in taking ownership of their work. Other technology utilized by Ellen included a projector and screen to display slideshows and websites to the class as well as overhead fraction manipulatives. Ellen shared how the ability for students to come up and move pieces affected their learning: "It was amazing how they could 'see' different ways of dividing a whole into various fractions when we laid them over each other. Being able to see this just made it click somehow."

In addition to these examples, Ellen included many forms of technology during the implementation of her cultural heritage curricular unit, from an online repository of high resolution images to slideshow presentations on life in France and the celebration of May Day. These presentations were

integrated into lessons that also included the reading of children's literature, class discussions, and student oral and written responses. Ellen also used websites pertaining to cultural studies in the elementary classroom to build her own background knowledge, a computer to prepare class materials and home communications, and the overhead projector to share a transparency about schools in other countries. Another technology material utilized during the unit was a children's book accompanied by a DVD of the author reading her story. Ellen developed a lesson in which students first discussed the location of the story, the Spanish words they would encounter, and the myth and legend genre of the story, then viewed the DVD and responded with comments and a writing activity. Finally, Ellen's culminating unit activity was the creation of "cultural research teams" to present a slideshow (designed by Ellen) about a particular country. Early work on this activity introduced the students to its expectations and asked them to think about what kind of information they would want to learn about each other's countries during the presentation. Students were given almost a week to research regions of the world and then worked with Ellen to develop and practice their presentation.

Throughout the semester, Ellen showed strong evidence in her journal of thinking about all of the principles, often mentioning them explicitly. Her thoughts on appropriateness often addressed multiple indicators at the same

time: she would identify a way in which technology was being used, demonstrate her understanding of what could and couldn't be done with that tool, then move right into planning strategies for her own use of it. Examples of this in Ellen's journal entries include considering the projection of fraction books and using software to merge photos with a timeline to give students an understanding of the passage of time. Her unit, which received a 1.75 for this principle, showed the same deep consideration of the technology's appropriateness.

Although her unit score of 0.75 for the fluency principle is slightly less than those for the other principles, Ellen's journals include numerous examples of her use of technology. Whether looking up education-related list serves, searching for well-put-together worksheets, or sharing powerpoint presentations with her class, Ellen was able to use a wide range of technologies effectively. This range also indicates her ability to transfer prior knowledge to new technologies, one example of which was her discovery of an online image repository similar in nature to a journal repository with which she was familiar.

Ellen talked about ethics in a variety of contexts, from wondering about the use of a school website when some families were unlikely to have internet access to considering how technology could be used to engage

students in the global community to wondering about the ramifications of setting up a penpal connection. Once again, she covered the range of indicators in her journals, and the 1.00 she received as a unit score for ethics confirms her understanding and use of the principle.

With regard to evaluation, Ellen frequently focused on the need to assess the trustworthiness of information, to validate its source, and to discriminate among choices. She often noted the preponderance of resources available online with the caveat of finding many of them to be either limited, biased, or inaccurate, regardless of whether the topic was math, social studies, or classroom management. Ellen's unit score for this principle was 1.00, showing a weakness in helping students to think about these same issues with which she was dealing.

Many mentions of application, both actual and envisioned, were present throughout Ellen's journal entries, including the planned use of the computer to create graphs with student data, the overhead manipulatives to support concept understanding of fractions, and the availability of high resolution images for the development of ideas about place and culture. In these examples and others, evidence of all the application indicators can be observed. Ellen's unit score for this principle, 2.00, also reflects a great

strength in this area. Overall, the rubric score for her unit was 1.30, placing its evidence well above the mean for this group of participants.

Alexis

As an elementary candidate, Alexis worked in a fourth grade classroom throughout her practicum experience. On the first survey, she reported a low belief in the importance of technology as an educational tool but indicated that she was a highly comfortable and frequent user of a variety of technologies herself. Asked to describe what technology made her think of, she replied, "I think of tools. I think of the internet and various websites, I think of wireless access and laptops, I think of projectors and smartboards, and I wonder about the tools I don't yet know of." Alexis expressed feeling somewhat supported by her cooperating teacher in her integration of technology into the classroom and feeling only slightly affected in this process by the college campus and the licensure program requirements.

During her placement, Alexis often used the internet to find lesson plans, ideas for her teaching, and materials, one example of this being a variety of physical and social maps of Canada which the students compared to look for relationships. She presented a number of lessons using powerpoint, frequently describing the slideshow as being "scanned textbook pages (basically a digital textbook)" and being followed by worksheets. When

implementing her unit, Alexis mentioned developing at least one slideshow of her own for teaching purposes, but was then unable to present it due to technical difficulties. In addition to projecting powerpoint presentations, Alexis used an overhead to display a play that students were working on as well as to have students share examples of their fractions work in math. Another way in which she integrated technology into her teaching was to find a version of the Oregon Trail game that she remembered from childhood and make it available for students to play during indoor recess times, realizing that the game had given her "a good sense of the challenges faced by the pioneers" and thus could be helpful for her students in terms of building their own background schema.

Alexis developed her curricular unit to focus on Canada and designed her culminating activity to be a powerpoint project in which "students present arguments as to why the different provinces should be connected to [a hypothetical] Canadian rail system." At the start of the assignment, she provided students with a list of information that they needed to include in their presentations and conventions for their powerpoint. These requirements were included in a rubric that Alexis used to evaluate student projects at the end of the unit. Students worked on their presentations during scheduled class computer time as well as during social studies time when laptops were

available. Alexis identified her successful collaboration with the computer teacher as one of the best aspects of her unit implementation: “My project integrated perfectly into the computer curriculum, because the students [had] been learning how to make and present powerpoint presentations. Although I would have preferred to give the students more time on the projects, they did a great job.”

Alexis’s evidence of the appropriateness principle in her unit was strong, scored as 1.75, with the only weakness being in connecting the classroom use of tech to the students’ own lives. All other aspects had a preponderance of evidence. Less is seen in her journal entries about this principle: she considered the use of a computer game, calculators, and a powerpoint at various moments during the semester but did not demonstrate an understanding of what could and couldn’t be done with technology.

When talking about fluency, Alexis was more likely to mention times when she had difficulty getting technology to work rather than times when she was successful. Her journal entries reflect difficulties with a projector and with printing a transparency. However, she was often able to fluently carry out a powerpoint presentation, and her unit score for this principle, 1.50, shows that it was an important aspect of her unit. No evidence of ethics was

demonstrated in her journal entries; her unit was scored as 0.50 for its consideration of student collaboration and responsible technology use.

Alexis's consideration of the evaluation principle frequently centered around her reflections on the result and impact of technology use. She saw students become excited by the opportunity to show their example on the overhead but also experienced them becoming silly and making shadow puppets during one use of a projector. In all cases, Alexis considered student engagement and its possible explanations, then thought further about how she would handle similar situations in the future. However, she makes no mention of evaluation in light of assessing and validating information, although evidence of this is seen in her rubric (which received a 1.50 for this principle).

Application was a strength for Alexis, particularly in her unit, which was scored as 2.00 for strong evidence of every indicator. Her journal entries also reflect this strength as she thought about how to use technology in meaningful ways to support content. This included developing a powerpoint project through which students would demonstrate their social studies knowledge, utilizing electronic resources to present students with examples of distorted maps, and introducing a computer game that was linked to content learning. Overall, Alexis's rubric score for her unit was 1.45, placing her just below the maximum of the cohort.

