EVALUATING TWO COURSE SECTIONS FOR ENHANCING NOVICE ELEMENTARY PRESERVICE TEACHERS' TECHNOLOGICAL, PEDAGOGICAL, AND CONTENT KNOWLEDGE

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William R. Kjellstrom, B.A., M.Ed., Ed.M

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EXECUTIVE SUMMARY

Stephanie L. Moore

Advances in digital technologies affected both industry and society over the past two decades, often altering established institutions in unforeseen ways. However, technology's transformative impact failed to substantially alter teaching and learning in K-12 classrooms despite considerable financial investments and renewed attention on technology in teacher preparation programs. Research conducted by the U.S. Department of Education indicated that practicing teachers often felt underprepared to effectively integrate technology in their classroom practices even though most colleges of education required graduates to take an instructional technology course. Some researchers asserted that the lack of efficacy in instructional technology courses was a result of narrow learning objectives; courses regularly focused on learning how to use technological tools without considering the content and pedagogical knowledge necessary to engage students in meaningful learning.

As a way of exploring what constitutes effective course content and delivery for preservice teachers, this study used an explanatory, sequential mixed methods approach to examine two course sections offered to novice preservice teachers learning to integrate technology into elementary classrooms. The first section of the course followed a format that featured a traditional, technocentric curriculum (control). The second section (treatment) was designed to develop participants' technological, pedagogical, and content

knowledge (TPACK) through carefully chosen interventions that were grounded in emergent instructional approaches.

The quantitative analysis revealed statistically significant differences on three summative measures: The treatment section scored higher on both lesson plan evaluations and final exams, and this group expressed more positive feelings on end-of-semester course evaluations. Follow-up qualitative analysis indicated that the treatment section's greater emphasis on pedagogy, curricular interventions, in-depth classroom examples, and the instructor's discourse likely influenced observed differences. The findings supported the chosen curricular modifications in the treatment section, and they also highlighted potential alterations that might better prepare novice preservice teachers to integrate technology into elementary classroom learning experiences.

Curriculum, Instruction, and Special Education
Curry School of Education
University of Virginia
Charlottesville, Virginia

APPROVAL OF THE DISSERTATION

This dissertation, "Evaluating Two Course Sections for Enhancing Novice Elementary Preservice Teachers' Technological, Pedagogical, And Content Knowledge," has been approved by the Graduate Faculty of the Curry School of Education in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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Dr. Stephanie Moore, Advisor

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Dr. Peter Youngs

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Dr. Glen Bull

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Dr. Nancy Deutsch

_________________________________ Date

DEDICATION

I dedicate this dissertation to my loving family without whom I would not have completed this academic milestone. I am forever indebted to their steadfast support over the years, especially my mother who nursed me to health after months of sickness. I would not be alive today, much less finishing a dissertation, without her patience, care, and love.

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I owe Brad Jenks much of the credit for this study's completion. He let me observe his classroom, spent countless hours planning with me, and spoke at length about what happened in both sections of the course. I am forever indebted to him for everything that I put him through- both during the data collection phase and long afterwards. All I can say is… Thank you.

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DEFINITION OF TERMS

The following terms and definitions were used in the study's description and analysis:

Flipped Classroom. An instructional approach that involves completing in-class activities (e.g., lectures) outside of class, thus freeing up time to engage in active learning experiences during face-to-face meetings.

In-service Teacher. An individual who is a practicing teacher in a K-12 classroom.

Instructional Design. A multifaceted and systematic approach for creating learning experiences for all ages and types of individuals.

Intentional Teaching. An instructional approach that focuses on building learners' knowledge, providing instances for viewing effective teaching, engaging in actual or practice teaching, and encouraging reflective practices.

Microteaching. An activity during which individuals teach a lesson to their peers as if they were a teacher in a classroom.

Preservice Teacher. An individual with little or no formal teaching experience who is actively seeking licensure with the goal of becoming a practicing, in-service teacher in a K-12 setting; with regards to this study, all preservice teachers were undergraduate students pursuing their degree requirements in order to become an elementary K-12 teacher.

Screencast. A form of video that consists of recorded actions on a computer screen that is often accompanied by verbal narration or spoken instructions.

Technocentric. A term used to describe instructional technology courses that focus on tools without considering pedagogical approaches, learning theories, context, content knowledge, or real-world classrooms.

TPACK. An acronym that stands for technological, pedagogical, and content knowledge; TPACK describes what teachers need to know in order to effectively integrate technology into classroom experiences.

CHAPTER 1: INTRODUCTION

> *1990s: …Computers are infiltrating the schools. The importance of this has more to do with laying the groundwork for the future than with its current impact. (Kurzweil, 1990, p. 429).*
>
> *2010s: …[Today,] most K-12 students in age-graded schools, abundantly filled with laptops, desktop computers, and hand-held devices, still experience classroom lessons unfold in the familiar progression of tasks and activities (e.g. homework, textbook assignments, worksheets, whole group discussions, small group activities, tests, etc.). For the most part, teachers have tamed technological innovations seeking fundamental reforms in pedagogy to fit their classroom practice since the early twentieth century (Cuban, 2013, p. 112).*

Thought-leaders and prognosticators trumpeted the beneficial effects of digital technologies on teaching and learning beginning in the 1940s and continuing through succeeding decades (Saettler, 1990). Individuals like Vannevar Bush, Ted Nelson, Alan Kay, and Ray Kurzweil believed that far-reaching, emergent forms of technology would shift education's model of how and what people learn from a linear flow of knowledge to one that involved access to repositories filled with self-accessed, web-like information (Bush, 1945; Kurzweil, 1990; Nelson, 1965). Like a "silver bullet," supporters who followed this line of thinking asserted that the mere inclusion of new technologies and its inherent affordances would disrupt what was a stagnant, factory-based educational system without the overt acknowledgement of significant shifts in thinking about what it meant to teach and learn. With each new technological breakthrough, however, frontline purveyors of knowledge (e.g., teachers and educators) continued to implement new tools in a manner that fit within their personal conceptualization of education, and this often aligned with ways that they learned before developing technologies were available

(Cuban, 2013). Yet, groundbreaking ideas and inventions like the Memex, Xanadu, DynaBook, hypertext, and the World Wide Web forced some to reconsider the possibilities of scholarship in an age of physical and digital advances.

Early Innovations: Precursors for Technological Change

As the director of the Office of Scientific Research and Development, Vannevar Bush altered America's pre- and post-wartime efforts in the 1940s. In addition to ensuring that the country had enough penicillin and medical drugs, Bush proposed and supported the Manhattan Project, America's initial foray into atomic bombs that culminated in the bombing of Japan and the eventual end of World War II (Dizikes, 2011). Yet, Bush was known as much for his desire to push scientific advancement and research as he was for his political and military accomplishments.

More so than many of his contemporaries, Bush believed that the future of America's prosperity was directly impacted by increasing the accessibility to all of mankind's knowledge (Bush, 1945). He outlined his scientific thoughts in an article entitled *As We May Think* that was published in *The Atlantic* in 1945. His forward-thinking ideas, especially his futuristic Memex, influenced and shaped some of the most important inventions in the decades that followed (Hoffman & Novak, 1996).

The fictitious Memex was conceptualized as an artificial, yet imperfect, machine that would replicate the associations made by the brain. According to Bush (1945), "with one item in [the brain's] grasp, [the brain] snaps instantly to the next that is suggested by the association of thoughts, in accordance with some intricate web of trails carried by the cells of the brain" (p. 6). The Memex mimicked this process of selective association by indexing information like books, records, and communications through microfilm stored in a desk-like structure (Wiederhoid, 1992). In Bush's vision, users entered information into the Memex and then quickly recalled entire volumes of texts that could be read by manipulating levers. Similar to modern day computers, the idealized Memex concurrently displayed multiple sources in a process that was quicker than retrieving physical items in a library, file drawer, or bookshelf.

Although these features appeared interesting in the 1940s, Bush's description of linking items stored in the Memex was what captured the thoughts of future innovators. Explained as "making trails," two or more stored items in the Memex could be joined using a special code such that all items in a trail referenced one another. For example:

> The owner of the Memex, let us say, is interested in the origin and properties of the bow and arrow. Specifically, he is studying why the short Turkish bow was apparently superior to the English long bow in the skirmishes of the Crusades. He has dozens of possibly pertinent books and articles in his Memex. First, he runs through an encyclopedia, finds an interesting but sketchy article, [and] leaves it projected. Next, in a history, he finds another pertinent item, and ties the two together. Thus, he goes, building a trail of many items. When it becomes evident that the elastic properties of available materials had a great deal to do with the bow, he branches off on a side trail which takes him through textbooks on elasticity and tables of physical constants (Bush, 1945, p. 107).

Indexing stored content and creating linked trails was Bush's idea to advance science and increase society's access to vast repositories of knowledge.

