Preservice Teacher Education Benchmarking a Standalone Ed Tech Course in Preparation for Change

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Abstract

In an effort to reform a teacher education program by strengthening content-area preparation and adding opportunities to practice by extending the time for student teaching, Arizona State University's Mary Lou Fulton Teachers College eliminated a group of teacher education courses, including the standalone educational technology course. Educational technology faculty members were charged with developing an alternative approach of infusing technology into methods courses. Our first step was to conduct this benchmarking study of the standalone course to determine the successful lessons and practices that should be incorporated into the new program design. Results from analysis of pre- and post-course survey results and focus-group data indicated that candidates' confidence and TPACK scores increased in the standalone course. We will share benchmarks that arose from the study with program developers for adoption or adaptation to the new technology-infused courses where appropriate. Findings may also be useful to other teacher credentialing institutions that are changing to a technology-infused instructional approach. (Keywords: technology integration, TPACK, benchmarking, technology course, preservice teacher education)

The Mary Lou Fulton Teachers College is transforming its teacher certification program. Because it is one of the largest teacher credentialing institutions in the United States, the actions taken with respect to technology integration in our preparation program may have implications for other preparation programs. The change was triggered by the need to include more content-knowledge coursework and to require two full semesters of student teaching rather than one. To make room for these two new requirements, we eliminated a course that was once required, TEL 313 Educational—Technology across the Curriculum, from the program. Educational technology instructors were charged with determining how candidates would learn to integrate technology in their lessons and teaching experiences without the foundational technology course.

This change in requirements was consistent with concerns that standalone technology courses are ineffective in providing teacher education candidates with appropriate preparation to successfully integrate technology into their instruction (Bielefeldt, 2001; Moursund & Bielefeldt, 1999). Others have also written about the value of integrating technology into methods and content courses to foster technology skills more strongly connected to use in PK–12 instruction and cognitive development of candidates (Pierson & Thompson, 2005; Shapely, Benner, Pieper, Way, Snider, & Gershner, 2003; Tonduer, van Braak, Sang, Voogt, Fisser, & Ottenbreit-Leftwich, 2012). Nevertheless, standalone courses have continued to be a critical element in initial teacher preparation programs (Gronseth et al., 2010; Kleiner, Thomas, & Lewis, 2007). Generally, these standalone courses provided an introduction to technology integration, and they were reinforced with technology integration in methods coursework (Gronseth et al., 2010; Kleiner et al., 2007; Wang, 2006). In one study that was conducted to directly compare a standalone course with a course that integrated technology, Anderson and Borthwick (2002) found there were greater gains in several areas from pre- to post-test assessment for the group in the standalone course.

The Current Standalone Educational Technology Course

The teacher preparation program includes 2 years of general studies and 2 years of teacher preparation courses. All candidates took the required educational technology course, TEL 313, during the first semester of their junior year, and it was one of the first courses candidates took upon admission to the program. The course addressed issues with respect to helping students (a) learn how to use technology tools for teaching and learning, (b) stay updated and adopt a mindset of being innovative with technology, (c) apply ethical principles of using technology with their students, (d) attain experiences with a variety of technologies and their use in classroom settings, and (e) integrate technology into teaching standards-based content. Further, this course content was reflected in what we asked students to do in major assignments.

Candidates experienced a variety of active approaches, most of which both modeled and taught technology integration, including lecture, discussion, demonstration, hands-on activities, project presentations, and constructivist-based approaches. The emphasis was on developing candidates' identity as technology-using instructors. Course goals included participating in collaborative work through Web-based digital tools, designing digital age learning experiences, and participating in professional development and leadership activities including practice teaching.

The following major projects addressed the curriculum goals and were aligned with the National Education Technology Standards for Teachers (NETS•T) and Students (NETS•S; ISTE, 2011):

- **Digital video storytelling:** Create a video for teaching and learning through determining a worthwhile need, script-writing, media capture, editing, and sharing.
- **Mini-teach:** Practice teaching using the TPACK framework.
- **Technology integration project:** Plan, implement, and evaluate a project-based learning unit that integrates technology.

A strand of curriculum addressing digital citizenship was integrated throughout all of the above projects, with attention given to digital footprint, copyright and fair use, digital equity, adherence to policy (acceptable use), and other ethical concerns.

Preparing for Change

Although accreditation processes have provided one level of scrutiny to determine whether programs meet required accreditation and preparation standards, including the NETS•T (ISTE, 2011), true indicators of success would require establishing the same level of curriculum and candidate readiness to teach with technology in the reconfigured courses as we had in the standalone course. We realized a large part of this effort would be in proceeding systematically.

We made two initial decisions to lead the change initiative. One was to hire a technology infusion and professional development coordinator; the second was to designate two teacher education methods courses as "technology intensive." Based on the technology integration results for these two courses, another set of courses could then be redesigned to be tech intensive as well. By the end of a 5-year period, all courses would be infused with appropriate technology integration components. By addressing the technology integration curriculum across an entire program instead of a single standalone course, teaching preservice teachers how to use technology would be conducted within the context of a content-rich environment, and educational technology experts in the college could support the redevelopment of new syllabi and signature assignments.