Although Alexis felt that her practicum experience was not a strong factor in her conceptualization of technology due to difficulties with the placement, she did describe technology in a way that reflected an expanded perspective. “I did realize the vast resources of the internet…and that was greatly beneficial…The world has shrunk…Technology has provided us with all sorts of new ways to communicate and share.” Having recognized these things, Alexis found that “[i]t was challenging to make my plans into a reality.” She recommended that future teacher preparation include more opportunities for brainstorming around ways to have students meaningfully interact with technology.

Paige

Paige, an early childhood candidate, completed her practicum in a kindergarten and a first grade classroom. Her response to the first survey indicated that she had a low belief in the importance of technology as an educational tool as well as that she was an occasional user of a variety of technologies with which she was somewhat comfortable. Paige thought “gadgets and electronics” upon hearing the word technology and defined the word as “any innovative device that simplifies tasks, relates to greater accessibility, or creates more options for users.” With regard to her integration of technology into the classroom, Paige reported feeling most supported (but

not affected) by her cooperating teacher and not at all affected by the college campus, teacher preparation program, or the school in which she was placed.

One of the primary ways in which Paige utilized technology during her practicum was in the use of the internet for background information and knowledge, examples of which included the reading of resources related to English language assessments, bullying, behavior management, and Spanish language review. She also incorporated the use of computer games that reinforced reading and math skills and of a projector to display math worksheets. After traveling to Ecuador, Paige developed and planned a presentation for her students using VuVox, a web-based software alternative to powerpoint. She spent some time investigating various possibilities and found that this one enabled her to make the presentation a more interactive experience.

Evidence of technology use in Paige's curricular unit included the mention of a website in her bibliography, the inclusion of a digital photo that was used during a lesson, and scanned images of student work. Paige also designed one lesson with the ELMO in mind, her goal being "to seek out ways to incorporate technology and media into classroom lessons (in this instance, the ELMO projector)." The lesson consisted of the introduction of American national symbols by means of images displayed via the ELMO. As Paige

introduced each image, she asked her students a number a questions about what they observed and then provided them with additional information about the symbols. This class activity was followed by individual student work on drawing their favorite symbol and writing about it.

Paige's use of the guiding principles was fairly weak, with an overall rubric score of 0.30 on her unit (placing her at the low end of the participant group) and few references to the principles in her journals. Her subscore for appropriateness was 0.75, the strongest of the five as the unit showed some evidence for taking the role of technology into account, utilizing appropriate technology, and employing it to enhance learning. Paige also observed teacher behavior in her school computer lab which she found wholly inappropriate and commented, "[t]his is clearly not the 'thoughtful application of technology' we have been discussing.'" She also addressed the appropriateness principle through her consideration of alternatives to powerpoint, wanting to find a different type of presentation software that was more flexible and more interactive.

The search to find this alternative revealed a great deal of fluency on Paige's part, as she needed to search for options and then experiment with what she found to see if it met her needs. Her description of how to view the presentation she created demonstrated the fluency she gained during this

experience, as did her mention of using the internet to refresh her Spanish language skills. Paige's unit score for this principle was 0.25, as its only evidence of fluency consideration was her own demonstrations.

No evidence for ethics or evaluation was found in the unit, but the above mentioned incident in the computer lab provided opportunity to Paige to reflect on the ethical use of school computers. She especially wondered about "what effect this [behavior] has on [the students'] sense of how one uses technology in school. Paige also discussed the evaluation principle in the context of searching for information about classroom management and bullying, describing how "knowing how to judge what you are looking at before adopting it wholesale is most important."

Paige's journal reflected little consideration for application outside of her experience with finding different presentation software and her use of video cameras for peer editing. Her unit received a score of 0.50 for this principle, having shown some evidence for embedding technology and enhancing students understanding, but no evidence of students' using or applying technology. Unfortunately, Paige was not able to carry out her plans for technology use due to the equipment malfunctions.

In reflecting on the semester, Paige described her experience as creating in her a "firmly established belief that technology should not be used

merely for the sake of using a gadget" and also mentioned that it was difficult to integrate appropriate technology given limited materials within the school. She felt that future work with pre-service teachers should include an introduction to various tools along with opportunities to become fluent in these tools and really understand how to use them in the classroom.

Leah

Another early childhood candidate, Leah spent her practicum in a kindergarten and second grade classroom. She reported a low belief in the importance of technology as an educational tool and indicated that she was an occasional user of a variety of technologies with which she was somewhat comfortable. The word technology made her think of computers and the internet. Leah felt most supported in her integration of technology into the classroom by the school in which she was placed and by her cooperating teacher but felt minimally affected in these efforts by the licensure program requirements, the school, and her cooperating teacher.

Over the course of her experience, Leah observed use of the overhead as the primary example of technology in her classroom. Although she experienced some difficulty with this tool the first time she tried to use it, she did continue to display materials on the overhead when appropriate, usually during math. At another time, Leah planned to have her students record

themselves reading a story so that they could listen to themselves with a focus on fluency and expression. She also used the internet to find ideas for lessons. In her curricular unit on deserts, Leah made transparencies of graphics for display on the overhead and included computer lab time in her schedule for student research, having identified a specific website in advance where her students could find the information they needed.

She gave a good deal of thought to these uses of technology in her unit, as demonstrated by her overall rubric score being 0.95, just above the cohort mean. Less evidence of considering the principles is found in her journal entries. For appropriateness, which received a subscore of 1.25, Leah mentioned a couple of situations in which she planned strategies for technology use, but did not address any of the other indicators for the principle. Her unit failed only to show evidence for encouraging students to think about the use of technology in their own lives.

In terms of fluency, Leah commented in her journal about a time when she struggled to demonstrate it, needing to take a few minutes to figure out how to use the classroom overhead. This experience helped her make a connection between the fluency principle and its effect on technology integration, as she said, “Moments like this and I know why I tend to steer away from technology.” Despite this, Leah’s unit earned a 1.25 for the fluency

principle, the only missing piece being the evaluation of students' technological fluency.

Ethics, although only demonstrated in her unit through requiring students to use technology responsibly, was a big source of Leah's thinking about the principle. In particular, she was wondering about copyright issues involved in puling materials off the web, wondering how much of that was appropriate and even legal. She also mentioned conversations she had with her cooperating teacher around liability issues with using email to communicate with parents. Her unit score for this principle was 0.25.

Leah's score for evaluation was also 0.25, and her one journal entry relating to this principle discussed the use of a website recommended to her by a peer, with the recommendation making her feel more at ease with the validity and usefulness of the material. With regard to application, Leah described her desire to have her students record themselves in order to practice their fluency and hear how it sounded. She also demonstrated strength in this area in her unit, receiving a 1.75 due to her continual use of embedded technology to enhance curricular content.

Rosa

An elementary candidate, Rosa worked in a third grade classroom throughout the course of her practicum. She expressed a high belief in the

importance of technology as an educational tool on the first survey but indicated that she was only an occasional user of a variety of technologies with which she was only somewhat comfortable. Rosa thought of "electronics, internet, any software that allows me to visualize data and access information" when considering technology generally. With regard to her integration of technology into the classroom, Rosa reported feeling most supported and most affected by the teacher preparation program and its requirements.

During the semester, Rosa regularly used the computer to write lesson plans, access the internet, and gather pictures to support her instruction. She also incorporated calculators into her math lessons three times when teaching about decimals. When implementing her curricular unit on weather, Rosa had students practice reading the temperature from thermometers as well as build and use a variety of other scientific measurement tools. Her list of resources included ten websites, one of which she specifically utilized in a lesson as the source of a variety of weather maps from around the world and others of which she cited as the source for activity ideas. Rosa's unit also evidenced the use of transparencies during class book discussions and the printing of images found online. One lesson involved the viewing of a weather video for review purposes and another allowed students to access the internet in order to answer some of their research questions about an extreme weather condition.