Ted Nelson (1965) extended Bush's concept of associative trails by advocating for a mechanism that enabled individuals to creatively and flexibly organize file structures. His staunch belief in the validity and helpfulness of "zippered lists" was, at the time, nearly a financial and sociological impossibility; computers cost $37,000, and most people believed that the machines were only accessible by large corporations. However, Nelson understood that writers and researchers needed to have a simple, dynamically indexed database for cross-indexing knowledge structures (Nelson, 1965).

Called Evolutionary File Structure (ELF), he asserted that the economic costs and inaccessibility would not be problematic; only a lack of foresight would prevent hypertext and hyperfilm from becoming a reality. In 1967, Nelson named his visionary system Xanadu, a reference to a poem that describes “a magical place of literary memory and freedom, where nothing would be forgotten” (“Project Xanadu,” 2003). The benefits of such a medium would ultimately impact the research community and educators like Alan Kay.

At a Xerox lab in Palo Alto, Alan Kay (1972) verbalized an educational equivalent for the Memex that supported children’s knowledge construction in ways not captured by Nelson (1965). Kay envisioned an affordable physical device that offered creative exploration of learning concepts in a safe and curiosity-inspiring manner (Kay, 1972). He called it the DynaBook.

Alan Kay illustrated the educational possibilities of the DynaBook in a fictitious scenario involving two students, Jimmy and Beth. He imagined that all children, like Jimmy and Beth, would be able to access more information than was previously possible with text-based sources, and this would usher in new ways of thinking. According to Kay (1972):

> …Jimmy connected his DynaBook to his class’s LIBLINK and became heir to the thought and knowledge of ages past, all perusable through the screen of his [DynaBook]. It was like an endless voyage through a space that knew no bounds. As always, he had a little trouble remembering what his original purpose was. Each time he came to something interesting, he caused a copy to be sent into his DynaBook, so he could look at it later (p. 2).

The notion of a Xanadu-like system that used virtual and physical components that a child could manipulate introduced the instructional possibilities of linked trails and large databases to the education community (Press, 1992).

In 1987, Jeff Conklin, author of *Hypertext: An Introduction and Survey*, described a computer system wherein objects in a database were linked with nodes such that recalling a specified node would open all of the connected objects (Conklin, 1987). Drawing from Nelson and Bush's inspiration but replacing the Memex's microfilm with a digital database on a computer (Bush, 1945; Nelson, 1965), Conklin (1987) asserted that an idealized hypertext environment would enable a user to search all of the links in addition to being able to navigate "around the hyperdocument using a browser that displayed the network graphically" (p. 15).

A few years later, Tim Berners-Lee incorporated Conklin's notion of hypertext into a proposal for a system called the World Wide Web (Berners-Lee, Cailliau, Pellow, & Secret, 1993; Berners-Lee, Cailliau, Luotonen, Nielson, & Secret, 1994). Using Hypertext Markup Language (HTML) to create links to online information and objects, Berners-Lee described the World Wide Web as:

> …a way of viewing all of the online information available on the Internet as a seamless, browsable continuum. Using hypertext jumps and searches, the user navigates through an information world partly hand-authored, partly computer-generated from existing databases and information systems (Berners-Lee et al., 1993, p. I.1).

The outcome ultimately produced what today we refer to as the World Wide Web and its interconnected links that connect disparate and similar bodies of knowledge.

Although Vannevar Bush never proclaimed that his fictitious Memex would lead to the development of hypertext or the invention of the World Wide Web (WWW), other individuals used personal insights and knowledge about trends to make predictions about the future. At around the same time as Tim Berners-Lee explained the WWW initiative to conference attendees, futurist Ray Kurzweil predicted that technology's rate of change would impact society in specific ways throughout the 1990s and 2000s (Kurzweil, 1990).

Interestingly, Kurzweil was remarkably accurate in many of his targeted prognostications, often years before they occurred. However, his conclusion that emerging technologies would substantially alter education was far from precise when retrospectively analyzing what had transpired in teaching and learning (Bork, 2003; Cuban, 2013; Cuban, 2001).

Predicting the Impact of Technology on American Society

Digital technology's impact on different facets of American society was limited ten years before the new millennium. Personal computer use was low; approximately 15% of American families owned a computer and only 37% of adults reported that they used a computer at work (Kominski, 1991). Microsoft had not released Windows 3, the precursor to its highly successful line of operating systems, and the mainstream popularity of laptops was in its infancy (Spector, 2010). The idea of an "always on," portable phone was far-fetched; brick-like cellular phones were accouterments for wealthy people who had an extra hand to carry the heavy devices (Cassavoy, 2007; Sims, 1987). Yet, a year before Tim Berners-Lee posted the first webpage on a server in 1991 (Berners-Lee et al., 1993; Berners-Lee et al., 1994), one man made bold predictions about technology's future impact on American society: Ray Kurzweil.

Ray Kurzweil's capacity to predict technological trends arose from his experience as an inventor, entrepreneur, and industry insider (Kurzweil, 2012). Creator of numerous assistive technologies that included the first optical character recognition software and the first fully functional text-to-speech device, Kurzweil's early accomplishments were recognized by companies that included Xerox and, later in his life, Google (Garreau, 2005; Ungerleider, 2012). He founded companies that serviced the fields of education and music as well as a venture capital firm that focused on investing in adaptive technologies that used pattern recognition (Kurzweil, 2012). His involvement in a wide array of initiatives and organizations informed his belief in the exponential growth of technological change, the basis from which he made his predictions in the early 1990s.

Kurzweil (2001) asserted that most people erroneously believed that rate of change, whether considering technology or biology, was both linear and constant. In doing so, prognosticators often overestimated what was immediately possible and underestimated long-term potential returns (Kurzweil, 2001). Conversely, Kruzweil said that technological change increased exponentially with the rate of progress. As evidence, he cited Moore's Law of integrated circuit capacity as one of five paradigms that illustrated this law of accelerating returns (Kurzweil, 2001).

Moore's Law was an accurate and far-reaching discovery made by Gordon Moore in the 1965 publication of *Electronics* (Moore, 1965). As Director of Research and Development for Fairchild Semiconductors, a company credited with making the first computer chips, Gordon Moore made an as-yet unrecognized observation: The power of information technology and integrated circuitry would double every 18 months (Moore, 1965). Akin to the idea of compounding interest, people were skeptical of his claim because this type of exponential growth had never occurred in the natural world (Garreau, 2005). However, Moore noted that the growth of the railroad industry initially followed just such a growth pattern prior to the Civil War but finite resources including land, steel, and coal stymied the expansion of rail production (Garreau, 2005). Unlike railroads, circuitry power continued to double for decades; in 2002, a single computer chip contained one billion transistors- the 27th doubling (Garreau, 2005).

In his book *The Age of Intelligent Machines* (1990), Ray Kurzweil used the idea of exponential growth to make a number of predictions about future trends that would impact society. His forecast included the following suppositions:

- People would be able to flexibly access globally dispersed information without extensive technical knowledge because of interlinked computers.
- Personal computers would have the capacity to cull personal data as well as publicly accessible databases available through networks.
- Wireless telecommunications would enable people to share files without hardwired connections between personal computers.
- Cellular phones would become small and inexpensive. So much so that people would be able to carry them without undue inconvenience.
- Self-driving cars would emerge from advances in embedded computers and sensors (Kurzweil, 1990).

According to Kurzweil, "these concrete examples represent only a few of the ways that the computer and other advanced technologies will shape our future world… It is virtually certain (barring a world calamity) that all of these [examples] will take place" (Kurzweil, 1990, p. 404).

Prediction Fulfilled

The accuracy of Ray Kurzweil's predictions emerged over the two decades that followed. Tim Berners-Lee created the first web page and browser and, in doing so, made a blueprint for accessing and communicating information around the world. By 2011, approximately 82% of all American adults used the WWW or emailed occasionally, and more than 75% of adults between the ages of 18-49 had broadband

Internet access at home (Zickuhr & Madden, 2012). The emergence of Internet search engines like Google and Bing allowed people to seek and find publicly available information on the World Wide Web with little technical knowledge. Wireless networks that connected both local computers (WiFi) and pocket-sized phones (cellular data services) also appeared. Companies like Google even piloted self-driving cars in 2012 (Kelly, 2012).

Apart from Kurzweil's prognostications, technologies began to alter fields like politics in unanticipated ways. For example, Barack Obama leveraged web-based, social media tools like Facebook to generate unprecedented amounts of funds and grassroots support, thus placing less emphasis on traditional outreach efforts like voter lists, phone banks, and direct mail during the 2008 presidential election campaign (Carr, 2008). The precipitous rise in online participation continued during the 2012 election; of the 13% of adults who contributed funds, nearly 50% made a donation online or by email and 10% used a cell phone app to send funds (Smith & Duggan, 2012).