On the one hand, it is the vision of technology integration advocates that the art of teaching with technology be integrated into the content of a program, rather than taught in isolation as a standalone course. On the other hand, the quality of the experience in such a dynamic field as technology may be best addressed by educational technology experts, whose primary responsibility is to keep up with the technological advancements and address ongoing changes to course content and teaching techniques. Instructors who teach science, social studies, mathematics, and language arts methods courses may not be experts in teaching about technology integration; even if content instructors teach with technology, they may not be capable of teaching preservice candidates how to teach in PK–12 classrooms with technology. We realized that we might need to sacrifice some control over the ownership of teaching educational technology to advance the endeavor of integrating technology in a more thorough and programmatic way.

Internal Benchmarking

Benchmarking has been a practice commonly used in business to discover successful lessons and practices that can be applied to create change. In benchmarking, organizations "learn from many different sources and then creatively adapt or imitate those lessons and practices that will advance their performance" (Watson, 2009, p. xi). Benchmarking has supported organizations to innovate in ways that embrace the full circumstance of their work, including customer need and situation. In benchmarking, organizations have conducted systematic observations and participated in rigorous conversations, which tend to create consensus on direction and alignment to the needs (Watson, 2009).

Before the rollout of a completely new program structure, we had one more semester in which the standalone course was being taught. To strategically move from one program structure to another without losing the elements of the old program that were successful, we conducted an internal benchmarking inquiry (Global Benchmarking Network, n.d.). This benchmarking procedure allowed us to retain those successful lessons and best practices of our current program that were appropriate so that we could apply them to the integrated model, which was scheduled to begin the following semester.

A benchmark process takes place in three stages:

1. **Determine best practices:** Analyze product or performance
2. **Identify enablers:** Identify factors associated with the successful product or performance
3. **Lead change:** Apply new learning to the culture of the organization (Watson, 2009)

This study addressed the first stage of benchmarking, as we felt identification of successful lessons and practices of the current standalone program would support our program developers as they sought to amplify the effects of the integrated model to ensure outcomes that equaled or exceeded those of the standalone course.

We believed our process of identifying successful lessons and practices from the standalone course was worth sharing, as this model of providing educational technology to preservice teachers is commonly used by other universities. We realized that documenting our pathway to change might be useful to others following our lead, to adopt an integrated programmatic approach for

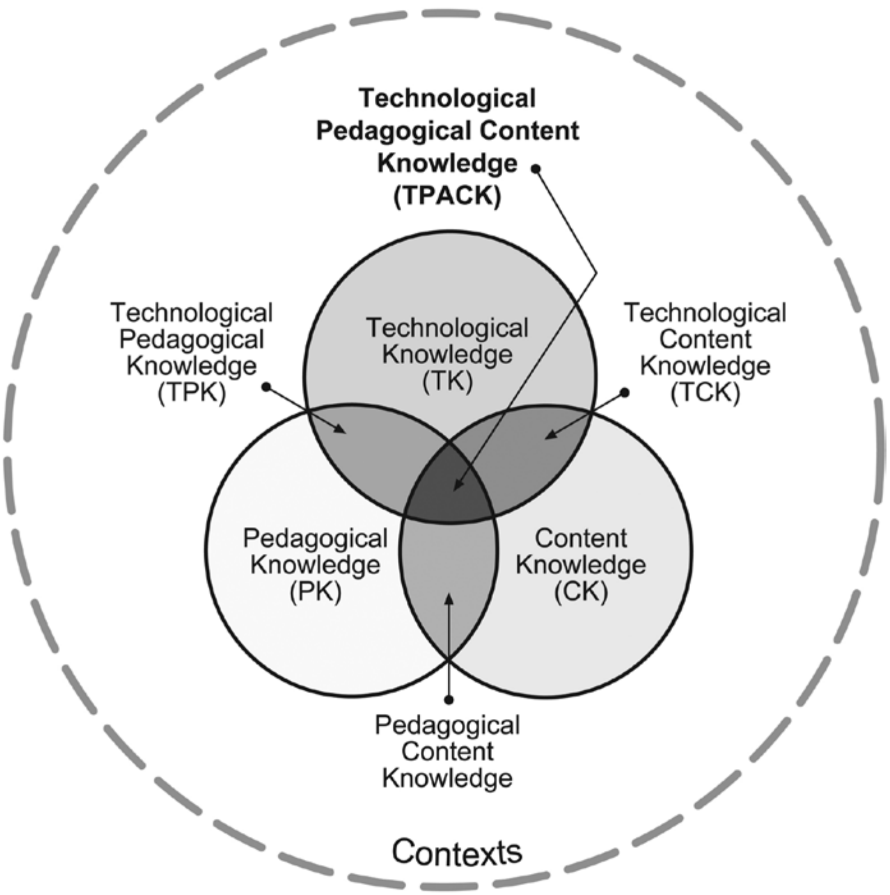

Figure 1. Technological Pedagogical Content Knowledge. (Adapted from http://tpack.org/ website and used by permission.)

supporting preservice teachers who are learning to teach with technology.

