Title:

Evolution of preservice to inservice teachers' technology integration knowledge, beliefs, and practices: How schools can support beginning teachers' use of technology?

Abstract

Beginning teachers often experience barriers that prevent them from using technology. Teacher education programs should prepare beginning teachers to overcome these barriers so they can integrate technology into their classrooms. Some have suggested that additional coursework or field experiences can help beginning teachers integrate technology. We examined a group of 4 technology savvy teachers that completed extra educational technology coursework and field experiences during their teacher education programs. This study examined how the technology integration knowledge, self-efficacy beliefs, value beliefs, and intentions of technology savvy teachers evolved from their teacher education program to their first two years in the classroom. We conducted interviews and evaluated documents at three intervals: (1) after coursework completion, (2) after student teaching experiences, and (3) after two initial years of teaching. Results showed that school resources and environment have a strong impact on beginning teachers' practices, regardless of strong internal enabling factors.

Background

What prevents teachers from integrating technology?

Studies and stakeholders have reported the positive effects of using technology on student learning outcomes (e.g., Hixon & Buckenmeyer, 2009; CITE MORE RECENT), but teachers are still not using technology to achieve these positive effects (CITE). Why is this? Some have suggested that the major barriers teacher encounter, such as lack of resources,

time, lack of support, and teachers' knowledge, beliefs and self-efficacy about technology (Hechter & Vermette, 2013; Hew & Brush, 2007), can sometimes limit their ability to integrate technology into their classrooms.

Many scholars indicate that technology has not been implemented in the ways stakeholders envision technology's educational possibilities due to the barriers teachers face (Inan & Lowther, 2010; Kopcha, 2012; Wachira & Keengew, 2011). In a large review of 48 empirical focused on technology integration barriers between 1995 and 2006, Hew & Brush (2007) found that teachers encountered 6 major barriers to technology integration: resources, institution, subject culture, attitudes, knowledge and skills, and assessment. Studies conducted on technology integration barriers since 2006 continue to highlight similar issues. For example, Pittman and Gaines (2015) surveyed 75 elementary teachers and found that the strongest barriers to technology integration were resources (lack of available technology, lack of time). In a broader population quantitative descriptive study on 430 in-service teachers, Hechter and Vermette (2013) found out the major barriers that hinder teachers' technology integration: inadequate resources, limited access to resources, time, insufficient training opportunities, lack of money and support. All of these barriers are first-order or external barriers (Ertmer, 1999), meaning that they are outside of the teacher's control. Resources, support, time, training are all areas that are external to the teacher and can be provided by a district.

However, the more difficult elements to change are typically second-order or internal factors which are internal to the teacher (Ertmer, 1999). Ertmer and Ottenbreit-Leftwich (2010) underlined the importance of these internal factors. Knowledge, self-efficacy, and pedgagogical beliefs have commonly been cited as the reasons for teachers' reluctance to incorporate technology into their classroom (Ertmer & Ottenbreit-Leftwich, 2010). One

study (Howard, 2015) found that teachers were not able to integrate technology due to their lack of knowledge about how to use technology in their specific subject areas. Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, and Sendurur (2012) interviewed 12 teachers who had won awards for their technology use. Those teachers reported that the attitudes and beliefs of other teachers were perceived as the greatest barrier to student use of technology in their schools (Ertmer et al., 2012). Internal factors (e.g., knowledge, beliefs) can become barriers. If teachers do not have the knowledge or a positive attitude towards technology, their uses of technology in the classroom may be limited (Miranda & Russell, 2012). These studies suggest that external and internal barriers continue to exist and their existence will most likely continue to impede technology integration efforts.

However, internal factors may also have the potential to facilitate technology use (Ertmer et al., 2012). In Ertmer and colleagues' (2012) multiple case study of 12 teachers, the teachers revealed that although they faced external barriers (e.g., lack of resources, pressures of testing), they described being able to overcome those barriers due to their own internal attitudes and beliefs. Miranda and Russell (2012) found from their survey of 1,040 teachers, that two of the most important factors in increasing teachers' use of technology were teachers' beliefs: beliefs about the benefits of technology and perceived importance of technology for teaching. Inan and Lowther (2010) created a model based on a survey of 1382 public school teachers showing that teachers' knowledge, beliefs and self-efficacy (readiness to use technology) directly related to their technology integration practices. These studies suggest the importance of internal factors in teachers' technology use.

In fact, we might suggest that if teachers have positive internal factors related to technology (e.g., knowledge, beliefs, attitudes), they may be better prepared to overcome potential external barriers and implement technology in their classrooms. But how can we

support the development of these internal factors? Studies have shown that to impact internal factors, teachers need extensive professional development and support (Kopcha, 2012; O'Hara, Pritchard, Huang, & Pella, 2013). For example, O'Hara and colleagues (2013) observed and measured the technology integration practices of 16 4th and 5th grade teachers after they had completed a 56-hour professional development program. During this professional development, XXXX. The results suggested that teachers' technology knowledge and interest in technology integration, transferred to their practices successfully (O'Hara et al., 2013).

Beginning teachers' difficulties. However, for beginning teachers, this looks a little different. Many have often indicated that beginning teachers are digital natives and are naturally pre-disposed to have technology integration skills and abilities (e.g., Bate, 2010; Starkey, 2010). While Gao et al. (2011) expressed that beginning teachers may be more open to technology and are being recognized as the technology leaders within their buildings, there are varied reports of whether beginning teachers are successfully using technology (Slaouti & Barton, 2007; Tondeur et al., 2016). Many have suggested that even when beginning teachers have more interest or skills with technology, they are unable to use technology successfully due to barriers (Bate, 2010; Salouti & Barton, 2007; Starkey, 2010).