Thinking about appropriateness was a huge strength of Rosa's, documented by her score of 2.00 for evidence of this principle in her unit. Rosa continuously reflected on the technology use that she observed and attempted, always describing what had happened and what she would do differently the next time. In one case, she had planned to use a pre-recording of storms to introduce the lesson, ended up having students share their experiences instead due to time constraints, but realized that this was probably the better choice anyways given the needs of her class.

Although not referenced in her journal entries aside from talking about teaching students to read thermometers, Rosa showed evidence of the fluency principle in her unit, receiving a 1.25 for the principle. The unit included demonstrations of fluent technology use, supported students in their own use, and prompted them discover how to find their own help. It did not include a way to evaluate students' fluency. Ethics was another principle with no references in Rosa's journal. However, as with fluency, there was evidence of ethics (0.75) in her unit since she required students to use technology responsibly, think about its possibilities, and consider its role in making them part of the global community.

Despite Rosa's strong reflective practice, her evidence of evaluation was weak, the only reference in her journal being about the storm lesson. Her

unit score for the principle was 0.50, with little consideration given to the modeling of the validation process for students and to ways in which they could be provided with guidelines for evaluating and choosing information. On the other hand, Rosa showed a strength in application, her unit score being 2.00 for meeting all the indicators. She also talked about the use of a video to support content learning and utilizing the computer lab for curricular work. Overall, Rosa's rubric score was 1.30, placing her above the cohort mean.

At the end of the semester, Rosa remarked, "I am aware of how much potential there is to engage students by using technology in lessons. I think my awareness has expanded because I have observed how teachers have access and…I am aware of the tools that were used." She hoped that future teacher preparation would include more practical examples of how to practically use technology in a variety of disciplines, particularly in creative ways. Rosa felt that although she had been able to effectively integrate technology, she used it primarily for traditional learning activities and wished that she had been able to be more creative.

Program Results

Across all 13 participants, the most unit evidence was found for the appropriateness and application principles (M = 1.31 and M = 1.33, respectively). The least unit evidence was found for ethics (M = 0.29), with

the evaluation (M = 0.48) and fluency principles (M = 0.79) falling in the middle (see Table 1).

Survey data indicated a relationship between individuals' level of comfort with technology and their frequency of use, in which more comfortable users were more frequent users. A relationship also existed between comfort level and self-evaluation of technology use and benefits in their unit, where more comfortable users reported greater technology integration in their unit. In addition, frequency of use was positively linked with participants' perception of their cooperating teachers' encouragement of technology use in the classroom. Technology beliefs, defined as participants' endorsement of the idea that technology plays a crucial role in education, were positively related to the self-evaluation of technology utilization, to the reported amount of technology observed in the practicum, and to the reported amount of technology utilized in the practicum. It was not related to the amount of evidence found in the units for the guiding principles. The amount of technology observed and the amount of technology utilized were positively related to each other and were both positively linked to the perception of the cooperating teachers' encouragement. (see Tables 2, 3, and 4).

Table 1

Unit rubrics summary

Participant	**Appropriateness**	**Fluency**	**Ethics**	**Evaluation**	**Application**	***Overall***
Amanda	1.25	1.00	0.50	0.25	1.75	*0.95*
Jessica	0.75	0.00	0.00	0.25	0.25	*0.25*
Sasha	1.50	0.75	0.00	0.25	1.00	*0.70*
Karen	2.00	1.75	0.50	1.50	2.00	*1.55*
Susan	1.50	0.75	0.25	0.25	1.75	*0.90*
Hannah	0.50	0.25	0.00	0.25	0.50	*0.30*
Pamela	0.50	0.25	0.00	0.00	0.50	*0.25*
Gina	1.50	0.50	0.00	0.25	1.25	*0.70*
Ellen	1.75	.75	1.00	1.00	2.00	*1.30*
Alexis	1.75	1.50	0.50	1.50	2.00	*1.45*
Paige	0.75	0.25	0.00	0.00	0.50	*0.30*
Leah	1.25	1.25	0.25	0.25	1.75	*0.95*
Rosa	2.00	1.25	0.75	0.50	2.00	*1.30*
Overall	*1.31*	*0.79*	*0.29*	*0.48*	*1.33*	*0.84*

Table 2

Participant background information

Participant	License	Importance of tech	Comfort	Frequency	Self-evaluation	Unit score
Amanda	E.C.	Low belief	Slight	Occasional	3.25	0.95
Jessica	E.C.	-	-	-	1.00	0.25
Sasha	E.C.	Low belief	Slight	Frequent	3.25	0.70
Karen	Elem	Low belief	High	Frequent	1.00	1.55
Susan	E.C.	High belief	High	Frequent	1.00	0.90
Hannah	Elem	-	-	-	-	0.30
Pamela	E.C.	High belief	Slight	Occasional	2.00	0.25
Gina	Elem	High belief	High	Frequent	-	0.70
Ellen	Elem	High belief	High	Frequent	1.00	1.30
Alexis	Elem	Low belief	High	Frequent	2.00	1.45
Paige	E.C.	Low belief	Slight	Occasional	3.00	0.30
Leah	E.C.	Low belief	Slight	Occasional	-	0.95
Rosa	Elem	High belief	Slight	Occasional	2.00	1.30

NOTE: The self-evaluation score is on a scale of 5, with 1 indicating a stronger use of technology. The unit score is on a scale of 2, with 2 indicating a greater use of the guiding principles.

Table 3

Correlation coefficients between selected variables

Variables	1	2	3	4	5	6	7
1. Comfort	-	-	-	-	-	-	-
2. Frequency	.860**	-	-	-	-	-	-
3. Techbeliefs	.406	.565	-	-	-	-	-
4. Unit_techtotal	.705*	.628	.668*	-	-	-	-
5. CT_encouragetech	.424	.675*	.579	.560	-	-	-
6. Observe	.152	.359	.685*	.206	.668*	-	-
7. Utilize	.141	.377	.640*	.216	.806*	.888*	-

*$p < .05$. **$p < .01$

Table 4

Description of selected variables

Variable	Description	Values
Comfort	Average comfort level with a variety of technologies	1 = Very comfortable 2 = Generally comfortable 3 = Somewhat comfortable 4 = Barely comfortable 5 = Not at all comfortable
Frequency	Average frequency of use for a variety of technologies	1 = Daily 2 = Weekly 3 = Monthly 4 = Occasionally 5 = Never
Techbeliefs	Endorsement of the idea that technology plays a crucial role in education	1 = Strongly agree 2 = Agree 3 = Neutral 4 = Disagree 5 = Strongly disagree
Unit_techtotal	Participants' self-evaluation of the overall use and benefits of technology in their unit	1 = Strongly agree 2 = Agree 3 = Neutral 4 = Disagree 5 = Strongly disagree
CT_encouragetech	Participants' evaluation of their cooperating teachers' encouragement of technology use in the classroom	1 = Strongly agree 2 = Agree 3 = Neutral 4 = Disagree 5 = Strongly disagree
Observe	Reported amount of technology use observed by participants in their practicums	1 = Almost always 2 = Frequently 3 = Occasionally 4 = Rarely 5 = Never
Utilize	Reported amount of technology utilized by participants in their practicums	1 = Almost always 2 = Frequently 3 = Occasionally 4 = Rarely 5 = Never

A strong relationship between license level and amount of technology use was observed, where elementary licensure candidates showed more evidence of the principles in their unit (M = 1.10) than early childhood licensure candidates (M = 0.61). Hannah was the exception for the elementary group, with a unit score of 0.3, while Susan, Amanda, and Leah contributed greatly to the early childhood mean with scores above 0.9. The role of the practicum placement was also important in terms of support and the encouragement of the cooperating teacher. Those students with the least evidence of the technology principles did not cite their placement as a source of support and were less likely to rate their cooperating teacher as an encourager of technology use. No relationship between constructivist teaching and learning beliefs and technology use was found, with very little variation observed in participants' constructivist beliefs (see Table 5). Most participants felt somewhat affected and somewhat supported by the teacher preparation program in their own use of technology (see Figure 1). Some reported that observing and utilizing technology occurred frequently in their methods courses, while others reported that this occurred occasionally (see Figure 2).