Framing Teaching with Technology: TPACK

As educational technology instructors, we viewed the move from an isolated educational technology course in the first semester of our preservice program to infusion of technology into two tech-intensive courses through an educational framework known as Technological Pedagogical Content Knowledge, commonly known as TPACK (Koehler & Mishra, 2008, 2009; Mishra & Koehler, 2006; see also Pierson, 1999). The use of the TPACK frame provided a focus on integration and offered affordances for the value-added features of technology. It encompassed aspects of teaching with technology that are important—namely the combination of technology with content-rich experiences and pedagogical approaches that make good use of the possibilities only technology can provide. Pierson (1999) proposed a forerunner of TPACK, a theoretical model of technology integration based on her thoughtful synthesis that combined technological knowledge with Shulman's (1986) pedagogical content knowledge framework to form "technological-pedagogical-content knowledge" (p. 224). TPACK is fitting for our preservice program, given this framework relies on the equal representation of the three important and interrelated perspectives when developing curriculum, instructional practices, and accountability measures (see Figure 1). Details about the TPACK model are also provided in an article by Koehler and Mishra (2009). As the figure indicates, three types of knowledge required to effectively integrate technology are content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK). Importantly, the areas that overlap in the figure reflect combinations of these different types of knowledge that are critical to technology integration. Specifically, the intersection of PK and CK represent a new type of knowledge, pedagogical content knowledge (PCK). Similar two-way interactions of TK with CK denote technological content knowledge (TCK), and TK with PK signify technological pedagogical knowledge (TPK). Finally, TPACK embodies the combination of all three types of knowledge, which is considered to be essential to effectively integrating technology into classroom instruction.

The TPACK framework was originally developed after 5 years of teacher professional development and faculty development in higher education (Mishra & Koehler, 2006). Due to its generalizability to a broad range of developmental levels and situational contexts, in a mere 6 years the framework has been adopted as an appropriate lens for PK–12 students, college-level instructors, inservice teachers, and preservice candidates.

Drawing on the TPACK work, Niess and her colleagues (Niess, 2011; Niess et al., 2009) explored the developmental stages of teachers who sought to use technology with their students. They suggested there were five stages:

1. **Recognizing:** Understanding the alignment of technology to content
2. **Accepting:** Having a favorable attitude toward teaching content with technology
3. **Exploring:** Integrating technology by thinking about and designing student-directed activities
4. **Adapting:** Adopting teaching of content with appropriate technology
5. **Advancing:** Making revisions to curriculum based on results of teaching with technology

The TPACK framework and Niess' developmental model helped us view the integrated program model for addressing educational technology with our preservice teachers as a developmental undertaking that may require a programmatic perspective for the curriculum associated with teaching with technology, rather than a scattering of experiences across content courses. Such a developmental perspective was useful in conducting the benchmarking work in the current study and will be useful in the research going forward. Finally, perhaps some of our findings will be helpful to other universities that have common structures and needs.

Research Questions

Consistent with benchmarking techniques, this step of the change process was meant to reveal how the current program was meeting the programmatic goals of preparing preservice teachers to teach with technology and to identify some of the associated successful lessons and practices that contribute to those accomplishments. The research questions that drove this inquiry included:

- **RQ1:** How and to what extent does the standalone course prepare candidates to integrate technology in teaching and learning?
- **RQ2:** What benchmarks from the standalone course would be useful for program developers of the integrated model?

Method

The Method section provides details about the participants, instruments, data sources, data collection, and data-analyses procedures.

Participants

Participants included 110 candidates from five sections of the standalone course who completed both the pre- and post-test questionnaire. These candidates were juniors who were in their first semester in the teacher preparation program. This group of candidates included 80 females and 30 males. The mean age of the participants was 24.68 years, with a standard deviation of 7.55 years. With respect to ethnicity, 80.9% were Caucasian, 3.6% were African-American, 12.7% were Hispanic, 1.8% were Asian or Pacific Islander, and 0.9% were Native American.

Instruments, Data Sources, and Procedures

Pathway Teacher Questionnaire. The Pathway Teacher Questionnaire (PTQ) was used to measure candidates' (a) attitudes about the usefulness of technology tools, (b) dispositions toward teaching with technology, (c) confidence in using technology, and (d) technology, pedagogy, and content knowledge, as well as combinations of these latter variables (Strudler, Schrader, & Asay, 2011). The PTQ was selected because it was closely aligned to our need to understand candidates' perceptions about their ability to become technology-using educators and was developed with the TPACK framework in mind (Koehler & Mishra, 2008, 2009; Mishra & Koehler, 2006). It should be noted that the PTQ was built on the earlier work of Schmidt and colleagues, who developed the instrument to survey the TPACK knowledge of preservice candidates (Schmidt, Baran, Thompson, Mishra, Koehler, & Shinn, 2009). The questionnaire was administered to candidates taking the standalone course during the first and last weeks of a 15-week course.