Several studies on beginning teachers' uses of technology have tried to explain their lack of use focused on the barriers that impede their uses of technology in their new classrooms (Slaouti & Barton, 2007; Starkey, 2010). For example, Starkey (2010) studied 6 digitally able beginning teachers as they identified the barriers and enablers to technology integration within their first year teaching. The teachers reported barriers and enablers in five different areas: access (availability & reliability of resources), support (policies, colleagues, staff support), beliefs, experiences, and school structure (e.g., timetabling). Depending on the

school's context, different areas were deemed as enabling or serving as a barrier to beginning teachers' technology use. For example, two beginning teachers reported that their school's access to internet sites served as a barrier to their technology use, while the others indicated that their school's access to internet sites helped them to use technology. The school context, policies, and support can have a huge impact on beginning teachers' ability to use technology. Starkey (2010) and Slaouti and Barton (2007) both argued three contextual considerations can support beginning teachers in their use of technology: (1) school policies that support technology use, (2) building a beginning teachers' self-efficacy and acknowledging their contributions, and (3) involvement in discussions about technology with experienced teachers in their subject area/grade level.

Therefore, how can teacher education programs prepare preservice teachers to become digitally able beginning teachers that can overcome barriers to use technology? Perhaps this comes down to facilitating the development of internal enabling factors of beginning teachers. In previous studies (Ertmer et al., 2006; Ertmer et al., 2012), experienced teachers have shown that due to strong beliefs about technology, they were able to overcome barriers. If beginning teachers develop these internal factors during their teacher education programs, can they overcome barriers in their first jobs and integrate technology?

Ed Tech preparation in teacher education programs. Beginning teachers typically have one required educational technology class included in their teacher preparation program (Gronseth et al., 2010). This may not be enough to build the internal factors (e.g., knowledge, beliefs, attitudes) of beginning teachers to enable them to overcome any external barriers (e.g., lack of resources, time, etc.) in their initial teaching years. Studies have shown that the level of inclusion of technology into teacher education programs can have an impact on beginning teachers' uses of technology (Tondeur, Roblin, van Braak, Voogt, & Prestridge,

2016). Tonduer and colleagues (2016) examined 6 beginning teachers uses of technology, and their self-reported experiences with technology during one of three different teacher education programs. Of the three teacher education programs, the beginning teachers that had graduated from the program with the most technology preparation were able to use technology more proficiently.

In addition, Tonduer and colleagues (2016) found that authentic experiences and internships during their teacher education program influenced beginning teachers' uses of technology. In other words, beginning teachers that received opportunities to integrate technology into actual classrooms reported feeling more prepared to use technology, used technology more frequently, and in more diverse ways. In another study, Alexander and Kjellstrom (2014) examined the influence of an optional technology-based internship on beginning elementary teachers' technology practices and decision-making. Those that completed the optional technology-based internship were more prepared for issues (e.g., time and classroom management) in their first year of teaching. This was likely due to the fact that the teachers were already exposed to those challenges associated with using technology in their internship. The teachers were able to reflect on these challenges and adapt their instruction. Alexander and Kjellstrom suggested that their technology decisions were "based on a more realistic view of technology…[and] they had outgrown their idealism with technology, which placed their focus more on logistics and pedagogy" (p. 281-282).

Ottenbreit-Leftwich and colleagues (2012) found that only 25% of teacher education programs required preservice teachers to use technology in their field experiences. Many have pointed out the importance of incorporating more technology into teacher education programs, especially through field experiences and relationships with mentor teachers (Alexander & Kjellstrom, 2014; Tonduer et al., 2016). However, as Strudler (1999) pointed

out, it is sometimes difficult to place preservice teachers in field experiences where mentor teachers are modeling technology use.

There are still many questions related to the development of beginning teachers and their technology use. If digitally-able beginning teachers are still struggling with technology integration due to barriers (Starkey, 2010), and field experiences are so critical, how do teachers internal factors change depending on their experience in the classroom with technology? And how can schools support beginning teachers in their use of technology?

We need to study the relationship between pre-service teachers' internal factors related to technology integration and how these factors are influenced by different points in their growth. Therefore, this study examined four technology savvy pre-service teachers that had completed additional coursework and field experiences with technology. We wanted to examine how their technology knowledge, self-efficacy beliefs, value beliefs, and intentions evolved or changed through their varied classroom experiences during their last stages of their teacher education programs and their induction years of teaching.

Method

We used a multiple case-study design to examine the interactions and developmental relationships between four preservice teachers' technology integration knowledge, value beliefs, self-efficacy beliefs, and intentions/practices (Stake, 2005). This study examined the evolution of those factors with 4 teachers in three phases between 2012 and 2015: (1) after the teachers had completed their teacher education coursework, (2) after the teachers' student teaching experiences, and (3) after their two initial years of teaching in their own classrooms.

Phases

For phase 1, all teachers completed the coursework required for a secondary teaching license (1 social studies, 2 math, and 1 English) and a computer educator license (CEL) including field experiences. To receive the CEL, they completed four additional educational technology courses varying from technology leadership to computer programming. With a CEL, teachers were certified to teach computer courses. Throughout the computer educator program, teachers were required to keep an e-portfolio. The e-portfolios were used to document and provide evidence of their knowledge of the National Educational Technology Standards for Teachers (ISTE, 2011).

For phase 2, all four had completed their student teaching (or full-time internship) for both their core subject areas (10 weeks) and computer education (6 weeks). These teachers were all searching for, or had received an offer for their first teaching jobs at the time of our phase 2 interviews.

For phase 3, all four had taught for approximately two years (2 interviews were conducted in late spring, while the other 2 were conducted in the summer). All four were employed fulltime in their core subject area, although all served as technology leaders in their building (either formally or informally).

Data Collection

In the first phase, data were collected via in-depth analyses of pre-service teachers' e-portfolios, followed by individual semi-structured interviews face-to-face. In the second and third phases, data were collected only from individual semi-structured interviews online. Each semi-structured interview lasted 50-80 minutes and were conducted in Fall 2012 (phase 1), Summer 2013 (phase 2), and Spring/Summer 2015 (phase 3). Interview questions asked preservice teachers to describe their educational technology knowledge (questions based on their e-portfolios), beliefs (questions on the value of using technology), self-efficacy (rating

their self-confidence), intentions (questions about their plans to use technology in the future), and their actual practices (in the second and third phases). They were also provided with scenarios that required them to explicate their beliefs and intentions. It was important to examine both their espoused beliefs (perception questions), as well as their enacted beliefs (scenario questions) to fully comprehend all their educational technology constructs (Fives & Buehl, 2012).