In industry, Pulitzer-prize winning author Thomas Friedman described how technology helped to "flatten the world" and enable businesses to outsource work to foreign countries at cheaper costs (Friedman, 2005). As a result, established companies closed warehouses and factories that employed hundreds of thousands of American workers. Barack Obama's 2012 State of the Union speeches referenced these practices, and he proposed taxing American companies as a mechanism for luring jobs back to the United States amidst a national recession (Obama, 2012). The globalization of businesses made possible by technology affected other countries as well. Often a source of cheap skilled labor, international companies based in China began relocating to countries like Vietnam and Malaysia because wages were even cheaper (Wolverson, 2012).

Similar to the shifting business model, freely accessible online news outlets and a rise in the number of mobile devices caused a sharp decline in print media circulation (Keeter, 2012). For example, Newsweek magazine ceased to produce physical editions in 2012 (Matsa, 2013). This cessation epitomized the $40 billion loss in ad revenue experienced by publication outlets that focused on newspaper and magazine circulation (Thompson, 2012). Mirroring lagging readership, the unstable future of print-based news coupled with limited growth opportunities and a fast-paced environment made being a newspaper reporter the worst job in 2013 according to CareerCast.com (Kensing, 2013).

While the impact of technology negatively impacted job opportunities in America and the media industry, technology produced numerous positive outcomes in science. Scientific breakthroughs enabled a monkey to control a robotic hand thousands of miles away through embedded probes in its skull (Nicolelis & Chapin, 2002), and researchers piloted wearable helmets that interpret the brain's electrical activity as a mechanism for controlling and flying unmanned drones (Kelly, 2013). Advances in science like these enabled an innovator like Dean Kamen to create a prosthetic arm to help a disabled war veteran pick up a bottle of water and scratch his nose using advances in robotics and neural control (Kamen, 2007).

Technological progress also shaped the direction of the music industry. In the late 1990s, Shawn Fanning's Napster enabled users to freely share copyrighted music in a digital form and, as a result, forced the recording industry to reconsider entrenched ideas about how consumers received and purchased music (Shirky, 2012). With Napster and other music sites offering free files, music companies sought ways to make money through legal, downloadable files as a means to supplement slumping CD sales. Identifying a need, Apple CEO Steve Jobs pitched a for-profit alternative in the form of iTunes that opened new revenue opportunities. However, consumers bought single songs instead of full-length albums through iTunes, a departure from the norm during the height of CD sales in 2003 (Covert, 2013). Although the RIAA found a stable model that continues to this day, music sales plummeted for ten years- from an estimated $11.8 billion industry in 2003 to nearly $7.1 billion in 2012 (Covert, 2013).

Technology not only altered established domains like politics, business, media, science, and music, but it also affected the daily lives of ordinary people. According to research published by the Pew Internet and American Life Project in 2012:

- 95% of Americans between the ages of 18 and 29 owned a cell phone;
- 51% owned a desktop computer; and
- 75% owned a laptop in 2012 (Zickuhr & Madden, 2012).

Although less dramatic, statistics for older individuals also reflected growing trends in technology ownership (Madden & Zickuhr, 2011; Zickuhr & Madden, 2012). American households even spent an average of $444 on products made by Apple, Inc. in 2011 (Taylor, 2012).

Yet, ownership and use reflected only one dimension of the sociological impact technology had on American society during the new millennium; technology also began altering the way that people felt and related to one another. For example, when college students were asked to go without media for 24 hours, many reported feelings similar to drug withdrawal and a number of students realized that they were addicted to technology

(Moeller, Powers, & Roberts, 2012). Strong psychological connections to technologies like smart phones were also evident in the results of a poll conducted by Harris Interactive. According to survey research conducted on over 1100 adult respondents:

- 72% reported that they kept their smart phone within a five-foot proximity the majority of the time;
- 9% admitted to using a smart phone during sex, 33% on a dinner date, 32% while at a child/school function, and 19% in a church or place of worship; and
- 12% of people in a relationship felt like their smart phone adversely affected their connection with a partner (Harris Interactive, 2013).

Ownership, deeply rooted psychological connections, and shifting norms showed that emergent technologies were affecting individuals in a similar way to what happened to business, music, and the publishing industry.

In most instances, the society- and industry-altering changes predicted by Ray Kurzweil occurred decades after the original publication of *The Age of Intelligent Machines,* the introduction of the WWW, and widespread use of computer-based digital technologies. According to Joel Garreau (2005), a ten or even 20-year time lag between the introduction of a new technology and its seen or unforeseen impact was reflected in historic examples. Models of technological upheaval like what was experienced in the 1950s with Sputnik, television, and mainframe computers resulted in a cultural revolution in the 1970s (Garreau, 2005). Similarly, the introduction of automobiles, refrigeration, radios, and telephones happened during the first decade of the 20^{th} century only to be followed shortly thereafter with the Great Depression and social unrest during the 1930s

(Garreau, 2005). Extrapolating from the trend, radical changes brought about by innovations in the 1990s would manifest in the 2000s much like what Kurzweil predicted.

In some respects, Ray Kurzweil was correct; individuals latched onto digital tools, and this created disruptions on a macro and micro scale. However, one facet of society reflected very few changes: education (Bork, 2003; Cuban, 2013; Cuban, 2001).

Technology and the American School System

Although Kurzweil's predictions were accurate in many ways, his prognostications for the field of education were less precise. Almost assuming computers were a "silver bullet," Kurzweil said that the learning process in schools would be transformed once "a critical mass [was] reached in the capabilities of personal computers, their availability to the student population, their portability, the sophistication of educational software, and their… [integration into wireless networks]" (Kurzweil, 1990, p. 429). Many of the cornerstones of Kurzweil's critical mass were reached in the past decade, but technology did not become the predicted transformative tool despite considerable financial investment (Cuban, 2001).

Funding Instructional Technology in American Schools

American K-12 schools spent tens of billions of dollars on technological infrastructure and tools during the previous decades. For example, total per pupil spending on technology doubled between 1970 and 1990, a trend that mirrored societal adoption of tools that included mobile devices, laptops, and social networking applications (Bannon, 2012; Johnson, Adams, & Cummins, 2012; Madden & Zickuhr, 2011). Conservative approximations of close to $70 billion were spent on technology during the 1990s; this figure accounted for nearly half of every dollar spent on educational supplies by schools (Oppenheimer, 2003). A 2011 report from the Boston Consulting Group indicated that technology expenditures reached $9.2 billion in 2010 (Bailey, Henry, McBride, & Puckett, 2011; Nagel, 2011). Although the percentage of money devoted to technology was much lower than the professional services and healthcare industries, the amount was nonetheless significant. Estimates from a 2010 national survey conducted by the Software and Information Industry Association placed annual expenditures on education software and digital resources at $7.76 billion alone (Richards & Stebbins, 2012).

Schools paid for technology by capitalizing on federal initiatives like E-Rate and the American Recovery and Reinvestment Act (ARRA). A component of the Telecommunications Act of 1996, E-Rate funding helped libraries and schools gain access to both hardware and technological infrastructure by steeply discounting purchasing costs (“E-rate,” 2013). The Federal Communications Commission (FCC) oversaw E-Rate’s list of eligible sources that included telecommunication services, Internet access, internal connections, and maintenance outlays (“Universal Service Administrative Company,” 2013). As the single largest source of Internet subsidy funds, schools and libraries accessed a capped amount of $2.25 billion each year with schools accounting for nearly 96-97% of monetary E-Rate disbursements (Chaudhuri & Flamm, 2013). Schools also used a portion of the $97.4 billion available through the ARRA to support technology initiatives during the 2009-2011 school years (Richards & Stebbins, 2012).

Technology and Teacher Training

Despite substantial monetary investments, access to emergent technologies was not responsible for the changes that Ray Kurzweil predicted for K-12 schools. According to Larry Cuban (2001), an emeritus professor from Stanford's Graduate School of Education:

> …[Every] student, like every worker, will eventually have a personal computer. But no fundamental change in teaching practice will occur. I can imagine a time, for example, when all students use portable computers the way they use notebooks today. The teacher would post math assignments from the text and appropriate links on her website, which students would access from home. Such access, however, will only marginally reshape the deeply anchored structures of the self-contained classroom, parental expectations of what teachers should be doing, time schedules, and teachers' disciplinary training that help account for the dominant teaching practices (p. 196).

Even with increased access to technology, entrenched ideas associated with the factory model of education dominated the last century (Collins & Halverson, 2009). The "error was not in citing the potential of technology to augment learning, the error was in underestimating the critical need for the changes required to use technologies effectively in learning" (Lemke, Coughlin, & Reifsneider, 2009, p. 5). To that end, the International Society for Technology in Education (ISTE) stated that one of the most important mechanisms for effective use of technology was teacher training (Kadel, 2008).