The PTQ consists of nine subscales. Three of the subscales are composed of 15 items each that are used to assess candidates' (a) attitudes about the usefulness of technology tools, (b) dispositions toward teaching with technology, and (c) confidence in using technology. An example item from the usefulness of technology is: "Please indicate how useful you find … word processing software (e.g., Word)." For dispositions toward teaching with technology, an illustrative item is: "Technology can promote deep understanding." An example item from the confidence scale is: "Please indicate your level of confidence in performing … locate information online." In addition to those subscales, six subscales with a total of 48 items were used to measure various components of TPACK, including 7 items that assess technological knowledge (TK); 15 items that measure content knowledge (CK); 7 items that evaluate pedagogical knowledge (PK); 5 items that measure pedagogical content knowledge (PCK); 5 items that tap technological pedagogical knowledge (TPK); and 9 items that assess technological pedagogical content knowledge (TPACK). To illustrate the nature of these items, an example from the PK scale is: "I can adapt my teaching style to different learners." An example from the TPACK scale is: "I can choose technologies that enhance the content for a lesson." Two additional items asked respondents to indicate the extent to which they observed modeling that appropriately combined technology, pedagogy, and content knowledge (TPACK) in their education courses and in noneducation courses. The TPQ instrument has been shown to be valid and reliable (Strudler et al., 2011), and results of reliability analyses are presented below for data from the current study. The survey is available, with authors' permission, at http://education.asu.edu/documents/iTeachSurvey.pdf.

Focus-group conversations. We used qualitative data to address the "how" in RQ1: How and to what extent does the standalone technology course prepare candidates to integrate technology in teaching and learning? Qualitative data came from focus groups of candidates in five different sections of the standalone course, from three instructors' classes. We selected candidates based on a combination of their interest in participating and instructor nomination. Although focus groups were comprised of candidates from the same section only, candidates retained anonymity with a participant number that prefaced each comment for ease of transcription. Candidates were assured their comments and recordings would not be made available to their instructors based on formal Institutional Review Board agreements.

Each focus group consisted of four to eight candidates and was facilitated by educational technology experts in the college who were not the candidates' instructors. Facilitators asked candidates to be sure their perspective to each question was addressed during the conversation, either by them or by another candidate. Facilitators used probing techniques to assure comprehensive and in-depth responses. The questions candidates were asked included:

1. How prepared are you to teach students to use technology to accomplish content standards?
2. What factors account for your level of preparation?
3. What would better prepare you?
4. Do you think you are representative of other candidates?
5. How important is it to teach students to be critical viewers of digital media?
6. How important is it to teach students to use technology to problem solve and become critical thinkers?
7. Does it really matter whether students document sources for their work and work to summarize rather than plagiarize the work of others?
8. Provide an example of how you would teach a lesson with student use of technology. What would the students learn? Why would this approach be better than an approach without technology?
9. What tech integration have you seen modeled in your teacher education courses? What technologies? What activities? What assignments?

Analysis of focus-group conversations. We digitally recorded and archived all focus-group conversations in a secured space. One of the researchers then reviewed the recordings to become immersed and to get an overall sense of the data. Analysis did not begin until the researcher gained an understanding of the dataset in its entirety (Esterberg, 2002).

Next, following a method described by Miles and Huberman (1994), the researcher conducted an initial coding process involving creating word/phrase labels for key concepts related to seeking benchmarks, the goal of the study. The concepts met the researcher's sense of being plausible, following Miles and Huberman's suggestion that "plausibility … is a sort of pointer, drawing the analyst's attention to a conclusion that looks reasonable and sensible on the face of it…." (p. 246).

Subsequently, the researcher completed the process of inductively forming categories, whereby she clustered the initial benchmark concepts and relabeled specific resulting themes to exemplify the attributes that were most relevant to each theme—in this case, each benchmark (Corbin & Strauss, 2008). Next, the researcher completed another pass of the data to identify cases where student remarks most closely exemplified the attributes of each benchmark theme. In sum, because the researcher returned to the interview data often, worked systemically and reflectively, and sought confirming and disconfirming evidence throughout the process, we believe our findings are authentic and credible (Miles & Huberman, 1994).

Results

This section presents results of the quantitative data as well as findings based on the qualitative data.

Quantitative Results

Analysis of Pathway Teacher Questionnaire. With respect to the current study, we obtained the following results for the quantitative data based on candidates' responses to the PTQ. Reliability coefficients for pretest scores ranged between .82 and .98, which indicated the subscales demonstrated very good reliability. We compared pre- and post-test data using a repeated measures multivariate analysis of variance (MANOVA). The repeated measures MANOVA was significant, $F(9, 85) = 8.45$, $p < .001$, with partial eta-squared equal to .472. We conducted univariate, follow-up ANOVAs for each of the nine dependent variables. As observed in Table 1, in which we compared pre- and post-test data, there were no differences based on statistical tests of the pre- and post-test scores for usefulness of technology and disposition for teaching with technology, because candidates already thought technology was useful and were favorably disposed toward teaching with technology. On the other hand, as noted in Table 1, six of the remaining seven comparisons of pre- and post-test scores were significant. Confidence in using technology and all the TPACK model variables, with the exception of CK, increased significantly from the pre- to post-test administration of the instrument. The most noteworthy increases occurred for confidence in using technology, TPK, and TPACK, which all demonstrated increases of one-half a point or more. PK and PCK demonstrated increases of more than four-tenths of a point, whereas TK increased by .36 of a point. By comparison, CK showed a 0.10 point increase, which was not significant. Moreover, for the various TPACK variables, effect sizes were all large effect sizes for a within-subjects design based on Cohen's criteria (Olejnik & Algina, 2000), with the exception of CK, which was not significant. Cohen (1988; Olejnik & Algina, 2000) suggested η^2 values equal to or exceeding .01, .06, and .14 are considered to be small, medium, and large effect sizes, respectively, when proportion of variance accounted for is used as a measure of effect size.