Table 5

Participant data ordered from least to greatest evidence of principles

Participant	Grade level	Most support	Most affect	Construct_ Beliefs	Unit_ techtotal	CT_ encourage
Jessica	K & 1	-	-	-	1	-
Pamela	K & 2	Mount Holyoke	Mount Holyoke	1.29	2	2.33
Hannah	5	-	-	-	-	-
Paige	K & 1	Mount Holyoke	Mount Holyoke & Practicum setting	1.29	3	4
Gina	6	Mount Holyoke & Practicum setting	Mount Holyoke & Practicum setting	1.49	-	1.33
Sasha	K & 2	Practicum setting	Mount Holyoke & Practicum setting	2.14	3.25	3
Susan	K & 1	Mount Holyoke	Mount Holyoke & Practicum setting	1.57	1	2
Amanda	K & 1	Mount Holyoke	Practicum setting	1.71	3.25	3
Leah	K & 2	Mount Holyoke	Mount Holyoke	1.14	-	2.67
Ellen	2	Mount Holyoke	Mount Holyoke & Practicum setting	2.14	1	3
Rosa	3	Practicum setting	Practicum setting	1.29	2	4
Alexis	4	Mount Holyoke & Practicum setting	Practicum setting	2.43	2	3.33
Karen	3	Mount Holyoke	Mount Holyoke	1.29	1	1.33

Figure 1

Role of the teacher preparation program

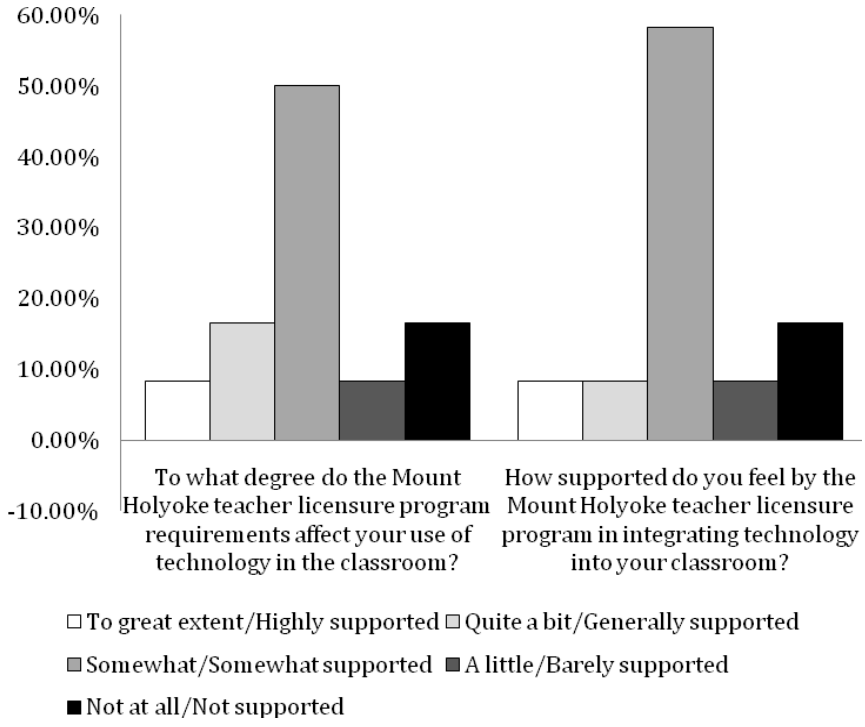
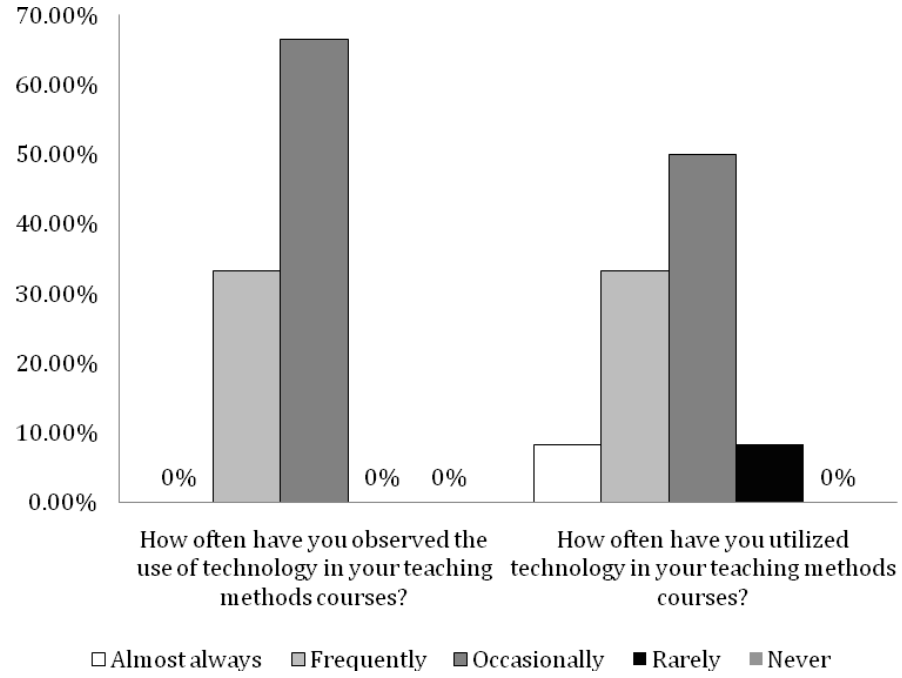


Figure 2

Technology in teaching methods courses



DISCUSSION

This study aimed to investigate the role of the guiding principles in pre-service teachers' conceptualization and utilization of technology. The many examples in which participants used the principles to reflect upon their own practice demonstrate the principles' usefulness in this regard. For those like Sasha considering the practical relationship between appropriateness and availability or Hannah thinking about the theoretical difference between appropriateness and evaluation as well as others, the guiding principles provided a framework for discussing the technology integration that they were seeing and thinking about. For other participants, such as Rosa, the principles were a confirmation of previously held beliefs and a goal towards which she felt education should aspire. In some cases, particularly Amanda's and Karen's, the principles were a springboard for trying out technologies in the classroom that they may not have done otherwise. Being explicitly asked to integrate technology into their practice while at the same time given a way to approach this integration through the principles enabled pre-service teachers to think more deeply about what they were trying to accomplish in their teaching and how they could achieve their goals. Despite the positive effects of the principles overall, difficulties also existed. Participants occasionally felt

frustrated by the additional consideration of technology that they were being asked to take on, and those who were placed in schools with limited technological resources found it much more difficult to use the principles given the fact that fewer opportunities existed for them to either observe or utilize technology.