Role of the Researchers

This study was conducted by three researchers, all interested in the examining the internal factors that influence teachers' technology integration. All the researchers were instructors in the computer educator program but did not have any instructor relationship with the participants during the time of this research.

Participants

The participants were all secondary teachers (3 female, 1 male). Two were secondary math teachers (Kara, Kristy), 1 was a secondary social studies teacher (Sam) and 1 was a secondary English Language Arts teacher (Bridget). During their teacher education programs, they were all part of the same CEL cohort and progressed through the same courses with the same instructors. They were also employed as undergraduate lab assistants (ULA) in the required technology integration course. As ULAs, they were responsible for helping pre-service teachers complete in-class technology integration projects and conducted demonstrations for some of the technology tools.

Data Analysis

The projects in the eportfolios were used to develop ideas for interview protocol. Interviews were the main source of data and were analyzed using thematic analysis (Patton, 2005). After collecting all the data, the researcher first read all the transcripts individually to

become familiar with the data. In a meeting, an Excel sheet was created to document the themes related to knowledge, self-efficacy, value beliefs and intentions with evidences. In the next analysis step, all the researchers conducted analysis of one of the participants and record the themes in the Excel sheet. In a meeting, all those different themes were discussed until agreement was reached for the themes emerged from the first participant. Those themes were documented in a separate document with examples. For the other three participants, same process was followed and the theme list was updated with new themes emerged. Interview quotes were added to support these findings (Denzin & Lincoln, 2008).

Issues of Validity and Reliability

From the beginning, all the researchers contributed and provided their input in team meetings to establish the research purpose, research questions, and develop data collection protocols and analysis procedures. In terms of credibility, this study used analyst triangulation (Denzin & Lincoln, 2005) to review the findings using multiple researchers. The use of multiple researchers helped improve both the rigor and credibility since we reviewed each other's thematic analyses and challenged each other's viewpoints. For example, when a conflict rose, the discussions continued until the researchers reached a consensus on the themes emerged from the data regarding knowledge, value beliefs, self-efficacy and intentions of the teachers.

Results

This study sought to examine how knowledge, self-efficacy beliefs, value beliefs, and intentions interacted across four technology savvy pre-service teachers with regards to integrating technology into core subject areas in a K-12 environment. Each construct will be discussed separately.

Knowledge

All four preservice teachers described evidence of their technology knowledge increasing over the three phases, although their technology experiences impacted how much their knowledge increased. They described that their knowledge increased in classroom technology management and pedagogical applications of technology. This knowledge growth was attributed to self-exploration, mentors, and environment.

Classroom technology management. All preservice teachers described learning more about managing computers, iPads, and technology in general with each new phase. For example, in Bridget's 1st interview, before she started her student teaching, she described her fear of students being distracted by technology: "The distraction factor is the only thing that I'm leery of. I don't think students should have technology at their fingertips all the time because it's a distraction. I can't expect freshmen to have that self control. I am not comfortable with my students using it as a distraction tool like when I am in front of the class lecturing. Having it so readily accessible scares me."

During Bridget's student teaching, she described how her student teaching experience with 1:1 iPads changed her approach to classroom management: "I can tell you from my English student teaching that my classroom management on the iPads was rough. But I was coming in with someone else's rules who was very relaxed about it. They can be a distraction if the teacher lets them be a distraction. If teachers know how to handle it – 'ok, we're not on our iPads now, pads on the desk' - it can be controlled. But that rests on the teacher's shoulders of how they are going to manage it and they have to manage it from day one." Bridget's 3rd interview, after she had taught for two years, she described that she was able to be flexible with students, managing their iPad use on multiple projects at one time. She was even confident enough in her classroom management skills that she was a part-time coach for her building, helping other teachers integrate technology into their classrooms.

Pedagogical expansion of teacher toolkit (ways to use technology). With each new stage, all teachers described new ways to incorporate technology into their subject areas and classrooms. These were typically dependent on the resources they had available to them at the time.

Self-exploration contributed to knowledge development. All teachers described developing their own technology knowledge through self-exploration. In every interview, all the teachers mentioned that one of the ways they gained their knowledge of technology integration was exploring new information online (e.g., social networking sites, Google searches) by themselves. For example, Sam indicated that before his student teaching, his technology-related knowledge was mainly developed from the technology courses in the teacher education program, as well as his own exploration of technology resources. By his third interview, Sam described that he self-explored and obtained knowledge about ideas of using technology in Social Studies from his social networking communities: *"it's just me searching around. I do look at Pinterest. I have my teachers on Twitter that I use…I check Twitter a lot. Mostly I have a Twitter app on my Mac for school. I leave that open. When I have some time, I just pull up a chair and read a couple of tweets at a time."* Kara also described how her self-exploration evolved by her 3rd interview: "*Most of my own development has been just hearing about something and then self exploration. That is the pace I want to learn. Just learning my own thing. I got a brief training [on Class Flow] and then I went on my own and did my own thing until I felt like I got what I wanted from it."*

Mentors contribute to knowledge development. The teachers described learning from their mentors and their environments. In Bridget's student teaching experience, her mentor had a great impact on her use of technology: *"That woman was a genius. You hand her a lesson and she understands how to put the technology in. A lot of that came from her own research. What I really learned from her is I had to have an arsenal of tools ready. And about once a week, I scour for apps or*

I would look for websites because that's how you had to be able to do it. And teachers come up and say, I need a lesson on magnets, and she's like oh look, here's an app that I found this summer." In Kristy's 3rd interview, she mentioned the importance of her colleagues in her school mentoring her on effective technology integration: *"there's another teacher in the building, she's on it. She uses a lot of technology, so we talk sometimes… She uses Remind, so I started to use Remind. So mostly from my fellow teachers, that's my biggest resource."*

Environments contribute to knowledge. Depending on the experiences they had, the teachers described that their environments contributed to their knowledge. All the teachers mentioned that the extra technology courses helped them learn new tools and create a repository of knowledge. Kara stated that *"Definitely [the educational technology courses had an impact], that was probably most useful for me of just learning all the technologies. The large amount of technologies I learned in a short period of time because I can say with every technology that has been put in front of me I am comfortable with."*