Both federal and state governments implemented a number of programs to increase the effectiveness of teachers' technology use in K-12 schools. Created in 1999, the Preparing Tomorrow's Teachers to Use Technology (PT3) program sought to address inadequacies in teachers' preparedness to use technology in the classroom. This comprehensive, professional development-focused initiative aimed to transform teaching and learning through faculty development, mentoring, video case studies, and course restructuring ("Preparing Tomorrow's Teachers," 2013). The program provided nearly $400 million to schools and educational consortia between 1999 and 2003. Similarly, the Enhancing Education Through Technology (EETT) State Program also provided funding for instructional technology and professional development. Authorized by Title II, Part D of the Elementary and Secondary Act, the primary goal of EETT was to improve student achievement through the use of technology. However, a secondary objective was to enhance teacher training with sustainable professional development ("Enhancing Education Through Technology, 2013). EETT appropriations totaled $270 million in 2009 but then dropped to $97 million in 2010 before defunding occurred.

Despite financial investments in infrastructure, training, and preparation, 2010 data from the U.S. Department of Education indicated that teachers continued to feel inadequately prepared to use technology in their classroom (Gray, Thomas, & Lewis, 2010). When asked to identify what training helped to promote effective uses of technology, teachers self-reported that independent learning (78%) was most responsible for their ability to integrate technology. Undergraduate (25%) and graduate (33%) teacher education programs reflected the smallest percentages among sampled teachers. The Bill and Melinda Gates Foundation also found that persistent barriers to technology use in the classroom were personal comfort levels and lack of training ("Innovation in Education," 2012).

The fact that schools of education offered courses in technology integration and graduates still felt underprepared prompted researchers to examine possible reasons. In a study that examined four-year teacher preparation programs in the United States, Gronseth et al (2010) found that 60% of education schools offered a standalone course on technology integration. Fewer programs (44%) required technology projects in methods courses, and only 25% incorporated fieldwork or classroom observations. The two most common course topics reported by faculty were personal productivity (78%) and information presentation (75%). Basic computer literacy was what most faculty members felt preservice teachers wanted in an instructional technology course (Gronseth et al., 2010). A comprehensive report from the U.S. Department of Education produced similar results; approximately 50% of higher education institutions with teacher education programs provided a standalone course on instructional technology (Kleiner, Thomas, & Lewis, 2007). Participating institutions reported that graduates possessed the skills to integrate technology (99 %) and the experience (89%) to do so. However, some contended that teacher training was heavily focused on learning how to use tools, a traditional approach with few successful examples from evidence-based research (Bork, 2003; Harris, 2005; Mishra & Koehler, 2006; Papert, 1987).

Issues with Integrating Technology in Classrooms

Educators asserted that a possible reason why formal learning opportunities failed to substantially affect teachers' capacity to effectively integrate technology was that courses and professional development experiences focused on technology devoid of the complex nature of teaching and learning (Harris, 2005; Harris, Mishra, & Koehler, 2009). Mishra and Koehler (2006) wrote that much of what transpired in early instructional technology courses, workshops, and professional development experiences was a form of "technocratic rationality- a view that technology [was] self-contained and [had] an independent integrity, and that to unlock its potential and power [required] merely learning certain basic skills" (p. 1031). This view focused on helping novices learn general tools across a variety of contexts without recognizing the contextual nature of integrating technology into instruction (Koehler & Mishra, 2005; Koehler & Mishra, 2008; Koehler, Mishra, & Yahya, 2007; Mishra & Koehler, 2006; Shulman, 1987; Shulman, 1986). Seymour Papert (1987) labeled this type of thinking “technocentric” because it overemphasized the tool to the detriment of fundamental questions related to child development and educational theories.

Technocentric thinking and technocratic rationality were thought to be problems of practice in teacher education programs (Kurzweil, 1990; Kurzweil, 2001; Mishra & Koehler, 2006; Papert, 1987; Zickuhr & Madden, 2012). Although understanding how to use technologies and feeling competent to do so were identified as important components for effective technology integration, a number of problematic trends existed (Mishra & Koehler, 2006). These included:

- the rapid change in technology;
- the design of software for businesses, not educational settings; and
- the growing realization that technology integration was not context neutral (Mishra & Koehler, 2006).

Re-conceptualizing how preservice teachers learned to integrate technology into classroom experiences became a focus for teacher education programs.

Operationalizing Effective Technology Integration

The degree to which technocentric thinking permeated higher education institutions and teacher education programs was due, in part, to the historic origins of the instructional technology field. Much of what was initially known about how technology improved teacher performance in K-12 schools arose out of media departments situated in colleges of education (Heinich, 1994). In the 1970s, the prominence with which tools like instructional television and computer-assisted instruction media framed this burgeoning field added a degree of technological specificity that de-emphasized the learning theories associated with their effective use (Seely & Richey, 1994). For many of the instructional technologists working in teacher education programs in its incipient stage, instructional technology was merely “providing stimulus materials and showing teachers how to use them” (Heinich, 1994, p. 62). This, in turn, limited the theory, research, and practice associated with the instructional technology field while reinforcing technocratic rationality.

The perceived limitation of confining instructional technology to tool instruction and “stimulus materials” prompted the Association for Educational Communications and Technology (AECT) to define the field as a theory-laden profession in its own right in the late 1970s. Instead of situating new technologies as objects to be shaped by knowledgeable teachers, AECT President Emeritus Robert Heinich and others asserted that technology could transform and alter traditional teacher practices (Heinich, 1994). Just like a textbook with an embedded pedagogical curriculum might affect a teacher’s instructional practices, well-designed technologies potentially impacted what and how students learned during classroom learning experiences. AECT’s 1977 definition of instructional technology sought to situate the domain as a “field, theory, and profession” (Seely & Richey, 1994, p. 20).

The AECT definition was revisited in 1994 to better align the guiding principles with modern techniques and theories (Seely & Richey, 1994). Building on the work of Robert Gagne’s effective learning conditions and Everett Rogers’ systemic approach to solving problems, the revisions resulted in a single statement: "Instructional technology is the theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning" (Seely & Richey, 1994, p. 1). The five domains- design, development, utilization, management, and evaluation- would become the framework from which the National Council for the Accreditation of Teacher Education (NCATE) based their standards for evaluating highly effective teacher education programs in media and instructional technology (Earle & Persichitte, 2005).

Alongside AECT's efforts to provide a theory-based articulation of instructional technology, educators at the University of Virginia were also exploring the context- and discipline-specific nature of technology in the sciences and humanities. Bill Wulf and colleagues Alan Batson, Ed Ayers, and Jerome McGann observed that computers and digital technologies were impacting entrenched domains in profound ways; "computers weren't just automating science as previously done – they were changing what could be done, [and] the questions that could be asked and answered with scientific rigor expanded enormously" (Bull, personal communication, May 31, 2013). Together they formed what would become known as the Institute for Advanced Technology in the Humanities (IATH) in 1992 to study how discipline-specific digital tools shaped and informed knowledge (Vaidhyanathan, 2012).

In the 1990s and 2000s, leaders from the National Technology Leadership Coalition (NTLC), a longstanding partnership between teacher education and technology associations, further affirmed the need to push beyond technocentric approaches to teacher education and consider how technology impacted teaching and learning in specific fields (Bell, 2001). According to Bell (2001):

> …[Although] some uses of technology transcend academic disciplines, other uses are more applicable in specific content areas. The widespread use of graphing calculators has transformed secondary mathematics education. Increasing access to primary on-line sources has similar potential to transform social studies and history. The use of simulation software enhances the learning of complex concepts in science education. Access to audiences for written works could potentially change aspects of English education. These uses are particularly suited for specific disciplines [just like] graphing calculators were designed to support mathematics education, not English education (p. 521).

Inherent within this articulated observation was the notion that the act of learning and how best to approach teaching was of utmost importance, and certain technologies better supported knowledge acquisition in particular disciplines (Lee & Hollebrands, 2008; Niess, 2005).

A byproduct of collaborations during an early meeting of this coalition of professional associations was the creation of Contemporary Issues in Technology and Teacher Education (CITE), a journal for individuals interested in best practices and research in the educational technology field. The journal's genesis reflected the leaders' belief that preparing teachers to effectively integrate technology required deep content, pedagogical, and technological knowledge, and this was only possible through jointly considering teacher educators in the core content areas and educational technologists.

The first issue of the CITE journal featured peer-reviewed articles from professionals in the domains of mathematics, social studies, science, and English. Mathematics educators asserted that technology needed to be introduced to preservice teachers in the context of learning mathematical principles or concepts that tightly aligned with pedagogies commonly associated with the field (Garofalo, Drier, Harper, Timmerman, & Shockey, 2000). In science, authors argued that children and adults often held misconceptions about scientific concepts, and carefully chosen technologies potentially illuminated crucial misunderstandings that could then be analyzed, addressed, and remediated (Flick & Bell, 2000). Technologies like digital libraries also created new opportunities to engage in historical inquiry that diverged from traditional didactic practices, and methods faculty needed to help preservice teachers enact what lessons with K-12 students might look like (Mason et al., 2000). Finally, English and language arts educators wrote that the research base that described the field's knowledge, principles, and pedagogies was the catalyst for any and all technology integration initiatives (Pope & Golub, 2000).