Regardless of their situation, the majority of participants had strong evidence for the principles of appropriateness and application in their units. This is likely the result of the high emphasis that the program puts on reflective practice. Candidates are continually asked throughout their methods courses to think about the most effective way to communicate and teach lesson objectives and are taught that all elements of instruction should have meaning and purpose for students. Thus, participants were already primed to consider whether or not a particular tool would be beneficial for student learning and were able to transfer this mindset to their consideration of technology. Also tied to this principle of appropriateness is the fact that many of the participants were originally skeptical of the focus on technology, many questioning why it was necessary. Such an outlook makes it more likely for a participant to critique the inclusion of technology and to critically consider its benefits.

This holds true for the principle of application as well. Participants had a great deal of experience from their methods courses and pre-practicums in which they were required to develop lesson activities that were directly connected to and drawn from content standards. This experience transfers well to thinking about application, the ways in which technology can be meaningfully used to support content learning. Furthermore, application tends to be an idea that is always considered in the context of technology. How a technological tool can be used is often the first aspect that is discussed. In addition, the majority, if not all, uses of technology in participants' own lives are application-driven: the technology is being used to accomplish a certain purpose. These factors make application a relatively easy principle for candidates to consider and an excellent place to start.

On the other end of the spectrum is ethics, the principle for which there was the least evidence across all participants. A possible explanation for this finding is that candidates' own understanding is weak. Although they live in an increasingly globalized world, consideration of how technology is changing the ways in which people interact in society may not be an everyday occurrence for these participants. Without having this frame of reference for digital literacy and its accompanying etiquette, it is difficult for them to think about sharing that with their students. It may also be the case that participants

do see these aspects of technology use in their own lives but then find it challenging to engage students in the same kind of thinking. However, the lack of journal entries relating to ethics indicates that it is a challenging conceptual principle overall. If this is the case, teacher preparation programs have a unique opportunity to begin to address this issue by bringing the ethics principle to the forefront in discussions about technology. Whether this be talking about copyrights and ownership issues in a collaborative world, including an explicit global component, or something else entirely, developing this awareness in pre-service teachers has the potential to create a trickle out effect to society through the schools.

This seems to be the case for fluency as well, as the lack of evidence was not the result of participants being unable to fluently use technology, since all of them demonstrated some level of competency. Instead, it seems that participants had difficulty providing students with the opportunity to develop and practice their own skills. Given time constraints and the need to address content objectives during a lesson, it is often easier to reduce the need for student fluency, whether by starting up the computers, navigating to the website, or any number of other things that the teacher may do for the students. In fact, participants' desire to use technology in a meaningful way (thereby addressing the application principle) may be hindering their

development of student's fluency skills. However, it is important to support students in the process of becoming independent users of technology, and fluency is a key component in that process.

The other principle that proved difficult for participants to provide evidence of in their units was evaluation. Once again, candidates described many examples when they relied upon this principle, particularly as they began searching for online sites related to their unit topics. A number of them mentioned the process of sorting through what was good (reliable, valuable, accurate), what was bad (incorrect, unusable, skewed), and figuring out how to do so, but very few planned to help students learn how to do this for themselves. The same was true in terms of evaluating the use of a technological tool: participants did this regularly in their reflection journals as they tried different technologies, but they rarely asked students to do the same. Yet in an age of exponential information growth and increasing technologization, the ability to evaluate both the work being done and information being found is crucial to technological literacy and should be explicitly communicated.

The survey results found trends similar to those of previous research: participants' comfort level and frequency of use are related to each other and to their use of technology in the classroom (Mayo et al., 2005), cooperating

teachers are a large determiner of students' technology use (Doering et al., 2003), and beliefs about technology influence use (O'Dwyer et al., 2004). Interestingly, self-reported measures of observation and utilization were related to technology beliefs, the role of the cooperating teacher, and to each other. Here, the direction of the relationship is particularly hard to pin down, as it could be that participants who are more confident in their technology use are better able to identify other's uses. On the other hand, it could also be that when less technology integration is observed or utilized, the participant is less likely to hold strong views on the importance of technology in education. While previous research has indicated a positive relationship between constructivist beliefs and technology uses, this finding did not emerge from this data, due to extremely low variance in the constructivist measure. All participants scored high on this measure, which points to the fact that the preparation program is likely highly constructivist in nature. Likewise a liberal arts college may attract higher percentages of students with an inquiry or constructivist orientation.

Recommendations

The teacher preparation program's strong emphasis on technology throughout this cohort's experience played a significant role in their engagement with the principles and the importance of teaching with

technology. This emphasis should continue, particularly as research shows that even one course that is well-infused with technology can have a lasting impact on candidates (Franklin & Molebash, 2007; Milman & Molebash, 2008). Considerable attention should be given to faculty modeling and thinking through ways in which course instructors can demonstrate effective use of technology. Not only has this been proven effective in developing pre-service teachers' ability to integrate technology into their own classrooms (Kim et al., 2008; Pratt & Stevenson, 2007), but it would also fit with participants' desire to see and experience more practical examples of how technology can be used effectively for teaching and learning. In planning for these experiences, program faculty should use the guiding principles to ensure that the modeling demonstrates each of the principles over time and should explicitly share with the pre-service teachers how the principles can be used for planning and evaluating instruction when using technology.

In addition to increasing effective modeling, the program should give careful attention to creating authentic opportunities for the pre-service teachers themselves to experience learning with technology. This involves more than just seeing the technology or having discussions about its possibilities. Although those aspects are certainly part of the process, it is crucial for pre-service teachers to have hands-on opportunities and experience

the learning benefits that can come from technology integration. Many participants' comments on how to better prepare teachers centered around gaining more experience with a variety of technologies, discussing practical ways in which others were utilizing technology in their classrooms, and brainstorming new and creative ways to use technology. All of these suggestions would be excellent ways to continue infusing the program with technology.

As this infusion occurs, particular attention should be given to the structure of course assignments and expectations, not just in the final student teaching seminar, but also throughout the other teaching methods courses. Again, this involves providing candidates with the opportunity to explicitly engage with different technologies, but also moving beyond mere utilization to greater reflection on how the guiding principles help them to conceptualize and understand the work that they are doing. The more opportunities in which candidates are asked to consider and utilize the principles, the more likely it is that they will internalize the approach and use it to guide their practice. Previous research has recommended making technology integration a requirement, with the caveat that there must be clear expectations and sufficient feedback (Schaffer & Richardson, 2004). The guiding principles

make this effort easier, as they provide a set of expectations and indicators by which candidates and program faculty can measure growth.

Finally, the program needs to consider the different factors that are related to increased integration of technology and think about what ways those factors can be developed and supported. One such area in which this could be addressed is in relation to selection of cooperating teachers. Since their encouragement and openness to technology is an important piece of pre-service teachers' use, the program should be actively recruiting cooperating teachers who are using technology effectively and have an understanding of its purpose. Another area for possible support is with regard to candidates' own fluency. Given that increased comfort and frequency of use is linked to greater technology education, it would likely be beneficial to provide skills training and troubleshooting. Lastly, the difference in technology use between the early childhood licensure students and the elementary licensure students points to a need to reevaluate the structure of courses in which these two groups are combined. Particular energy should be devoted to researching and sharing effective ways in which to use technology in the early childhood classroom as well as to look for examples that stretch elementary candidates beyond the typical uses towards greater integration.