With respect to observing TPACK modeled instruction in education and noneducation courses, for the end-of-semester data, there was a statistically significant effect, $F(1, 105) = 12.88$, $p < .001$, with partial $\eta^2 = .109$, a medium effect. The mean for modeling in the education courses was 3.95 with $SD = 0.92$, whereas the mean for the noneducation courses (courses offered in other colleges but taken by these same candidates) was 3.66 with $SD = 1.02$. Overall, these data suggest that modeling of educational technology in education courses, other than the technology course, was higher than in noneducation courses.

Results with respect to RQ1. Taken together, there are several noteworthy findings based on the quantitative data. First, these results suggest candidates' participation in the standalone course increased their confidence in using technology. Growth in confidence was statistically significant and substantial, as demonstrated in the very large effect size for this variable, which showed time of testing accounted for more than 38% of the variation in scores on this measure. Further, all the TPACK measures showed statistically significant increases,

Table 1. Variables, Alpha Reliability Coefficients, Pre- and Post-Test Means and SDs, and Statistics for Subscales of the Pathway Teacher Questionnaire

Variable	Alpha Reliability Coefficient	Pre- & Post-Test Means and SDs	*F*-Test Statistic and *df*	*p* Level	Effect Size, Partial η^2
Usefulness of Technology	.82	4.31 4.35 (0.56) (0.51)	0.44 (1, 107)	< .51, NS	---
Disposition for Teaching with Technology	.98	4.36 4.46 (0.83) (0.78)	1.34 (1, 107)	< .25, NS	---
Confidence in Using Technology	.88	3.70 4.24 (0.81) (0.66)	65.80 (1, 107)	< .001	.381
Technology Knowledge (TK)	.94	3.61 3.97 (0.95) (0.87)	25.88 (1, 106)	< .001	.196
Content Knowledge (CK)	.87	3.92 4.02 (0.60) (0.59)	3.78 (1, 103)	< .06, NS	---
Pedagogical Knowledge (PK)	.89	3.87 4.28 (0.60) (0.54)	33.87 (1, 104)	< .001	.246
Pedagogical Content Knowledge (PCK)	.85	3.43 3.88 (0.89) (0.69)	24.81 (1, 102)	< .001	.196
Technological Pedagogical Knowledge (TPK)	.96	3.75 4.27 (0.82) (0.62)	34.19 (1, 104)	< .001	.247
Technological Pedagogical Content Knowledge (TPACK)	.90	3.64 4.14 (0.73) (0.59)	38.96 (1, 100)	< .001	.280

with the exception of CK. Moreover, the largest gains were shown in PK, TPK, and TPACK. Gains in these variables attest to perceived changes in technology integration capabilities of these candidates.

Qualitative Findings, Quantitative Corroboration

In response to RQ2, the qualitative data resulted in the development of four benchmarks thought to be lessons and practices from the standalone course that might be useful in the new integrative approach to educational technology. Quantitative data that confirmed or disconfirmed these findings are presented within this section to demonstrate the complementarity of the quantitative and qualitative data (Greene, 2007).

Benchmark 1: Technology skills. All candidates agreed that they were exposed to a wide variety of technological tools, most of which they had not used previously. This is typical of their thoughts: "I feel prepared in the sense of being aware of all the technology I can use, not so much in the sense that I can use them all individually…. I was satisfied with that because it allows me to pick and choose the ones I would want to go deeper into instead of being forced to learn a certain number of [tools]." Moreover, observing their instructors using technology tools, leading a mini-teach, participating in many mini-teaches, and having time to explore various technologies mattered. Candidates were grateful to have been exposed to so many tools, and although the focus-group candidates admitted that most candidates in their classes began the semester with basic technology skills, they concluded that they increased their comfort level as technology-using teachers. All candidates who participated in focus groups had a general sense that their comfort with technology increased. They felt that "before the class technology was my weakness and it was hard for me to learn on my own…. Now I'm more independent." These findings were consistent with the quantitative data, which showed confidence for using technology increased along with increases on the TK, PK, PCK, TPK, and TPACK scales from the PTQ.

Some candidates, however, reported, "Some things I could have learned [on my own] in a fraction of the time." Candidates debated about whether they appreciated the time spent learning just a few tools with depth, including the TPACK knowledge, or reviewing a broader set of tools. Overall, most candidates agreed that when the time comes for them to use a specific tool "with my students," "I would know the technologies that would hit home with my students." They said they would be motivated to spend the time and that they were adequately prepared with enough technology skills and know-how to learn almost any tool to the basic operational level. One insightful candidate reminded us that she grew up during the time when some key technologies, such as cell phones and Facebook, were introduced to the market. She felt she was more technology savvy than most teachers in the field.