Conceptualizing the TPACK Framework

Using AECT and IATH's foundation, NTLC's direction, and the initial writings from the CITE journal, Koehler and Mishra (2005) proposed a conceptual framework for understanding effective technology integration in K-12 classrooms. The framework was initially called Technological Pedagogical Content Knowledge or TPCK (Koehler & Mishra, 2005; Koehler & Mishra, 2008; Koehler et al., 2007; Mishra & Koehler, 2006). This acronym was changed to Technological, Pedagogical, and Content Knowledge (TPACK) as a way to make the concept friendlier and less onerous for educators, students, and teachers (Thompson & Mishra, 2007).

Building on Lee Shulman's Pedagogical Content Knowledge framework (Shulman, 1987; Shulman, 1986), Koehler and Mishra (2005) defined TPACK as the intersection of three knowledge types that, when fully formed and applied to classroom learning experiences, comprised the necessary components to successfully teach with technology. The three knowledge types included technological knowledge, pedagogical knowledge, and content knowledge (see Figure B1). Although each kind of knowledge represented a unique set of understandings about teaching and learning, researchers asserted that effective technology integration was possible only through the combination and resulting transformation that occurred when merging all three (Archambault & Barnett, 2010).

The TPACK framework provided a general guide for what teachers needed to know in order to effectively integrate technology into classroom practices. Prior to its conceptualization, few models fully captured both the complex nature of teaching and how technologies enhanced learning. By articulating the complicated process of teaching and learning with technology, researchers indicated that technocentric approaches to teaching technology integration principles over-emphasized technological knowledge to the detriment of the other TPACK constructs (Harris, 2005). Some educators contended that the preponderance of technocentric thinking in teacher preparation programs was partly the cause of why technology failed to promote meaningful changes in education (Bork, 2003; Cuban, 2013; Cuban, 2001; Harris, 2005; Mishra & Koehler, 2006; Papert, 1987).

Problem Statement

From the creation of the WWW to the ubiquity of computers to the recent developments in mobile devices, technological innovations expanded exponentially during the 1990s and 2000s (Quittner, 1999; Zickuhr & Madden, 2012). In many respects, new tools altered the practices of entrenched industries like music and media in addition to individuals' daily interactions. Despite sociological changes and futurists' predictions, practitioners in American K-12 schools failed to fully embrace technology as a tool for promoting learning. Many teachers reported feeling underprepared to integrate technology into their classroom practices despite considerable spending on technology and professional development ("Innovation in education," 2012; Gray et al., 2010). Educators and researchers suggested that potential barriers included structural impediments within the educational system, time, comfort level, perceived competency, and lack of training ("Innovation in education," 2012). Organizations like ISTE advocated for renewed attention on instructional technology in teacher education programs as a potential remedy (Kadel, 2008).

Although schools of education incorporated technology into courses of study, technocentric approaches and the decontextualized nature of such practices failed to create meaningful change (Harris, 2005; Mishra & Koehler, 2006; Papert, 1987). In response, educators and researchers advocated for experiences that helped individuals develop their technological, pedagogical, and content knowledge (TPACK) in a way that more accurately represented the complex nature of teaching and learning. A number of published studies documented positive changes in preservice teachers' self-reported TPACK when this became a focus of instruction (An, Wilder, & Lim, 2011; Chai, Koh, & Tsai, 2010). Articles also reported positive gains in assessments that included design projects and field observations (Koehler et al., 2007). Additionally, thought-leaders in teacher education contended that preservice teacher training should focus on discipline-specific technologies that tightly aligned with the content and pedagogical knowledge associated with each subject area (Bell, 2001; Bull et al., 2000; Flick & Bell, 2000; Garofalo et al., 2000; Mason et al., 2000; Pope & Golub, 2000).

Despite increased support for TPACK-focused instructional technology courses, guidelines for how to achieve this goal were less defined. Some educators advocated for design-based experiences that featured project-based activities with real world outcomes (Angeli & Valanides, 2009; Koehler & Mishra, 2005; Koehler et al., 2007). Others demonstrated that segmenting courses into sections that focused on elements of TPACK provided optimal results (An et al., 2011; Chai et al., 2010; Hardy, 2010; Lee & Hollebrands, 2008; Özmantar, Akkoç, Bingölbali, Demir, & Ergene, 2010). With inconclusive evidence as to the course structure that best enhanced TPACK, some educators supported an instructional model called the "flipped classroom" as a way to create meaningful classroom learning experiences (Bull, Ferster, & Kjellstrom, 2012; Fulton, 2012b).

Flipping classroom instruction garnered increased attention in K-12 classrooms and higher education coursework during the past five years even though its educational lineage began at the turn of the 21st century (Baker, 2000; Lage, Platt, & Treglia, 2000; McCray, 2000). Also known as "flipping," the "inverted classroom," or a "flipped approach to instruction," educators who practiced this educational delivery model chose to shift didactic instruction from an in-class experience to an activity that occurred outside of class (Bergmann & Sams, 2012; Herreid & Schiller, 2013; Pierce & Fox, 2012). This often occurred through online videos that presented direct instruction through pre-recorded lectures (Foertsch, Moses, Strikwerda, & Litzkow, 2002; Lage et al., 2000), web-enhanced PowerPoint presentations (Gannod, Burge, & Helmick, 2008), screencasts (Bergmann & Sams, 2012; Bull et al., 2012), or other short demonstrations of taught content (Bergmann & Sams, 2012). By using videos to provide necessary information outside of class, freed time during class was often spent in active learning experiences that better capitalized on beneficial teacher-student interactions and peer feedback (Bergmann & Sams, 2012; Fulton, 2012a; Goodwin & Miller, 2013; Hamdan, McKnight, McKnight, & Arfstrom, 2013; Pink, 2010).

Flipped classroom proponents contended that shifting what was traditionally done in class optimized the opportunities to meaningfully engage students in face-to-face meetings that were more personalized, hands-on, and assistive (Bergmann & Sams, 2012; Fulton, 2012a; Goodwin & Miller, 2013; Hamdan et al., 2013). Results from published research indicated that students often preferred the flipped classroom to traditional lectures in higher education (Foertsch et al., 2002; Gannod et al., 2008; Lage et al., 2000). Other evidence suggested that students in a course with a flipped instructional approach learned more than a comparable course taught in a traditional manner (Pierce & Fox, 2012). However, many studies reported positive but not statistically significant comparisons on learning gains (Carlisle, 2010; Day & Foley, 2006; Johnson & Renner, 2012; McCray, 2000; Ruddick, 2012).

Although the flipped classroom approach received support within the educational technology community (Bergmann & Sams, 2012; Bull et al., 2012; Bull & Kjellstrom, 2013; Fulton, 2012b), no published research studies existed as to the efficacy of this model in instructional technology courses for preservice teachers. Likewise, little evidence supported intentional teaching, a promising framework grounded in widely accepted theories of learning (Hamre, Downer, Jamil, & Pianta, in press; Hamre et al., 2012; Kinzie et al., 2006).

Intentional teaching was first described as an outline for the types of activities that best promoted learning about the act of teaching (Hamre et al., in press). Proponents of the model asserted that learning experiences for teachers needed to increase *knowledge*, provide examples of *seeing* effective classroom practices, incorporate instances where novices engaged in the *doing* of teaching, and promote *reflection* (Hamre et al., in press). The researchers who advocated for the "Know-See-Do-Reflect" components of intentional teaching built their supposition on Lee Shulman's pedagogical content knowledge framework (Shulman, 1987; Shulman, 1986), literature supporting the value of video-based examples of actual classrooms (Cannings & Talley, 2002; Kale & Whitehouse, 2012; Kurz, Llama, & Savenye, 2004; Kurz & Batarelo, 2010), David Kolb's theory of experiential learning (Kolb, 1984), and what was known about reflection (Hatton & Smith, 1995).

The Study

The purpose of the study was to better understand the nature of teaching and learning in two sections of a course about effective technology integration in K-12 classrooms. The primary learning objective for both sections involved increasing elementary preservice teachers' capacity to effectively integrate technology using the TPACK framework. As a way of addressing participants' conceptual deficiencies, instructional design experts and educators made three alterations to one of the section's format and structure (treatment). The alterations reflected what was known about TPACK and subject-specific technologies (Bell, 2001; Bull et al., 2000; Flick & Bell, 2000; Garofalo et al., 2000; Mason et al., 2000; Pope & Golub, 2000), flipped approaches to classroom instruction (Bergmann & Sams, 2012; Herreid & Schiller, 2013; Pierce & Fox, 2012), and intentional teaching (Hamre et al., in press; Hamre et al., 2012; Kinzie et al., 2006). The other section used a more tradition, technocentric curriculum that focused on tools (control).