Limitations

Given the structure of this study as part of an action research project to improve a particular teacher preparation program, the data is both local and nuanced. In this sense, it is incredibly rich and offers a great deal of insight into how the participants worked with this idea of technology integration throughout the semester. At the same time, this makes its findings highly ungeneralizable to other populations. However, given that the results correspond with much larger studies conducted over a period of time, it is likely that similar studies in different contexts would yield yet again similar results. In addition, it should be noted that the small participant pool also means that there is very little power associated with the correlations presented. However, their existence does indicate that there is a likely relationship between the two correlated variables.

Future Research

Data and feedback gathered in this study should be used to revise the guiding principles material for future use. Participants expressed some confusion about the difference between appropriateness and evaluation, so those two principles should be delineated more clearly to reflect the fact that appropriateness refers to the consideration of whether or not to use a technology tool and, if so, which one, while evaluation refers to thinking

about whether or not the use of a particular tools was effective and about how to validate information.

The indicators for pre-service teachers and the unit evaluation rubric could also benefit from revision. Indicators could be further developed into essential and non-essential elements for each principle. Essential indicators would be those that are absolutely necessary in order to demonstrate that the principle has been considered, while non-essential indicators would be those which certainly demonstrate a particular principle but without which an understanding could still be demonstrated. For example, troubleshooting and knowing where to find answers would be essential indicators of fluency; whereas knowing common file types might be important, but non-essential.

In terms of the unit evaluation rubric, the performance indicators should be further broken down so that each one is associated with a distinct component to be measured. It might also be helpful to create two rubrics for future use, one that looks at the student teacher's personal use of technology and whether or not that use shows evidence of taking the principles into account and one that looks at the student teacher's instructional plans and demonstrations for the students. Future research with the guiding principles could involve their use in another teacher preparation program or with

teaching faculty in the field, asking questions similar to those explored in this study.

Future research with respect to the program should involve implementing the recommendations provided and tracking results. Questions to ask include: Do candidates demonstrate an increased ability to integrate technology into their lessons? Do they feel more prepared to teach with technology upon graduation? Do candidates go on to use technology in a meaningful way, and if so, for how long? Do they attribute their technology infusion to the program? Do the guiding principles serve them well even after graduation? These questions could be used for follow-up research with this particular cohort. Other lines of investigation, such as the exploration of the distinction between the early childhood and elementary licensure students and the role of the cooperating teacher variable across candidates could be used with future cohorts and/or examined over time.

In an era of increased accountability and focus on data-driven decisions, studies such as this are likely to become mandated components of state and national teacher licensure approval processes as they are crucial to identifying and addressing perceived areas of need. Although large-scale research projects and results provide helpful information and direction, localized studies are also necessary to understand specific, nuanced data being

gathered and more importantly to effectively identify next steps for addressing issues and improving instruction and learning outcomes. When such focused research is conducted and recommendations addressed, not only will the local problems have some viable solutions to work with, but larger, mandated outcomes may also begin to emerge.

APPENDIX A

Technology Guiding Principles

[NOTE: In this appendix, "students" refers to both K-12 students and student teachers.]

Appropriateness

Students should know when to use technology, as well as what to use; this knowledge should guide and inform their use of technology.

Technology is a tool, just like a pencil and a chalkboard. Knowing when it is appropriate to use this tool is the first step towards effective use of technology. Sometimes the right choice is the pencil or the chalkboard. However, oftentimes the right choice is technology, making necessary a second choice about what type or technological tool is most appropriate. In making these choices, it should be kept in mind that using technology for the sake of using technology is not worthwhile, particularly when the result is a product that could have been created just as well without technology. This does not imply that things should not be done most efficiently or that students do not need to learn to use technology tools, but that simply adding technological flairs to a task or project is not effective. Instead, technology should be utilized when it will enhance learning, such as by adding depth, facilitating ease of work, or reaching across learning styles.

Fluency

Students should know how to use technology effectively; this includes a working knowledge of computer hardware and software as well as knowledge of technological resources such as the Internet.

Fluency is the basic "how to's" of technology use. While there are numerous skills that should provide a baseline for technological fluency, such as using word processing programs and accessing the internet, many students will enter with a general mastery of these. Instead, the educational focus should be on equipping students to utilize this knowledge effectively so that they are able to obtain the greatest results with the least amount of time and effort. This is not to say that the process is not important, but technology in general is designed to make things simpler and its use should not be cause for greater complication. Most importantly, technological fluency should be founded upon a knowledge of where to find an answer. Rather than attempt the impossible task of teaching students every little trick for each program, a general sense of how to get help or additional information should be the focus.

Ethics

Students should know the legal and ethical issues surrounding technology and its use; this includes understanding technology's potential as well as its drawbacks, abiding by legal and ethical constraints on technology use, and recognizing consequences of non-ethical behavior.

Perhaps the thorniest of all the principles, an understanding of ethics, is also the most important. Students need to comprehend technology well enough to understand what they are enabled to do with it, but also to understand that simply because something can be done does not mean it should be. Beyond simply knowing "right" and "wrong," there should be a discussion of why particular issues fit into one category or the other and of those that don't fit neatly into either box. With the overwhelming influence of technology on everyday life, students should learn about the responsibilities inherent in its use as well as about the possible consequences of their actions, consequences which may include ethical, legal, and social ramifications. Furthermore, technology naturally engenders a global community made up of learners from diverse cultural and societal backgrounds. For students to be able to effectively and respectfully learn within this community, a grounding in technological ethics must include aspects of cultural understanding and global awareness.

Evaluation

Students should be able to evaluate the work they are doing and the information they are finding in order to determine its usefulness and truthfulness.

While the skill of evaluation extends beyond technology to critical thinking in general, it is particularly important within a technological framework. Students need to be able not just to use the technology, but to know whether or not they have used it effectively for the purpose they intended. To this end, metacognition needs to be an ongoing part of the process, enabling students to organize themselves and reflect on their work. Furthermore, when students are using technology to search for information, they need to understand how to evaluate what they find. Students should be able to determine the nature of the information and should have a set of standards for knowing whether or not what they have found is useful and valid, a skill which is particularly important when it comes to the internet. In both cases of evaluation, students should have an understanding of basic guiding questions which they can ask themselves in order to ascertain the usefulness of their own work and the truthfulness of the information they find.

Application

Students should be able to use technology meaningfully in order to make connections and apply the knowledge or information gained to specific contexts or disciplines.

Without some form of application, technology is essentially useless, as learning technology simply to learn it will fail to bring widespread benefits to students. In a sense, all of these principles exist within a context of application, for the use of technology in education should take place within a larger curriculum where the technology is being used to enhance learning of other topics. Students should be able to use technology to answer questions, find results, generate products, and much more within and across specific contexts and disciplines. In doing so, they should be able to understand the purpose behind using a particular technological tool in terms of what advances or enhancements the tool makes possible. Broadly speaking, effective application should demonstrate students' abilities to create, integrate, and communicate the ideas with which they are working.