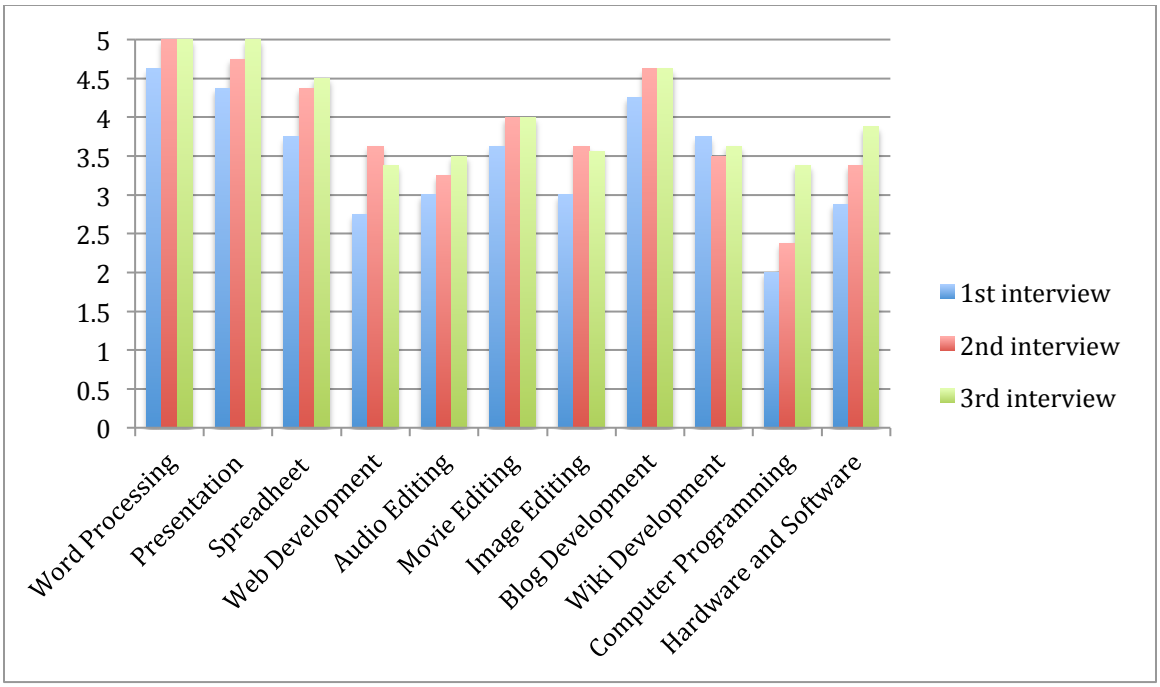
Three of the teachers were placed in technology-rich schools during their student teaching with 1:1 technology access. Although they all mentioned that this type of environment had challenges (such as classroom management with 1:1 access), it also provided opportunities to learn new tools and try out new ways of using technology. For instance, Kristy explained how her school environment allowed her to learn about a variety of new technologies: *"The school culture is all about technology. That was one thing that I loved about New Tech is the school culture was surrounded in technology. They put it a big emphasis on using technology and using it well - responsibly using it to its full potential as opposed to just it's technology and find something to do with it. That played a big role."*

Kara's first teaching job was in a 1:1 technology-rich school (she was the only teacher not in a 1:1 environment during student teaching). Kara described how this

environment changed the way she approached technology: *"[The school] became 1:1 this year. I definitely focus on technology based on what I have available. So like the change from the ThinkPads and now the iPads, and probably back to the Chromebooks, So just thinking how could I use these so that my kids can get the most out of it."* Kara followed up on the fact that her resources in her school also facilitated her knowledge of technology and how to use it effectively: *"I'm realizing now that I have to use technology, it's not even a choice. I have a Promethean board that is here [in the middle of my whiteboard space], so I don't have any choice but to use it because it's stuck right in the middle of my board. And then we have My Big Campus, that's what this school uses. And I have to post my homework and stuff on it - you have to use it."*

Knowledge conclusion. All four teachers seemed to gain classroom management knowledge and technology integration pedagogical knowledge from self-exploration, mentors, and their environment. These changed with each new phase, as they were exposed to new ideas, people, approaches, and resources. Their knowledge seemed to expand and become more mature, with greater options for flexibility. With regards to the pedagogical knowledge, their idealism or discrete application of technology was replaced with more flexible considerations when planning (Alexander & Kjellstrom, 2013). For example, Bridget idealized PBL in her first interview, but found that there were excellent uses for drill-and-practice technology applications. For classroom management, they similarly expanded their ideas of how to facilitate their students' technology use, typically providing more freedom and focusing on logistical support. For example, Sam encountered challenges with students' accessing files in his first interview, but by his third interview, he was enabling his students to use their cell phones, providing clear instructions before their use. It seemed that similar to Tondeur et al. (2016), the additional coursework and field experiences had an impact on these beginning teachers' knowledge with regards to technology integration.

Self-efficacy Beliefs



In general, all teachers' self-efficacy seemed to increase with exposure to other teachers, students, and classrooms. In all twelve interviews, all the teachers self-identified that they felt very well-prepared or well-prepared to teach with technology. In Bridget's 3rd interview, she indicated that she felt *"Well prepared [because] I don't think you can ever be very well prepared for teaching."*

All of the teachers expressed high self-efficacy in their abilities to adopt new technology tools. For example, in his first interview Sam described himself as an avid technology user in his personal life and technology came easy to him: "Even if I hadn't had the CEL I still would probably use a lot of technology just because it's who I am and how I live my life." In his third interview, Sam described how he quickly picks up technology and his confidence in his abilities to adopt new technology tools: *There was a science conference last week. They showed us Kahoot and I was like this is so easy, I can do this. Besides that, sometimes I see other teachers doing things that I pick up, mainly stuff that I've known already or random things that I find."*