This study used an explanatory, sequential mixed method approach to examine differences between the treatment and control sections of the course. The research questions that guided the analysis included:

1. What differences exist between preservice teachers in the treatment and control sections on summative assessments (revised lesson plan outlines, final exam, course evaluation)?
2. How does the instructor's implementation of the curricula, his instructional practices, and the modes of assessment affect what learning opportunities are available in both sections of the course?
3. From the standpoint of the preservice teachers, what opportunities to learn do they experience in the treatment and control classes?

The results contributed to what was known and unknown about courses designed to help elementary preservice teachers integrate technology into learning experiences.

CHAPTER 2: REVIEW OF THE LITERATURE

The study explored how to enhance preservice teachers' content knowledge, pedagogical skills, and ability to integrate technology into learning experiences. It was grounded within theories of learning, curricular design principles, and use of emergent technological tools. Each construct provided a basis for the cumulative, synergistic input in the overall methodological framework and research strategy.

Pedagogical Content Knowledge (PCK) Framework

In an effort to find a more coherent way of explaining the teaching process, Lee Shulman (1986) postulated three distinct knowledge types needed by teachers to create meaningful learning experiences. The first was content knowledge (CK) which he defined as "the amount and organization of knowledge per se in the mind of the teacher" (Shulman, 1986, p. 9). Shulman explained that content knowledge was often specific to subject matter such that mere understanding of facts in a domain was insufficient; a teacher with content knowledge needed to know the structure of the domain, how ideas in the discipline related to one other, and the ways in which truths were verified or falsified. He also asserted that robust content knowledge included a teacher's ability to "explain why a particular proposition is deemed warranted, why it is worth knowing, and how it relates to other propositions, both within the discipline and without, both in theory and in practice" (Shulman, 1986, p. 9).

The second knowledge type was pedagogical content knowledge (PCK) (Shulman, 1986). Shulman emphasized that an effective teacher needed to be able to convey subject-specific content matter in a comprehensible and approachable manner. This included using worthwhile representations, analogies, illustrations, examples, explanations, and demonstrations. Shulman also stated that PCK comprised an understanding of what learners find difficult or easy, a grasp on students' background knowledge, and an ability to use research-based strategies to address commonly held misconceptions.

Finally, Shulman identified curricular knowledge as a necessary precursor to effective teaching (Shulman, 1986). According to Shulman (1986), teachers who possessed curricular knowledge knew about:

> …the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both indications and contradictions for the use of particular curriculum or program materials in particular circumstances (p. 10).

He asserted that the amount of curricular knowledge correlated with a teacher's ability to choose appropriate instructional interventions and assessments as well as a capacity to connect taught content to important issues or additional subject areas (i.e., lateral curriculum knowledge).

The triad of teaching knowledge types was expanded in an article for the *Harvard Educational Review* (Shulman, 1987). Shulman added that the informed teacher also possessed general pedagogical knowledge, knowledge of educational contexts on both a micro and macro community level, and knowledge of the purposes of education including the values, ends, and philosophical underpinnings that guide learning. The totality of all of the knowledge sources, including his earlier writing, became known as the pedagogical content knowledge framework for effective teaching (Shulman, 1987; Shulman, 1986).

Despite general acceptance, some researchers disagreed with the pedagogical content knowledge framework. Segall (2004) wrote that the idea of separate content and pedagogical knowledge structures reflected a fundamental flaw in the nature of teaching; content and the disciplines that each represented were inescapably linked to the "how" of teaching. Applying pedagogy to a content domain disregarded the pedagogical nature of content that "is already instructional and interesting" (Segall, 2004, p. 501). McEwan and Bull (1991) also rejected the idea of unique pedagogical content knowledge in teaching. Their contention, like that of Segall (2004), was that the core foundation of Shulman's framework rested on an objective epistemological worldview, thus making the distinction between content knowledge and pedagogical content knowledge untenable (McEwan & Bull, 1991). Their stance implied that all content was inherently pedagogic.

Technological, Pedagogical, and Content Knowledge (TPACK) Framework

Technological, pedagogical, and content knowledge (TPACK) was first defined as an outgrowth of Shulman's pedagogical content knowledge framework (Koehler & Mishra, 2005; Shulman, 1986). Koehler and Mishra (2005) explained that Shulman's original model of teacher knowledge sources could account for what is necessary for effective technology integration if a third dimension was added: technological knowledge. Thus, TPACK became a conceptual framework for describing the knowledge that teachers need in order to effectively integrate technology into classroom practices (Koehler & Mishra, 2005; Koehler & Mishra, 2008; Koehler et al., 2007).

As originally conceived, TPACK consisted of three primary, interrelated constructs: content knowledge, pedagogical knowledge, and technological knowledge (see Figure B1). In totality, TPACK was conceptualized as:

> …the connections and interactions between content knowledge (subject-matter that is to be taught), technological knowledge (computers, the Internet, digital video, etc.), pedagogical knowledge (practices, processes, strategies, procedures and methods of teaching and learning), and the transformation that occurs when combining these domains (Archambault & Barnett, 2010, p. 1657).

When thought of as three interlocking circles, the TPACK framework reflected additional constructs including pedagogical content knowledge (PCK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK).

As a way of clearly defining technological knowledge (TK), Koehler and Mishra (2008) described technologies as "the tools created by human knowledge of how to combine resources to produce desired products, to solve problems, fulfill needs, or satisfy wants" (Koehler & Mishra, 2008, p. 5). Included in their definition was a broad categorization that went beyond modern technologies like computers, mobile devices, and the Internet; tools also consisted of things like pencils, chalkboards, and books (Mishra & Koehler, 2006). They also argued that technological knowledge consisted of more than just an awareness of a tool and an understanding of how to use it. TK involved "[a requirement] that persons understand information technology broadly enough to apply it productively at work and in their everyday lives, to recognize when information technology can assist or impede the achievement of a goal, and to continually adapt to changes in information technology" (Koehler & Mishra, 2008, p. 15).

Pedagogical knowledge (PK) was expressed as the knowledge about ways to approach teaching such that all students learned (Koehler & Mishra, 2008; Koehler & Mishra, 2008; Koehler et al., 2007; Mishra & Koehler, 2006). PK also included:

> …knowledge that is involved in all issues of student learning, classroom management, lesson plan development and implementation, and student evaluation. It includes knowledge about techniques or methods to be used in the classroom; the nature of the target audience; and strategies for

> evaluating student understanding. A teacher with deep pedagogical knowledge understands how students construct knowledge, acquire skills, and develop habits of mind and positive dispositions toward learning. As such, pedagogical knowledge requires an understanding of cognitive, social, and developmental theories of learning and how they apply to students in their classroom (Mishra & Koehler, 2006, pp. 1026-1027).

PK was conceptualized as a generic form of knowledge that was both different and related to pedagogical content knowledge.

Mishra and Koehler (2006) described content knowledge (CK) and pedagogical content knowledge (PCK) in a manner similar to Shulman's original definition. Content knowledge consisted of an understanding of the subject matter being taught to students. CK encompassed "knowledge of concepts, theories, ideas, organization frameworks, knowledge of evidence and proof, as well as established practices and approaches towards developing such knowledge" (p. 13). The authors recognized that CK varied among disciplines and served as a gateway for transferring correct information or misconceptions. Similarly, PCK was defined as the knowledge of pedagogy associated with a particular discipline (Koehler & Mishra, 2005). This included an awareness of subject-specific misconceptions, an understanding of how to connect content in a coherent way, alternative teaching strategies, and the knowledge students typically possess when beginning a learning experience (Koehler & Mishra, 2008).

The final two constructs identified in the TPACK framework were technological content knowledge (TCK) and technological pedagogical knowledge (TPK). TCK was conceived as the reciprocal, intertwined relationship between a technology and a content domain (Koehler & Mishra, 2005; Koehler & Mishra, 2008). This included a teacher's understanding about the ways in which a particular technology might enhance learning in a specific subject as well as how an employed technology might be changed depending on contextual factors inherent within a discipline. TPK referred to "knowing the pedagogical affordances and constraints of a range of technological tools as they relate to disciplinary and developmentally appropriate pedagogical designs and strategies" (Koehler & Mishra, 2008, p. 16). TPK required a teacher to be aware of various tools' existence, capabilities, and constraints when applied to teaching and learning in a particular setting.

Even though Koehler and Mishra (2005) ascribed a name to TPACK, the intersection between technological, pedagogical, and content knowledge was a topic of prior research. Keating and Evans (2001) used an ethnographic approach to study the impact of comfort level with technology both inside and out of the classroom in terms of preservice teachers' PCK. These researchers suggested that one goal of teacher preparation programs should be the development of TPACK (Keating & Evans, 2001). Additional studies focused on case study explorations of the development of technological knowledge through mentor-mentee relationships and preservice teachers' notions of TPACK in mathematics and science teaching (Margerum-Leys & Marx, 2002; Niess, 2005).