Benchmark 2: Technology access in the field. Candidates who used technology with PK–12 students were very motivated to learn more about teaching with technology because they witnessed its impact on students. One candidate reported that her internship site was a one-to-one computing site and her mentor teacher was a technology coach. This candidate's vision for technology integration was expanded greatly. She reported, "[My mentor teacher's] classroom is 95% paperless. It's been really interesting to see how she uses it throughout the day.... Pretty amazing stuff."

Conversely, some candidates reported in their field experience that they "… don't really have the [desirable] access" to technology, had ill-maintained equipment, and their mentor teachers were not too concerned or interested in teaching with technology. They also indicated that in some practice teaching experiences, they were not afforded adequate access to technology tools and wireless Internet connection. These candidates felt the work that goes into integrating technology was not always worth the payoff. One candidate gave an example of technology limitations, and many others agreed: "I know in my [field experience] classroom, the wifi is just horrible. A lot of the kids have 3G connections that are a lot better than even the Internet service they have [at the school]. And like there's [sic] kids who want to go out into the hallway so they can have access to the Internet. So when we are designing all these heavily technology-loaded [lessons] I have to wonder if I'm going to be faced with these situations later, and is it worth it. I'm not really a traditionalist, but we have to account for a lot of districts not being able to provide the kinds of things we want to employ."

Benchmark 3: Orientation of class content and access to resources. Candidates in one focus group wanted researchers to know that they liked how the structure of the class geared them toward teaching with technology because it was very process oriented and gave candidates experiences with "getting more familiar with the resources by doing [sic] [using] them." Again, these findings complement the quantitative results.

However, the content was not a perfect match for all candidates. Because candidates in the standalone educational technology course represented a variety of grade-level and subject interests, some candidates felt that some class content was not relevant because teaching scenarios were mismatched to them. Because of this, "we don't put the whole effort into [the task at hand]." As one candidate put it, "The things that we do spend a lot of time on, are not necessarily used in the [field experience] classroom. Like, we are spending four weeks on a digital story, which is a good technology to learn, but I think that four weeks could be spent using Smart boards or practicing making more lessons using technology … learning how to integrate it with the little resources that we have." Secondary education candidates especially noted the class content was not always relevant. As one candidate put it, "I haven't quite figured out how to incorporate technology into even half the standards. I'm a chemistry major, so a lot of the standards are based on lab activities, so it would be hard to incorporate [much of what I learned in the class]."

This concern about content is consistent with the lack of change in the CK variable of TPACK, the only variable that did not change from pre- to post-test assessment on the TPQ. These candidates felt that even hypothetical situations presented to them during class meetings or mock experiences with a handful of real students would have been preferred to provide a safe first experience. One candidate pointed out that tools such as microscopes were not introduced in the standalone course but would be critical to his teaching of science. He pointed out that knowledge of the content his students need to learn is the most critical component of teaching with technology.

Benchmark 4: Teaching and TPACK. Because this benchmark was manifested in terms of integrating technology into instruction, it draws on aspects of benchmarks 1, 2, and 3. Thus, for example, candidates must be able to employ their technological knowledge (Benchmark 1) and apply class content and resources (Benchmark 3) to fully develop technology integration skills they can use in teaching with technology (Benchmark 4). Candidates felt moderately prepared to teach with technology for a variety of reasons, including lack of (a) understanding of how specific tools might address content, (b) time to "play" (either during class or at home), (c) time to troubleshoot, and (d) comfort with using technology with PK–12 students due to troubleshooting. Some felt they lacked the kind of technology skills necessary to lead a technology-driven lesson. On the other hand, they felt confident in their abilities to figure things out, given adequate time, use of tutorials, online support, online teaching resources and idea banks, etc. One candidate captured the essence of confidence that most candidates felt when he said, "While we may not have had the time to go through and learn how to use all the specific features…I'd be comfortable rolling [these tools] out with kids, assuming I had the time [to prepare]." Again, the increase in confidence exemplified in the qualitative data is consistent with the increase in confidence in using technology demonstrated in the quantitative data.

All candidates could (and most did) explain a technology-integrated unit or lesson that met the full TPACK framework. They were able to articulate the difference between teaching that involved technology and teaching that was reformed by technology to the point that the experience relied on it. One candidate gave a good example: "[Atlas and dictionary use] were once skills … that were a building block. But now we just go to the Internet and in 2 seconds we can have like 17 definitions. So, it helps us, and I think that's great. But we [as teachers] need to make sure we're not using technology in a less than positive way … not as a crutch. Where is our thinking going to be?" They were clear that the tools would continually evolve over time and that they would need to embrace this characteristic should they desire to help students maximize its use over the course of their careers.

Candidates indicated that two of the signature assignment projects in the course were instrumental in helping them learn how to integrate technology. The Mini-Teach project, in which candidates were given a technology tool they had not explored before, and were asked to lead a 20-minute PK–12 teaching experience to demonstrate the tool within the context of delivering a content-area lesson appropriate for school-aged students while using their classmates as "students," was a low-risk way to practice teaching with technology. This project appeared to be successful for candidates. One candidate recognized the power of practice when she suggested more of "practicing doing lessons … teaching each other … so that we have more hands-on practice" would be helpful for her future use of technology. The Technology Integrated Project Plan, in which candidates developed a project-based unit that integrated technology, helped candidates develop real materials that could be used in their future teaching.