In addition, Kristy described that based on her classroom experiences during student teaching, she felt more confident in her use of technology: "*I'm even more comfortable using technology to teach than I was before. I definitely feel more comfortable…I think I just understand ins and outs of school technology better, like the policies and kind of like the back end of it more. What was on in a school network, what was on all student accounts and how that works. More patience with technology problems that I didn't expect. So I'm learning to double plan what happen if this doesn't work, and this is my back up plan."* So even when things went wrong, she had learned coping mechanisms for dealing with technology problems and felt confident in her abilities to do so. This was further exhibited in her third interview: *"I'm very well-prepared to teach with technology. I feel confident using pretty much everything you put in front of me. I feel confident to use in terms of technological know how…in terms of… say you give me a specific technology…I can use it in my Math classroom."* She described that based on her two years of teaching experience, she feels more confident in using technology in her math classroom. *"I think I just feel a lot more confident in my teaching…after a year and a half of teaching."*

Reasons for changes in self-efficacy.

We looked at the changes in each teacher over their three interviews and self-efficacy rankings. When the teachers rated themselves *lower* on a successive interview, one reason they supplied was that it had been some time since they had used the software and would need to reacquaint themselves first. For example, Kara's student teaching took place on a Navaho reservation which had limited access to technology, while her first job was in a school with 1:1 laptops. In her third interview, she described how student teaching negatively impacted her self-efficacy, and how she gained it back once she started teaching in her own classroom with abundant resources: *"It [student teaching] had a reverse effect because while I was in Arizona, I didn't use technology and there was no motivation for me to use it cause it was not*

available. And now I have it all and I'm like OK. I can do it again." Brittany also described in her second interview that she had lower self-efficacy teaching web development software because she had not used it recently: "*I just haven't touched it. It's not something that I practice, so the longer I'm away from it, the more leery I am of it."*

Another reason teachers rated themselves *lower* on a successive interview, was because they had realized there was more technology out there (e.g., more software programs, greater capabilities of software) and they need to find out more before teaching or using that technology. For example, in Kristy's third interview, *"I kind of understand more of the vastness of Excel. I know another teacher who taught Excel, and there's just so much."* Sam shared a similar perspective in his third interview: *"I thought I knew everything [about Wikis]. There is so much to it you can add. They are so adaptable; I don't know why I would have rated myself as a five before. I used them in my field experience. I did a whole lesson using a Wiki."* The old adage seemed to apply - 'the more you know, the more you find out you don't know.'

More often than not, the teachers rated their self-efficacy higher in successive interviews. When they rated their self-efficacy *higher* in a successive interview, many indicated that this was due to their experiences teaching; it helped them feel more confident in using and teaching specific technologies. For example, in his first interview, Sam described how serving as an undergraduate lab assistant (ULA) for the technology class helped him develop his self-efficacy: "*I think I learned probably most from being a ULA. It definitely taught me how to teach with technology, just from troubleshooting the Google presentations to the little things like that.*" After having the opportunity to see technology within the K-12 context and witness the ups and downs of technology use with actual students, all teachers described higher self-efficacy in being able to replicate this in the future. For example, after Kristy's student teaching experience, she described herself as more confident to deal with technology programs: *"I am*

more comfortable using technology to teach than before. Definitely …I think I understand the ins and outs of school technology better, like the policies and the back end of it. What goes on in a school network, what goes on in having student accounts and how that works. I think I understand that more. I'm also more patient with technology problems that I didn't expect. So I'm learning to double plan - what happens if this doesn't work, and this is my back up plan." Kristy's self-efficacy increased even more after two years of teaching: *"I think I'm very well-prepared to teach with technology. I feel confident using pretty much everything you put in front of me. I feel confident to use. In terms of technological know how…in terms of…so say you give me a specific technology…okay, use this in your Math classroom."* Summarize.

Another reason why the teachers rated their self-efficacy *higher* on a successive interview was based on their interactions with other teachers; they realized they knew more about technology than most teachers. For example, after Kristy's student teaching, she described taking over the Microsoft Office lesson because she knew more about the technology than her mentor: *"I took more of a lead on doing new technology things. My mentor, she'd taught for a long time, had her ways already figured out. So I took more lead in there and did workshops with the kids. I think I probably understood the Microsoft Office a little better than she did especially for something like Access and Excel."* In Bridget's student teaching, she was paired up with a technology coach and helped train many of the teachers in her building on how to use technology. She described that this experience was empowering, and provided her with the self-efficacy to use it in her future classroom: *"I think I got a lot of confident in my student teaching and what I can use. And I can effectively plan lessons with it. But I think it's just about the confidence from student teaching that really made the difference for me."* Brittany further described this empowerment in her third interview after she had taken on an additional role as a technology integration specialist for her building: "*I took on another position this year, technology integration specialist for the*

building with another teacher. We were going to go out to HECC and all the technology integration conferences, which makes me more comfortable using it and I think using it more properly in the classroom."

Self-efficacy Summary

Overall, over a four-year research period, all the teachers had described themselves as very well- or well-prepared to teach their content areas with technology in classrooms. Since the completion of coursework in the CEL program, the teachers have established a certain level of self-efficacy, adopting and using technology tools in their student teaching and initial two years of teaching. When teachers were asked to rate their self-efficacy to teach with specific technology (see Figure XX), they seemed to rate their self-efficacy higher with each passing year. The teachers described this evolution in self-efficacy was due to their increased experiences with integrating technology (knowing what works and what does not work in different instructional situations). Moreover, being able to teach other teachers how to use technology or troubleshoot for them boosted their technology self-efficacy. Nevertheless, when the teachers described a decrease in their self-efficacy, it was typically due to limited access to technology resources or the fact that they now realized new facets of particular technology tools that they were previously unaware of. The findings entail the importance and influence of teaching contexts and experiences of teaching with technology on teachers' self-efficacy of technology use.