APPENDIX B

Compilation of 2008 MA Competencies

Standard	K-2	3-5	6-8	9-12
Appropriateness *"students should know when to use technology, as well as what to use"*	1.7 2.5	1.8 1.11 1.14 2.4 3.6	1.8 1.12 3.4	1.5 1.10, 1.11 1.15 1.17 1.25, 1.26 1.31, 1.32 1.35 1.41 2.8 3.1 – 3.3
Fluency *"students should know how to use technology effectively"*	1.1 – 1.6 1.10 2.7, 2.8	1.1 – 1.7 1.9 1.12, 1.13 1.15 – 1.17 1.19 1.21 2.10 2.13	1.1 – 1.7 1.9, 1.10 1.13 – 1.15 1.17, 1.18 1.20 – 1.23 2.12, 2.13 3.8	1.1 – 1.4 1.6 1.8, 1.9 1.12 – 1.14 1.16 1.18 – 1.24 1.27 1.29, 1.30 1.34 1.37 – 1.40 2.5 3.4
Ethics *"students should know the legal and ethical issues surrounding technology and its use"*	1.9 2.1 – 2.3 2.6	2.1 – 2.3 2.8, 2.9 2.11, 2.12	2.1 – 2.7 2.9 – 2.11 2.14	1.7 2.1 – 2.4 2.7 2.11 2.13 – 2.15
Evaluation *"students should be able to evaluate their work and information for usefulness and truthfulness"*	2.4 3.2	2.6, 2.7 3.3 3.9	1.16 1.19 1.25 2.8 3.1, 3.2 3.6	1.28 1.36 2.6 2.9, 2.10 2.12
Application *"students should be able to use technology meaningfully to make connections and applications"*	1.8 3.1 3.3, 3.4	1.10 1.18 1.20 1.22 2.5 3.1, 3.2 3.4, 3.5 3.7, 3.8 3.10	1.11 1.24 3.3 3.5 3.7 3.9	1.33 3.5 3.6 – 3.10

Note: This table sorts the 2008 MA competencies for each grade level into the five standards. While some competencies meet more than one standard, here they are only listed once under the most relevant.

APPENDIX C

Indicators for Pre-Service Teachers

Appropriateness

Pre-service teachers should know when to use technology, as well as what to use; this knowledge should guide and inform their use of technology.

- Understand what can and can't be done with technology
- Choose appropriate technological tool or information source
- Plan strategies for the use of technological tools
- Use technology to support learning
- Identify ways in which technology is used in schools, workplaces, and society

Fluency

Pre-service teachers should know how to use technology effectively; this includes a working knowledge of computer hardware and software as well as knowledge of technological resources such as the Internet.

- Perform basic computer skills

  (turn on/off/restart, open/close/save files, use keyboard/mouse)
- Be able to use multiple platforms (PC and Mac)

- Troubleshoot common computer, network, and IT problems
  (frozen screen, printing issues, internet connection, etc.)
- Utilize common applications
  (word processing, spreadsheets, databases, power point, drawing tools, website creation, video and sound programs)
- Understand common file types (pdf, jpeg, etc.)
- Recognize the importance of backing up files and know how to do so correctly
- Operate external equipment
  (printer, flash drive, camera, scanners, etc.)
- Navigate the internet
  (access, send email, find websites, use search engines)
- Search electronic sources for information
  (determine source, use syntax, cite properly)
- Know how to find answers to common issues or problems for various technologies
- Transfer general or specific knowledge to new technologies

Ethics

Pre-service teachers should know the legal and ethical issues surrounding technology and its use; this includes understanding technology's potential as well as its drawbacks, abiding by legal and ethical constraints on technology use, and recognizing consequences of non-ethical behavior.

- Demonstrate safe and responsible use of technology
  (proper treatment of equipment, awareness of computer viruses, appropriate sharing of personal information)
- Comprehend dangers of the internet, file-sharing, downloading, etc.
- Be aware of network and information security issues
- Know legal, ethical, and social consequences for technology use
  (district's internet use policy, possible repercussions from social networking sites, etc.)
- Understand issues of ownership, plagiarism, and collaborative work
- Develop global awareness and an appreciation of the possibilities
- Recognize human, cultural and societal impacts of technology use

Evaluation

Pre-service teachers should be able to evaluate the work they are doing and the information they are finding in order to determine its usefulness and truthfulness.

- Determine whether or not the use of technology is productive and effective
- Assess trustworthiness of information
- Validate a website or source of information
- Understand issues of information distortion or exaggeration
- Discriminate between sources and provide support for the choices made
- Reflect meaningfully on impact of technology use
- Use available sources of knowledge to make informed decisions

Application

Pre-service teachers should be able to use technology meaningfully in order to make connections and apply the knowledge or information gained to specific contexts or disciplines.

- Use particular technological tools to enhance understanding of material

- Integrate technology use into routine tasks and projects
- Organize a variety of information to connect ideas and themes
- Analyze retrieved data within a disciplinary context
- Communicate results of work to others effectively with technology
- Apply existing knowledge to solve new problems

APPENDIX D

Survey 1

[NOTE: This survey was administered online through FormSite.com]

Please answer the following questions to the best of your ability, based upon your past and current experiences at Mount Holyoke and in your practicum classroom.

1. When you hear the word technology, what do you think of? What do you view as technology?

2. Please describe the technology that is available in your classroom and in your school for you to use with your students, indicating the type of technology as well as its location and availability.

3. Please describe the technology that is available through the Mount Holyoke campus and teacher licensure program for you to use with your students.

~//~

Please rate your agreement with the following statements.

4. Technology is a necessary part of education.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

5. Technology can enhance learning.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

6. Technology education should focus on how to use computers.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

7. Technology facilitates higher order thinking.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

8. Technology can support learning.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

9. Technology education takes away from core curriculum instruction.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

10. Technology increases student collaboration.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

~//~

Please rate your agreement with the following statements.

11. Students learn best through project-based learning.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

12. Students learn best when given high expectations.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

13. Students learn best by engaging multiple senses.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

14. Students learn best when provided with regular feedback on their performance.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

15. Students learn best when their questions and interests are reflected in the curriculum.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

16. Students learn best through experiential activities.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

17. Students learn best when given opportunities to build upon previous knowledge.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

~//~

18. To what degree does your academic experience at Mount Holyoke affect your use of technology in the classroom?

To great extent / Quite a bit / Somewhat / A little / Not at all

19. How supported do you feel by the Mount Holyoke campus in integrating technology into your classroom?

Highly supported / Generally supported / Somewhat supported / Barely supported / Not supported

20. How often have you observed the use of technology in your Mount Holyoke courses?

Almost always / Frequently / Occasionally / Rarely / Never

21. How often have you utilized technology in your Mount Holyoke courses?

Almost always / Frequently / Occasionally / Rarely / Never

~//~

22. To what degree do the Mount Holyoke teacher licensure program requirements affect your use of technology in the classroom?

To great extent / Quite a bit / Somewhat / A little / Not at all

23. How supported do you feel by the Mount Holyoke teacher licensure program in integrating technology into your classroom?

Highly supported / Generally supported / Somewhat supported / Barely supported / Not supported

24. How often have you observed the use of technology in your teaching methods courses?

Almost always / Frequently / Occasionally / Rarely / Never

25. How often have you utilized technology in your teaching methods courses?

Almost always / Frequently / Occasionally / Rarely / Never

~//~

26. To what degree do the expectations of your cooperating teacher affect your use of technology in the classroom?

To great extent / Quite a bit / Somewhat / A little / Not at all

27. How supported do you feel by your cooperating teacher in integrating technology into your classroom?

Highly supported / Generally supported / Somewhat supported / Barely supported / Not supported

28. To what degree do the school's standards affect your use of technology in the classroom?

To great extent / Quite a bit / Somewhat / A little / Not at all

29. How supported do you feel by your school in integrating technology into your classroom?

Highly supported / Generally supported / Somewhat supported / Barely supported / Not supported

~//~

30. How often have you observed the use of technology in your pre-practicum placements?

Almost always / Frequently / Occasionally / Rarely / Never

31. How often have you utilized technology in your pre-practicum placements?

Almost always / Frequently / Occasionally / Rarely / Never

32. How often have you observed the use of technology in your practicum?

Almost always / Frequently / Occasionally / Rarely / Never

33. How often have you utilized technology in your practicum?

Almost always / Frequently / Occasionally / Rarely / Never

~//~

Please indicate your agreement with the following statements.