Research Studies on TPACK

Since 2012, approximately thirty-six research studies explored strategies to support teachers' development of TPACK (Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2012). The studies ranged from conceptual development and teacher beliefs, explorations of preservice and in-service teachers' TPACK changes, and enhancing TPACK through instructional technology courses.

Due to the number of articles on TPACK development, this literature review focused on studies that emphasized developing preservice teachers' TPACK through instructional technology courses with efficacy evidence grounded in an articulated methodology (see Table A1 for a summary). A number of published pieces failed to meet these criteria despite promising initiatives like learning activity types, modeling, and inquiry.

The instructional technology courses in the identified studies targeted different populations. Some enrollees were graduate students who worked with faculty members on design-based projects (Koehler & Mishra, 2005; Koehler et al., 2007) while other studies included participants that were elementary or secondary preservice teachers (Wetzel, Foulger, & Williams, 2008). Most courses tailored content to specific groups; two studies detailed instructional interventions for elementary preservice teachers (An et al., 2011; Angeli & Valanides, 2009), three focused on future secondary mathematics teachers (Hardy, 2010; Lee & Hollebrands, 2008; Pierson, 2001), and one documented gains in TPACK with preservice science teachers (Jang & Chen, 2010).

The structure for TPACK-focused instructional technology courses varied across the published studies. The most common approach involved breaking up semester-long instructional sequences into smaller segments or workshops that featured different elements of TPACK. This frequently occurred through three to four week-long sections that introduced pedagogical approaches, necessary content knowledge, or technological tools (An et al., 2011; Chai et al., 2010; Hardy, 2010; Lee & Hollebrands, 2008; Özmantar et al., 2010). Also prevalent in the literature were courses that used longitudinal, design-based tasks (Angeli & Valanides, 2009; Koehler & Mishra, 2005;

Koehler et al., 2007). These studies featured real-world, collaborative projects that participants created throughout a semester spent developing TPACK. Finally, one published article used an action research methodology to better understand enrollees' TPACK by producing culminating application assignments (Wetzel et al., 2008).

An often-used mechanism for assessing TPACK development was self-reported measures that asked participants to state their perceived comfortableness with isolated constructs. For example, Chai, Koh, and Tsai (2010) examined changes in secondary preservice teachers' self-reported perceptions of TPACK within the context of a twelve-week instructional technology course. Enrolled preservice teachers initially met five times to learn general pedagogical approaches that included problem-based learning, project-based learning, and inquiry-based learning. After the initial course meetings, instructors organized the next six sessions on developing TK through examination of tools, affordances and limitations, and connections to pedagogical approaches. The preservice teachers created a final project using taught content within the context of a particular subject area. Preservice teachers' perceptions of TPACK were assessed before and after the course using a modified version of a validated TPACK instrument (Schmidt et al., 2009). Results indicated that the preservice teachers believed that their competency in incorporating TK, PK, CK, and TPACK increased as a result of the course and its design.

In another study, elementary preservice teachers enrolled in an online instructional technology course after completing a preliminary course designed to enhance TK and technological competencies (An et al., 2011). Researchers found that the participants' self-reported beliefs in TPACK competency increased upon completion.

The authors asserted that the two-stage approach to TPACK development- beginning with a course on TK and related skills followed by a holistic course dealing with all of the constructs- was an appropriate model for teacher education programs (An et al., 2011). Similar positive changes in preservice teachers' beliefs about TPACK competency were also reported in courses that featured design-based tasks (Koehler & Mishra, 2005).

Researchers also used performance-based assessments and general surveys to gather feedback about a TPACK-based, instructional technology course. During three consecutive semesters, Angeli and Valanides (2009) explored first- and second-year elementary preservice teachers' development of TPACK through weekly course meetings and laboratories. The weekly course meetings consisted of direct training in the instructional design process as well as explicit, content-specific examples of technologies and relevant learner-centered pedagogies. The participants also attended weekly laboratory sessions where the instructor created real teaching opportunities for the participants to apply their understanding of TPACK. Performance-based assessments consisted of two design tasks; one was administered at the midpoint of the semester and the other at the end. Both peers and the instructor assessed the first design task, but only the instructor assessed the final task. Finally, an end-of-semester course evaluation elicited participants' reactions about their personal growth as well as feedback on the course activities. The results indicated a statistically significant difference between the participants' scores on the first and second design tasks that showed improved growth over the course of the semester. Furthermore, course evaluation data showed that participants go through a four-step process when going through a design task: they must gather initial information, engage in real-world, authentic tasks, share and discuss with others, and then consult with experts about design decisions (Angeli & Valanides, 2009).

Improving TPACK in instructional technology courses. Experiences that involved microteaching or "practice teaching" resulted in improved TPACK. Jang and Chen (2010) studied 12 preservice teachers learning how to integrate technology into science classrooms. The delivery mechanism was an online learning management system that contained content, PowerPoint slides, and online references. In teams of four, participants first learned content knowledge through activities that culminated in a final discussion and assessment. During weeks four through eight, participants observed and reflected on two mentor teachers' delivery of a science lesson. The third and longest section of the course involved microteaching experiences where participants delivered short lessons to their peers for feedback and constructive criticism. The final two weeks of the course focused on participants' reflections on the microteaching experience in a peer-coaching format. Data collection consisted of artifact analysis, video recordings of microteaching, and interviews. The results indicated that observing a taught science lesson helped preservice teachers apply TPACK in constructive ways, and the microteaching experience made the abstract idea of technology integration more real and applicable. Similarly, researchers from Turkey found that microteaching experiences helped preservice teachers articulate disciplinary knowledge and use of multiple representations in mathematics (Özmantar et al., 2010).

Video-based teaching cases also helped participating students develop their TPACK. Lee and Hollebrands (2008) studied how a TPACK-infused mathematics unit impacted secondary preservice teachers' understanding of technology integration. Using an iterative, design-based research model, the researchers evaluated a five-week unit on data and analysis that featured the use of technologies as “reorgainizers” of knowledge. The instructional sequence also included videos and video-based teaching cases as tools for highlighting student reflection and pedagogical approaches. When compared to a more traditional approach, participants who received the experimental unit showed statistically significant gains in content and technology knowledge ($p < .10$) across pre- and post-assessments. However, measures of pedagogical understanding were not statistically significant.

Smaller, isolated projects were less likely to prepare students to use their TPACK to integrate technology into classroom practices. Using action research as a primary methodology, Wetzel, Foulger, and Williams (2008) explored preservice teachers’ self-reported reflections on TPACK after participating in a collaborative project called “The Wisdom of Our Elders.” In this project, preservice teachers were asked:

> …to be historians by chronicling the eyewitness accounts of their elders. Students collected and edited video, audio, and digital images to then produce digital stories of family members, friends, or other people they got to know through their research. To research the topic and write the interview questions, students learned to conduct searches using historical indexes with guidance from their technology instructor and the education liaison librarian… The pedagogical knowledge reflects the tenets of project-based learning as students conducted research on their topics, planned, storyboarded, videotaped, edited, and presented their projects (Wetzel et al., 2008, p.69).

Modeling TPACK through participation in a collaborative group project resulted in many preservice teachers (83%) stating that they would be able to enact the project in an actual classroom. However, nearly 30% of the participants felt like the project did not prepare them to teach a similar assignment in a future classroom. The researchers asserted that this finding was likely a result of not explicitly highlighting how the preservice teachers learned content, pedagogy, and technology skills. The subject-specific nature of the task was also a potential reason for lack of transference to other domains. Final recommendations included greater technology integration in methods courses where students are developing their CK and PK- a shortcoming with standalone instructional technology courses like the one in the study.

TPACK and instructional practice in K-12 classrooms. Few studies examined the connection between TPACK-focused instructional technology courses and changes in teachers' instructional practices in classrooms. Of what research existed, most of the participants were in-service teachers who had already completed a teacher preparation program. However, one study featured preservice teachers applying learned TPACK during their student teaching. Overall, findings indicated that carefully designed TPACK instruction resulted in formative changes in specific instructional practices like planning for instruction.

In one study, preservice teachers in a secondary science methods course received direct TPACK instruction as a framework for understanding technology integration within inquiry lessons (Maeng, Mulvey, Smetana, & Bell, 2013). This included critiquing examples of technology use during course meetings and learning about technology-enhanced inquiry instruction- an approach that combined general pedagogical understandings for teaching content with specific tools. After completing their coursework, participants applied what they learned during their student teaching placements. Interviews, observations, and artifact analyses revealed that the participants used a variety of technologies that supported inquiry instruction, applied TPACK concepts, and were better able to select appropriate tools for pedagogical purposes. The preservice teachers also took advantage of the content-specific affordances of included technologies to better address scientific topics.

Taiwanese researchers also explored changes in six elementary teachers' instructional practices after completing a teacher professional development program (Liu, 2013). After completing a TPACK-focused PD experience, all of the participants designed a lesson, uploaded it to an online repository for critique and feedback, and then implemented the lesson in a classroom. Focus groups, observations, and field notes revealed that the teachers' notions of effective technology integration shifted from teacher-centered preferences to more student-centered experiences as a result of the professional development program's emphasis on TPACK. Additionally, the authors suggested that helping teachers use technologies that promoted specific pedagogical approaches resulted in more dramatic shifts in their instructional practices.