Self-efficacy Discussions

The four beginning teachers' self-efficacy of technology use has been found increasingly evolved over a four-year period, from their student teaching to second year of teaching. These four teachers were are nowadays considered as digital natives, who are immersed in and used to technology in their daily lives, have reported having fairly high confidence in teaching with technology since they were student teachers. Rikhye, Cook, and Berge (2009) stated that one of the characteristics of digital natives is t that hey pick up new technology quickly and start learning how to use it by experimenting it. Digital natives are "not afraid of making mistakes because they learn more quickly that way" (p. 8). However, there is lack of evidence from empirical studies showing direct relation that teachers with higher confidence for technology integration performs

It seemed that teachers' self-efficacy of technology use can be gained from the continuous immersion in technology-sufficient environment with abundant of experiences

of teaching with technology. Even though teachers' confidence might get lower when they faced negative teaching experiences with technology, their self-efficacy belief can gain back shortly after they tried more in classrooms and had positive experiences. It was discovered that the more experiences of using technology in classrooms, the stronger self-efficacy belief the teachers would have. The teachers' experiences and familiarity of technology, knowing ups and downs of technology and being able to solve problems in teaching practice, triggered the growth of teachers' self-efficacy beliefs. → "Teachers are more confident when they have experience using computers" (Willims, 2015-dissertation).

→ Teachers' confidence and attitudes towards technology use "can be determined by the training they have had, the time spent other than school use, and their openness to change."

In addition to teachers' teaching experiences with technology affect teachers' self-efficacy beliefs, the school culture, interaction and collaboration with other teachers in technology use can be an enabler of teachers' self-efficacy growth.

Value Beliefs

Although the teachers' value beliefs did not change dramatically, these beliefs evolved in their specificity and detail with each passing interview. The beliefs evolved due to real world limitations (e.g., culture, student capabilities, availability of resources) and provided more mature, contextual examples. For example, Kara (a secondary math teacher) mentioned throughout her interviews that technology can be used to make abstract concepts more concrete in math, focusing heavily on visualization techniques (graphing calculators, Geogebra). In her first interview, she described how a teacher could use Geometer Sketchpad to help explain mathematical proofs by exploring simulations: *"Technology helps for visualization and I think that is very important. I have realized that there is a lot of ways I did not realize how to visualize math like graphically, or geometric sketchpad, and graphic calculators. Geometer Sketchpad is very easy to use and there is the geometry aspect of it and you can open the grid view and have students find an intersect between two points, solely investigate a shape and why it is congruent if there's a line through it*

and you can find the measurements of the angles on it without computing it by hand but then they have to think of what if I move it around. Like the whole proof aspect of math."

By her third interview, Kara's beliefs still focused on the visualization, but she provided more specific examples of how it can be used to help students visualize complex math topics: "*For Math, [technology for] visualization is very important and they can see things in different ways. I have my algebra students download GeoGebra the first day on their laptops. They could check graphs with Geogebra. We did it a lot for checking and with visualizing, some of the more hard topics like system of equations. There are two graphs and the whole goal is to find where the two graphs intersect. They were struggling with one type of system, so I just said look at the graph. You can see the answer, you know what's going to visually be, but how do you solve it? And that helped them a lot. There's also, when solving things that is hard to conceptualize, where something has infinite solution or no solution, so we checked it with a graph to show what does that mean and that was very helpful, too."*

In addition, another theme that was common throughout all of Kara's three interviews was that technology should not take up too much time. She described that teaching students a new technology will not be worth while if it is just for one lesson – it needs to be something the students will use more often. If the students will not be using the technology often, she mentioned that it should be a teacher-led activity instead. For example, in her first interview, she described how technology could be used to reduce laborious tasks (like entering calculations over and over again): "*There are technologies that help make things more effective and pick up speed for class, like Excel where they still have to look at everything but they have the formula thing where they can pull things down, students doing remote calculations over and over, that is kind of taking time away."* In her second interview, she shared her student teaching example where students were asked to buy a graphing calculator and she only used it once in 5 months. She mentioned that this was not worth the cost (especially since so many families on the Navaho

reservation lack sufficient funds). By her third interview, she described how technology could save her and her students time and effort with greater detail. She stated that technology was able to save her valuable time in her first two years of teaching, by her making quizzes easier to grade, creating templates, and using other teachers' creations to save herself time as a teacher.

Summary of Value Beliefs

In Kara's case, her beliefs about technology's value remained consistent, although they became more specific and gained greater detail. This was similar for the other three teachers. In both Sam's and Bridget's first interviews, they described the value of technology to engage students and support PBL. By their third interviews, they were still describing the value of using technology to support this approach, but had expanded their ideas to incorporate more varied approaches such as feedback and engagement. In Sam's 3rd interview, he described his students' excitement in using Kahoot to provide a gaming feedback session on concepts. In Bridget's 3rd interview, she described the importance of using Moby Max to provide her students with low reading capabilities to practice and receive individualized feedback.

Intentions & Practices

In general, during the first interviews, the preservice teachers anticipated first-order barriers in their future teaching situations (i.e., lack of resources). However, they seemed to have strong knowledge, beliefs, and intentions that should have enabled them to overcome first-order barriers. For example, one of the scenarios asked pre-service teachers how they would handle filters in their future schools, blocking relevant videos. They were able to use their strong knowledge and beliefs to describe how they would overcome those barriers. In theory, their internal factors (knowledge, self-efficacy beliefs, and value beliefs) should have

been strong enough to overcome barriers and illustrated a strong intent to use technology in their future classrooms. However, practices were a different story. Their actual practices were much more guided by the availabilities of resources. In fact, two of the teachers described their first teaching job as lacking resources, while the other two described having enough resources. Those without enough perceived resources used less technology, while those with perceived access to resources described a wider variety of uses and implementations.

LACK OF RESOURCES

Both Kristy and Sam conducted their field experiences and student teaching experiences in technology-rich environments. In fact, they were both placed in a New Tech High School with 1:1 laptops, wireless internet, and other technology resources for their student teaching. However, for their first teaching jobs, their schools had severely limited resources and were considered low socio-economic status: Kristy (65% free/reduced lunches), Sam (77% free/reduced lunches). In both Kristy's and Sam's situations, the actual classroom barriers in their first teaching jobs seemed to be too much to overcome and were unable to implement technology as they originally intended.