Discussion

In the discussion that follows, we examine how the benchmarks can help us implement technology-integration curriculum at high levels in the new integrative-technology approach.

With respect to RQ1, "How and to what extent does the standalone course prepare candidates to integrate technology in teaching and learning?" we found the standalone course helped candidates increase their confidence for using technology and TPACK knowledge, and the effect sizes were large, with the exception of CK. With respect to the lack of significant results for CK, note that candidates had not yet taken their content methods courses and thus lacked a context for addressing this knowledge.

Benchmark 1: Technology skills. Candidates need sufficient experiences with many technologies to foster confidence in learning and using new technologies. This benchmark suggests that methods courses be infused with opportunities to learn about several different digital resources and tools so candidates can develop a broad content-based technology repertoire. The intent is for candidates to "learn how to learn technology" within the context of teaching circumstances by developing a deep knowledge of one tool, as well as to gain awareness and basic understanding of other content-specific technology tools. As they progress through methods courses, we want to help them develop their technology skills as well as their ability to seek new tools so they can select just the right tool for the content to engage their students and foster learning.

Acclimating students to the world of teaching with technology is becoming a more difficult task, given the wide range of generations from which our students come. This is unique, as students in PK–12 are assigned curriculum by age; once at the university level, age does not prescribe curriculum. For example, the majority of our students are Generation Z students, "digital natives" who were born post-1990. They have "spent their entire lives surrounded by and using computers, videogames, digital music players, video cams, cell phones, and all the other toys and tools of the digital age" (Prensky, 2001, p. 1). They rely heavily on technology in their everyday lives, and given the opportunity and the resources, would take it upon themselves to figure out how to leverage the power of technology for learning (Prensky, 2007). In the same class, we likely have some millennials (Generation Y) and Generation Xers. This scattering of students may or may not have had the same level of exposure to technology as our digital native candidates. This makes it more difficult to provide instruction for the wide range of technology skill sets as well as the attitudes and beliefs about how useful technology can be to teaching and learning. Further, these differences establish a challenge for curriculum development as well as for teaching. We do not have an answer yet to this dilemma, but as we move forward with the idea of creating a programmatic approach to developing candidates who are tech savvy and who teach with technology, we will be working to resolve this challenge through further innovation.

Benchmark 2: Technology access in the field. Candidates benefit from technology-rich field experiences (Bielefeldt, 2001; Moursund & Bielefeldt, 1999). In our setting, finding enough classrooms that meet this criterion has been a difficult task. Because our candidates participate in field experience every semester of their programs, we recommend more diligent placement in locations with adequate technology access, with a teacher who models technology integration. On the other hand, we recognize that dealing with roadblocks is an important skill for technology-using teachers, and we support candidates developing a realistic sense of how they might integrate technology into their instruction, no matter what type of access is in place.

It seems that our challenges to provide students with technology-rich field experiences—classrooms where access to technology is abundant and where mentor teachers are capable and interested in exploring technology integration with their mentees—pose a significant roadblock to our work in helping candidates learn how to teach with technology. These findings are consistent with the conclusions drawn by other researchers, who indicate that appropriate field experiences with technology continue to be a formidable problem (Nordin, Morrow, & Davis, 2012). Mentoring programs continue to be recommended as a way to provide support for the daily challenges that arise while using technology with PK–12 students (May, 2000; O'Dwyer, Russel, & Bebell, 2004), especially where tools that are new to the field of education are concerned (Oigara & Wallace, 2012). Of significance to us, the National Council for the Accreditation of Teacher Education (NCATE, 2008) calls for improvements in the way college courses and field experiences address how candidates learn to teach with technology.

In our programs, we continue to debate the role of the university in addressing the integration of technology within local education settings: Should we be addressing technology based on the realities, which include limited access to technology in many cases, or should we be promoting visionary use of technology and supporting our candidates to be teacher-leaders who seek to push the limits of the systems in which they work? We are still deliberating about the most appropriate and proper balance. Ultimately, we recognize that the position we take will need to be feasible and aligned with the realities of local field experience settings.

Benchmark 3: Orientation of class content and access to resources in university courses. Candidates need sufficient experiences with content-related uses of technology. Thus, infusing technology into methods courses provides an ideal environment to expose candidates to digital resources and tools that are aligned with grade levels and subject areas. Our candidates were clear that when content and tools are taught in tandem, they experienced how powerful technology can be for teaching and learning.

Teachers' identities, beliefs, and perceptions of efficacy generally become firmly rooted during preservice coursework and field experiences, and frequently resist change (Tschannen-Moran, Woolfolk Hoy, & Hoy, 1998). Thus, it is incumbent on those preparing future teachers to ensure the appropriate content and tools are readily available as these identities and perceptions about efficacy are being shaped. Moreover, teacher preparation programs that are directly and intentionally providing candidates with the most current technology practices and which embrace new technology innovations have greater potential to foster candidates' preparation for the use of technology (Boyd, Grossman, Lankford, Loeb, Wyckoff, et al., 2008). Nevertheless, ensuring that knowledgeable, content-focused faculty also embrace and remain current on the newest technologies and resources will be an ongoing need as technology-infused courses become the primary mode through which candidates learn to integrate technology into their instruction.