34. My cooperating teacher encourages students to use technology to support their learning.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

35. My cooperating teacher encourages me to use technology to enhance my own learning.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

36. My cooperating teacher encourages me to use technology in my own instruction.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

~//~

37. How comfortable do you feel with the following technologies?

(The following scale was used for all items: Very comfortable / Generally comfortable / Somewhat comfortable / Barely comfortable / Not at all comfortable)

a) Email

b) Word processing

c) Spreadsheet software (such as Excel)

d) Presentation software (such as PowerPoint)

e) Database software (such as Access)

f) Drawing tools or image programs (Paint, Photoshop, etc.)

g) Data analysis software (like SPSS)

h) Video and sound programs (Media Maker, iMovie, etc.)

i) PC platform (Windows interface)

j) Mac platform (Apple interface)

k) Digital camera

l) Digital video camera

m) Audio recorder

n) Zip/flash drives

o) Printer

p) Scanner

q) Basic programming languages (HTML, C++, etc.)

r) Website creation

s) Wikis

t) Blogs

u) Social networking sites (Facebook, MySpace, etc.)

v) Online media content (YouTube, Pandora, etc.)

w) Internet searching

x) Online databases and resources

y) Network spaces

~//~

38. For these same technologies, please indicate how frequently you use each of them.

(The following scale was used on exactly the same items: Occasionally / Monthly / Weekly / Daily)

~//~

39. At what grade level are you completing your practicum? (If early childhood, please indicate the grade levels of both placements.)

40. What are your ideas about the best ways to encourage pre-service teachers to gain new knowledge or expertise in technology?

41. Please comment on anything else that you would like to add or that you don't feel was sufficiently addressed in this survey.

APPENDIX E

Survey 2

[NOTE: This survey was administered online through FormSite.com]

Please answer the following questions in as much detail as possible.

1. How has your thinking about technology changed as a result of your practicum experience? Please comment upon both the ways that it has changed and the reasons you think it has changed.

2. What would you change or add in the teacher education program at Mount Holyoke so that the program could better prepare teachers to infuse technology into their teaching?

~//~

3. How often did you observe the use of technology during your practicum?

Almost always / Frequently / Occasionally / Rarely / Never

4. How often did you utilize technology during your practicum?

Almost always / Frequently / Occasionally / Rarely / Never

5. Please describe any technology that you used during your practicum and the frequency with which you used it.

~//~

6. I designed a unit that incorporated technology.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

7. I utilized technology during the implementation of my unit.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

8. I believe that incorporating technology enhanced my unit.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

9. I believe my students benefited from the use of technology during my unit.

Strongly Agree / Agree / Neutral / Disagree / Strongly Disagree

10. Please comment on your experience with incorporating technology into your unit.

APPENDIX F

Reflection Prompt

Did you use technology in your classroom this week? If so, please provide a brief description (what, how, why, etc.). Which principles do you feel were addressed during your lesson? If you did not use technology this week, please explain why or discuss areas where you could integrate it into the lessons.

APPENDIX G

Rubric Criteria

Each criterion was assessed through the performance characteristics "No evidence," "Some evidence," or "Strong evidence."

Appropriateness

…The unit shows evidence of taking the function and role of technology into account as related to its content.

…The unit utilizes relevant, grade-appropriate technology to communicate its goals and accomplish its purposes.

…The unit employs technology to enhance learning.

…The unit encourages students to think about the use of technology in their own lives.

Fluency

…The unit includes demonstrations of fluent technology use.

…The unit supports students in the process of exploring new technologies and skills or reviewing old ones.

…The unit prompts students to discover where to find help for the technology being used and how to troubleshoot.

…The unit evaluates students' technological fluency and shows evidence of preparation to meet differing abilities.

Ethics

…The unit requires students to use technology safely and responsibly and to consider possible consequences or dangers posed by the technology.

…The unit encourages students to think about technological possibilities and impacts as well as about legal and ethical issues surrounding its use.

…The unit asks students to think about issues of ownership and collaborative work within the context of information both discovered and produced.

…The unit helps students to understand and analyze their role in the global community provided by technology.

Evaluation

…The unit considers the source of the information being used and models the validation process for students.

…The unit discusses possible questions that students can ask themselves when thinking about usefulness and truthfulness.

…The unit presents students with choices about material and asks them to think about standards they can use to make a decision.

…The unit asks students to reflect on their own use of technology and evaluate its effectiveness in accomplishing their purpose.

Application

...The unit embeds technology within itself as a tool for teaching and learning.

…The unit utilizes technology to enhance students' understanding of curricular material.

…The unit enables students to use and understand technology with a specific purpose in mind.

…The unit asks students to use technology to integrate ideas and to organize and communicate their thoughts and findings.

APPENDIX H

Coding Categories Outline

I. Significant aspects
   - A. Documentation
   - B. Preparation
   - C. Time
   - D. Computer class
   - E. Tech changes
   - F. Web
     1. Web for content
     2. Web for research
     3. Web for information
     4. Web for resources
     5. Web for extension
     6. Web for ideas
     7. Web for knowledge
     8. Web for materials
   - G. Communication
     1. Communication with parents
     2. Teacher communication
     3. Sharing resources
     4. Collaboration
     5. Peer communication
   - H. “Thinking”
     1. Necessity of tech
     2. Evaluation

3. Possibilities
4. Retrospect
5. Differentiation
6. Extension
7. Accommodation
8. Perception
9. Adaptation
10. Reflection
11. Definition
12. Planning
13. Integration
14. Experience
15. Awareness

I. Benefits
1. Tech-only
2. Engagement
3. Making easier
4. Improvement
5. Creating comfort
6. Efficiency
7. Validation

J. Difficulties
1. Avoidance
2. No tech
3. Access
4. Accessibility
5. Poor use

6. Resistance
7. Technical difficulties
8. Reaction
9. Cuts
10. Availability
11. Challenges
12. Reliability
13. Support

K. Examples
1. Audio
2. Calculator
3. Use of tech
4. Online books
5. Video
6. Publishing/publication
7. Visuals
8. Sharing
9. Reward
10. Follow-up

L. Appropriateness
1. Time filler
2. Appropriateness
3. Grade level

M. Ethics
1. Ethics
2. Copyright

N. Demo/modeling
    1. Demonstration
    2. Modeling

O. Application
    1. World connection
    2. Application
    3. Background schema
    4. Real-world example
    5. Research
    6. Skills
    7. Data
    8. Organization
    9. Content support

II. Technology used
A. Software
    1. Other
    2. Word processing
    3. Publishing software
    4. Graphing program
    5. Games
    6. Spreadsheet
    7. Powerpoint
B. Hardware
    1. Computers
        a. General computers
        b. Laptops

c. Computer lab

2. Copier
3. Overhead/projector
4. Calculator
5. Printer
6. Science tools
7. Camera
8. Phone
9. Scanner

C. Web

1. Internet
2. Email

D. Media

1. Video
2. Audio
3. Pictures/visuals

III. Principles

A. Appropriateness
B. Fluency
C. Ethics
D. Evaluation
E. Application

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