In Kristy's 1st and 2nd interviews, she described using a wide range of technology resources (e.g., iPads, projector, Nearpod, graphing calculators, promethean board, presentation tools, etc.). She kept mentioning she wanted to do different things with technology for students' engagement and her own teaching efficiency. However, her first teaching job had significantly fewer resources. In her third interview, when she described how her students use technology, it was heavily focused on productivity uses:

"*I [use technology in] simple way like kids using a calculator on their phone. Sometimes I have kids take a picture of the Math problems. I don't have enough books, so I said "Ok, you'll get your phone out*

and take a picture of the problems you do, so you can do this at home." I would also have a paper copy available, if they don't have a phone. I haven't really come up with any good ways to use it. I know I could use things like PollEverywhere, using your phone as clickers, but I haven't had the time to figure out how to make that work and what do I do for students who don't have a phone? That's probably a third of my students. Beyond using them as a calculator in my Math class, I haven't come up with any good uses for it."

When she used technology, it was typically for teacher-centered activities or communication such as Remind to send text message reminders to students or the Promethean board to draw and provide notes. She indicated that her limited use of technology was due to the lack of resources and "*a lack of time to figure out what I can do and plan it out."* She described one instance in her third interview where she tried to implement the Khan Academy videos, but was limited due to resources and structure problems: "*Last year I tried using Khan Academy. I didn't get far because 1) Youtube was blocked, you couldn't watch videos at school, and 2) lots of students don't have home computers and Khan Academy's not great on mobile device."*

However, she did indicate that she still had strong intentions to use technology if resources became available. For example, during her student teaching, she described using technology ubiquitously on a daily basis in her second interview:

"[I used] technology in my math placement everyday. We used the program called Air Server. Cause all the teachers had iPads, so I used that to mirror my iPads to our projector. And we got a cart of iPads in my classroom. So we used online textbooks, and calculating apps, graphing apps, whiteboarding, and others… pretty much everyday. I would teach from my iPads instead of writing on the chalkboard. Just used like an whiteboarding app and mirror it onto the screen, so they could see." In her third interview, she described her intent to purchase her own tablet if her school got wireless internet due to her positive experiences during her student teaching field experience. Therefore, even with strong technology knowledge, value beliefs, and self-efficacy, Kristy was not able to fully

overcome the resource and time barriers during her first few years of teaching. Her intentions to technology use in her classroom still remains strong, although her practices were not representative.

Similar to Kristy, in Sam's 1st and 2nd interviews, he described using a wide range of technology resources in the local New Tech High including Learning Management Systems ECHO, blogs, 1:1 laptops, Google Docs, Google Sites, podcasts, iMovies, and a range of social media. His intentions to use technology from his first interview, aligned with the practices he implemented in his student teaching (as described in his 2nd interview). He kept describing how he used technology to engage his students in social studies: *"we had computers for every student. We used a PBL approach. We used our learning management system to post the daily agenda, links to readings, bell work set up. I tried get them to read a social studies article, start working on their projects, get back into where you were yesterday. I used Google Docs for everything. They did make some multimedia things. When I first started, they were finishing up making radio shows. And I made an activity on Google Sites."* Based on the description of technology used during his student teaching, his intentions and practices were able to align due to the infrastructure and resources. He focused on using technology to support PBL (project-based learning) lesson, integrating social studies readings and engaging projects with social media and collaboration.

However, during his first two years of teaching, his job was in a school with limited technology resources: "*I was limited by the resources. Now we have 30 Chromebooks, they work great, but we don't have Google accounts so it's difficult because we can't really use them. They took away our old Mac laptops. We had really old crappy Mac Laptops, but at least those had Word and Pages on it and we could still save to our flash drive. Now with the Chromebooks, they don't have an account, so I haven't had them do anything typed because they don't have access…it's too difficult to manage."* The limitation of resources impacted how he could use technology. In his first two years of teaching, his implementation of technology typically supported teacher-centered practices: *"Beside that, I mainly use instructional technology more than the students using it. I have acquired things…I now have an Apple TV. So that's really convenient. I can do things wirelessly. I project and play music wirelessly. I use my document camera all the time, basically everyday. The document camera is one of my favorites."* He tried investigating ways for his students to use technology, even having them use their cell phones, although this was against typical school policy. *"So today I let them pull out their phones. But our rule is that we really aren't allowed to have cell phone, ifit's for educational purposes and you can*

justify it, then it's fine." He had students use their cell phones to participate in a formative assessment game, Kahoot. This is a far stretch from his previous PBL activities that he implemented within his student teaching experience. However, he continued to state that when the Chromebooks were usable, he planned on returning to his previous PBL approach again.

Before his student teaching, Sam seemed to begin with high intentions of technology use such as using Google Form and ECHO in teaching practice. In New Tech, he used technology everyday because he had no lack of technology resources. However, in his second year teaching, he did not use much technology due to the lack of resources even though his intention of technology use remained strong. At the same time, he kept learning how to use different technology resources from other teachers and hope to integrate those ideas when he has available technology. In that situation, he had tried to use mobile device as the alternative of computer/laptops. This was his solution to the lack of computer/laptop at the school, which is the evidence of being able to do something in practice when a teacher has strong beliefs and intentions. He had tried to apply for different grants and get support with technology he can use in his classroom (e.g., Apple TV).