Benchmark 4: Teaching and TPACK. Our qualitative data revealed that candidates' confidence in teaching using the TPACK framework increased, largely based on their experiences teaching to their peers. Thus, we suggest candidates need similar teaching experiences in methods courses that fully exploit the TPACK framework, make them feel safe, promote taking large risks, and prioritize innovative uses of technology to address content.

These interpretations are consistent with studies of preservice teachers who are digital natives, which suggest these candidates (a) are everyday users of quick-to-learn new technologies, (b) are very adept with social networking tools, and (c) generally use technology for personal reasons (Lei, 2009). But, of significance to us, they "lack the knowledge, skills, and experiences to integrate technology into classrooms to help them teach and to help their students learn, even though they fully recognize the importance of doing so" (Lei, 2009, p. 92).

With respect to our ability to guide candidates to teach with technology, it seems that education as a whole can be viewed as an "early adopter" system (Rogers, 2002), at least in cases where we follow the lead of innovators. In other words, we are very good at adapting and sometimes adopting tools that were created for other reasons, professional or social (e.g., Edmodo is modeled after the familiar interface of Facebook but used to meet educational collaboration needs). Perhaps this adoption (or copy-cat) mindset is necessary, given the economic barriers of product development; but, as a result, we have not fully embraced our own creativity as educators. In fact, Mishra, one of the originators of TPACK, points out that bringing together pedagogy, content, and technology in an original manner to produce the kind of "learning that breaks disciplinary boundaries to cross-pollinate ideas, and thus help students become creative divergent thinkers" (Mishra & The Deep-Play Group, 2012, p. 16) may be the required big leap programs need to make to attain the next level of innovation.

Advancing TPACK to a Programmatic Level for Technology Integration

If TPACK is a developmental process, as Niess and colleagues suggest (Niess, 2011; Niess et al., 2009), then is the one-semester educational technology curriculum with a traditional stand-alone course adequate to foster teaching using technology integration? Should integrating technology be purposefully developed throughout the program with a scope and sequence that is woven across all learning events, including field experiences? In any event, it will be critical for instructors of methods courses to carefully coordinate this curriculum to teach to candidates' learning trajectories, based on the semester in which their course resides.

The mandated change from the standalone course to the programmatic approach to technology integration provides a one-time opportunity to make use of the successful lessons and practices obtained in our benchmarking work. Although we gained insights through this process, we also realize there are aspects of the technology-infused, programmatic approach that warrant thoughtful consideration as we move forward with this effort.

For example, this change in who teaches the technology-integration curriculum poses an additional problem, as the instructors teaching content methods courses are first and foremost experts in their content. That being said, they may or may not be experts in teaching (that content) with technology. With the dynamic nature of technology, this poses an interesting dilemma to the educational technology instructors about how to keep content courses updated with technology and how to promote the field of educational technology creatively and innovatively as we see it.

Another concern is related to field experiences and technology. Because context is an important part of the TPACK framework (Mishra & Koehler, 2006), the amount and type of available technology in field experiences matters. We realize access to technology is varied in the local settings, and so are expectations related to integrating technology. Because candidates will be experiencing curriculum that integrates technology beyond a single semester, they will be able to teach with technology in multiple school settings and with a variety of mentoring experiences. This will help them realize the possibilities, roadblocks, and facilitating aspects, including technology and personnel resources, that may be required. We expect that candidates will learn to acclimate quickly to site cultures without jeopardizing their vision and interest in teaching with technology. Additionally, we expect candidates will continue to develop their teacher-leader qualities by seeking new and innovative methods, given the available resources in the field, and that they will become advocates of change by promoting the integration of technology by their peers. Of course, this also means our field placement staff will be seeking to find more technology-rich sites for field experiences every semester, rather than just the semester required for the standalone course.

Conclusion

Although responding to change can be challenging, it affords wonderful opportunities to be innovative and creative, as well. That is the case with our situation, when we were asked to eliminate a standalone technology class and replace it with technology-infused courses in our teacher preparation programs. Naturally, our efforts are in the initial stages of the process, but we believe the benchmarking process will allow us to incorporate the best ideas, activities, and instructional processes from the standalone course into the to-be-developed technology-infused courses that will be included throughout candidates' preparation.

We anticipate that this phase of reporting on our innovative approach to addressing the development of preservice teachers' abilities to teach with technology will result in two very important contributions. First, we will share the benchmarks with program developers in our college so that they can make use of the nuggets of success currently in place in the standalone course. Second, we believe our findings will contribute understanding and insights to others who provide technology instruction to preservice candidates or to others who might follow our lead by reforming to a program-wide curriculum for educational technology.

Times are exciting as we anticipate the development and implementation of our vision of truly integrating technology into content. We plan to fully document the next steps, including the process of change as well as the summative results about how the TPACK framework assists instructors to meet the needs of preservice teachers to teach with technology using the integrated model. We shall see.

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