In his initial interview, before even student teaching, he was realistic about doing what he could with the resources he had available to him – and he recognized that his first job would probably not have abundant technology resources: *"My student teaching experience is very much technology-based. I have full use of whatever I want. I can teach however I want; I don't have to worry about not having enough technology. That's something that, I don't think I'll have the same luxury at other places. I hope that if I can get a job at a school that will have a one-to-one program, but I can't decide that. It's not necessarily my choice. So I can end up in a school that has one computer in my classroom for me, and a projector and that's it. I could end up there and have to deal with what I had, I'll hopefully be able to do something. With either a computer lab or something. But if I'm stuck in a room with a chalkboard and thirty desks then, that's what I have. I plan on using it however I can, with what I have. Use what I have to its fullest advantage. If I have a document camera, then I'm going to use it. And why not use what I have and can gets my hands on. If I can't, then I've got to adapt a little bit. I think my problem is adapting backwards, there are teachers right now who have to adapt forwards."*

It's not just resources. These two teachers mention struggles with school policies and structure (YouTube blocked, cell phones banned). Even if schools are unable to provide enough access to resources, they do have control over making technology easier to use. By creating policies and structures that support use of the resources already owned, they can help facilitate beginning teachers' use of technology. This was similar to Starkey's (2010) recommendation where providing beginning teachers (and really all teachers) with policies and structures that "encourage and allow access to digital technologies" (p. 1437), teachers

may be more likely to try to use technology. However, continually running into barriers takes up valuable time and can also damage teachers' self-efficacy/sense of agency (Starkey, 2010). Another recommendation may be to allow teachers to bypass certain policies or structures if they provide reasonable rationale. For instance, Sam was able to have one-time students use of their cell phones after describing the activity to his principal. Perhaps, after strong rationale is provided, that teacher can have a free pass to incorporate cell phones into his class.

ABUNDANT RESOURCES

Bridget and Kara had different student teaching experiences; Bridget was in a school with newly launched 1:1 iPads while Kara was placed in a Navaho reservation with one computer lab. However, for their first teaching jobs, they reported that their schools had more technology available to them. They taught in districts with higher socio-economic status than Kristy and Sam: Kara (40% free/reduced lunches), Bridget (50% free/reduced lunches). However, both mentioned that many of their students lacked access to technology at home. In both Kara's and Bridget's situations, their schools seemed to support their use of technology, with Kara's school culture heavily promoting technology.

Bridget. With Bridget, her variety of uses increased with each interview. In her first interview, she described the desire to make learning English literature accessible. Since she knew her student teaching school was launching a 1:1 iPad initiative, she had identified iPad apps for animation and production for the Romeo & Juliet unit she was assigned to teach. In addition, she described searching for apps to help with the process of writing. However, in her second interview, she stated that she was unable to implement it because did not realize she would be limited by the other English classes teaching Romeo and Juliet:

"*I was given a prescribed unit, the whole school has to follow the same unit for* Romeo and Juliet. *So I didn't have much creativity in the lessons. So I focused on integrating the new iPads as much as I could because it was just killing me to just do the checklist. I focused on figuring out how they could tweak their lessons and instead trying to get the iPads in. Instead of choosing to draw comics, we used Toondoo. Or they could make a video. Just little things like that."*

During her second interview, after her student teaching experiences, she described that she planned on using more technology in her own future classroom. At the time of the second interview, she had been offered her first teaching job. Although she knew the basic context of her school and the subjects she would be teaching, she was still unsure about what her access to certain resources would look like:

"*I'm fortunate that my department has more resources than others. We do have our own lab that can be used. We do have our own iPads cart that are older and slower, but you can still do everything on them. So coming from a place like [my student teaching placement], I don't feel like I'm lacking technology in my room. In fact, I might have a little bit more, because I do have Promethean and I do have the clickers. So it's going to be a little bit different, I'm not going to be able to get a lab at the drop of a hat, but there are ways to go around it."*

She uses it now in a variety of ways. Promethian Board. Response clickers for Bell Work (correcting grammar with 3 sentences of texting) and attendance (daily). MobyMax for individual tutorials & feedback and reporting. Every month have word processing or presentation (PPT, Prezi, movie, other media). Blogging in response to constructed responses or summaries of what they read (easy to grade). Still has goals to do more ("I try on a very small scale of what I actually want") – especially pushing more student-centered uses and approaches

Kara. As a secondary math teacher, in her first interview, she described intentions to use Geogebra,

Discussion and Conclusion Notes

Other studies have shown preservice teachers do not feel fully prepared to use technology in their classrooms (Smarkola, 2008, typically citing that they will use very loose ideas like using the Internet to help in their classroom, without the specificity of how they would use it. And furthermore, in Smarkola, only half of the preservice teachers reported being able to use technology in their field experiences. Even after student teaching, Smarkola found that their ideas were not refined and discussed the use of computers in a limited way, primarily focusing on Internet usage. With 88% using the internet to plan or teaching and 69% asked their students to use the Internet.

Furthermore, experienced teachers who don't see the value of integrating technology into their classrooms can negatively impact the use of instructional technologies by newer teachers (Abbott & Faris, 2000; Hazzan, 2003). For example, Hazzan examined novice high school mathematics teachers' attitudes toward integrating technology into their instruction. Results revealed how perceptions of a negative undercurrent from veteran teachers toward such practices discouraged novices from using technology in their lessons.

In previous studies, they've shown that experienced teachers could overcome the lack of resources and time (external barriers) due to internal factors. However, with beginning teachers, even with strong internal factors, they were not as easily able to overcome external barriers. This is most likely due to 'reality shock'. There are so many other things that beginning teachers have to adjust for. However, if 3-4 years go by before they are able to use technology in their classrooms, the technology that they were made aware of before may be outdated, or they need to learn an entirely new set of technology skills. Therefore, it's important to form a partnership with schools. Schools need to support these beginning teachers. Honestly, with resources, supportive school policies/structures, and collaborators, the 2 beginning teachers seemed to thrive.

CONCLUSION

These teachers were well-prepared to use technology in their classrooms. They received additional educational technology coursework and field experiences. Their self-efficacy, knowledge, beliefs, and intentions to use technology were fairly strong and established at the time of their graduation. However, even with all these strong enabling factors, the external barriers were sometimes too substantial to overcome and implement their intentions. These included school structures, policies, culture, and resources. For beginning teachers still experiencing reality shock, substantial external barriers may be too much to overcome in those first few years.

However, for the two teachers who were placed in an environment where technology was supported and encouraged, they thrived. They were able to accomplish not only their intentions, but go beyond these intentions and quickly expand their educational technology toolkit to incorporate a wide range of practices.

Therefore, if teacher education programs continue to provide these types of experiences to their preservice teachers, schools can support these beginning teachers by providing three elements: (1) adequate resources and structures, (2) supportive policies and teacher input into these policies, and (3) school culture supportive of experimenting and failing.

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