When professional development experiences focused on developing TPACK around subject-specific activities, in-service teachers engaged in thoughtful planning prior to implementing lessons with students (Harris & Hofer, 2011). Researchers found that secondary social studies teachers who received guidance on how to integrate content-based activities prior to selecting a relevant technology were more strategic, incorporated more student-centered experiences, and demonstrated judicious application of tools. Using a case study analysis of seven experienced educators, the authors concluded that basing TPACK instruction around pre-selected activities would not "revolutionize" teachers' instruction but could "diversify" what students experienced and encourage more appropriate use of technologies.

Intentional Teaching Framework

The concept of intentional teaching arose out of research on best practices for early childhood education and, more specifically, positive teacher-student interactions (Hamre et al., in press). As originally conceived, the intentional teaching framework outlined the type of instruction that was necessary for preservice or in-service teachers to learn effective classroom practices. This included four core principles:

- *Theoretical Knowledge:* Teachers needed to possess a robust knowledge base consisting of developmentally appropriate strategies, pedagogical approaches that addressed learners' needs, and content mastery. Shulman's pedagogical content knowledge framework provided support for including activities that promoted knowledge construction during instruction (Shulman, 1987; Shulman, 1986).
- *Observation:* Teachers needed to not only know what effective teaching looked like, but they also needed to see it in practice and carefully analyze what aspects engendered success and beneficial learning outcomes for students. Theoretical support for *seeing* drew from literature about the positive effects of using video-based exemplars to enhance teachers' repertoire of strategies (Cannings & Talley, 2002; Kale & Whitehouse, 2012; Kurz et al., 2004; Kurz & Batarelo, 2010).
- *Practice:* Teachers needed opportunities to rehearse or enact effective teaching principles in order to become sufficiently adept at translating learned experiences into actual classrooms. David Kolb's theory of experiential learning was cited as evidence for the *doing* component of the intentional

teaching model (Kolb, 1984). Kolb (1984) defined experiential learning as a "process whereby knowledge is created through the transformation of experience" (p. 38). He emphasized the importance of activities like internships, field placements, role-playing, and simulations in the development of new knowledge.

- *Assimilation and Accommodation:* Teachers needed to iteratively engage in reflection about teaching practices and carefully consider how alternative approaches or changes might result in improved teaching (Hamre et al., in press). This involved the Piagetian process of assimilating new knowledge into existing schemas as well as altering knowledge structures to accommodate divergent realizations (Piaget & Cook, 1952). Theoretical support for including this principle built on research documenting the benefits of engaging in *reflection* in teacher preparation programs (Hatton & Smith, 1995).

According to the creators, an intentional teaching approach to teacher education was metaphorically similar to a motor; the four principles acted like gears that helped to symbolically indoctrinate instructors into new ways of thinking about teaching and learning (Hamre et al., in press).

Intentional teaching was defined as a system with distinct characteristics that helped all individuals learn how to effectively teach. These qualities included:

- beginning with any of the core principles when designing learning experiences for teachers;

- an understanding that a principle might prompt change in one individual whereas another person might require exposure to either different or multiple principles;
- recognition that the process of knowing, seeing, doing, and reflecting takes time to enact permanent change in teaching practices; and
- an awareness that each teacher brings unique qualities that impact what is learned or gleaned from instruction (Hamre et al., in press).

As a system, intentional teaching interventions that sought to change individuals' capacity to teach required careful consideration of all of the principles as well as each person's experience (see Table A2 for a summary).

Research Studies on Intentional Teaching

Hamre et al. (in press) identified the My Teaching Partner (MTP) project as evidence of an intentional teaching approach that embodied the core principles of knowing, seeing, doing, and reflecting (Kinzie et al., 2006). As an exemplar, MTP provided professional development for early childhood teachers of at-risk students through the use of online videos, supplementary materials, and consultation that focused on young children's phonological and written awareness skills (Kinzie et al., 2006). This occurred through a web-based library of videos that showed actual teachers implementing activities that supported key skills and understanding (seeing). Participants also accessed supplementary materials that included online explanations of techniques and strategies that appeared in the video-based activity scenarios (knowing). MTP consisted of more than just a repository for best practices; participating teachers also submitted videotaped lessons that early childhood experts analyzed for convergence or divergence with known topics and effective practices (doing). Using videoconferencing, email, and online journals, participants engaged in reflective dialogue with experts about areas of success and ways to improve instruction based on submitted videos (reflection). A randomized, controlled trial with approximately 240 teachers indicated that MTP participants who engaged in all four principles were more sensitive to student cues, better able to use a variety of formats to engage students, and more facile at language modeling (Pianta, Mashburn, Downer, Hamre, & Justice, 2008).

Additional evidence occurred during a semester-long course designed to improve early childhood teachers' interactions with children during language and literacy instruction (Hamre et al., 2012). Approximately 440 preschool teachers were randomly assigned to a treatment or control group. The treatment group participated in the course. The first eight meetings involved learning about the importance of positive teacher-student interactions, ways of encouraging emotional support, classroom organization, and mechanisms for enhancing instruction (know). Outside of class, participants in the treatment group read articles and analyzed videos that showed teachers demonstrating effective instructional techniques (see). During weeks nine through eleven, enrollees enacted sample activities in their respective classrooms (do). The final sessions consisted of watching the participants' videotaped recordings and reflectively analyzing what transpired in a whole group setting (reflect). The control group "received business as usual supports and were not exposed to any of the coursework provided [to the treatment group]" (p. 101). Results indicated that teachers in the treatment group demonstrated better knowledge about effective interactions, could easily identify good instruction in videotaped examples, and were more likely to stress the importance of language and literacy skills for young children (Hamre et al., 2012).

Video-Based Case Studies

Researchers defined an educational case study (i.e., case) as a lens or "slice of life" through which an outsider can observe the teaching and learning processes in a classroom or educational setting (Greenwood, Fillmer, & Parkay, 2002; Sudzina, 1999). More than a lesson plan with background description, cases were explained as "candid, dramatic, highly [approachable accounts] of teaching events… that gave life to abstract principles and propositions" (Shulman, 2002, p. xi). Yet, a vivid, realistic account was not the only characteristic of cases in education and teacher preparation. In order to maximize usefulness and applicability, authors asserted that an educational case must illustrate a principle, dilemma, problem, or practice that highlighted particular theories of learning or relevant aspects of teaching (Eggen & Kauchak, 1999; Greenwood et al., 2002; Shulman, Whittaker, & Lew, 2002). Researchers contended that these qualities helped to define three broad categories of cases in educational domains: ones that acted as exemplars, others that stimulated analytic viewpoints, and those that promoted personal reflection (Cannings & Talley, 2002).

Educators used cases for a variety of different instructional purposes. A common rationale involved providing classroom examples that illustrated the complexity of teaching. As models for study, cases grounded potential discussions about taught content or theoretical principles in a scenario that realistically showed teachers and students engaged in learning (Kurz, Batarelo, & Middleton, 2009; Sykes & Bird, 1992). When coupled with guidance and interpretation from facilitators or experts, cases often prompted thoughtful reflection on expert teachers' tacit knowledge of classroom situations (Nirula & Peskin, 2008).

Research Studies on Video-Based Case Studies

Video-based case studies featured video as a supplementary form of evidence that enhanced the reality and immersion of the presented case. Like written cases, video-based case studies placed more emphasis on a specific situation than on the exposition of theories (Sykes & Bird, 1992). Researchers also emphasized that video-based case studies were more than just a series of videos; successful cases often contained:

- segmented clips that consisted of short scenes lasting only a few minutes (Kale & Whitehouse, 2012);
- segmented clips presented in a sequential order (Kale & Whitehouse, 2012);
- background about the teacher and the students who appeared in the video (Kurz et al., 2004);
- scaffolding in the form of guiding questions that prompted the viewer to carefully examine specific aspects of what appeared in the video (Kurz & Batarelo, 2010);
- asynchronous or synchronous discussion tools (Cannings & Talley, 2002);
- feedback and analysis from experts (Kurz et al., 2009); and
- additional resources like student work or lesson plans (Cannings & Talley, 2002).

The degree to which a video-based case study aligned with the aforementioned characteristics partly determined how influential the case was on preservice teachers' reflective practices and learning (see Table A3 for a summary).

Video-based case studies often introduced additional affordances when used in teacher preparation programs. First, conventional instruction in education courses regularly involved authoritative sources (e.g., instructor or textbook) that served as the foundation from which individuals applied personal understandings to some activity or product. Conversely, video-based teaching cases served as mirrors that required individuals to reflect on the presence or absence of taught theories, pedagogical approaches, or content in a real-world classroom (Sherin & Van Es, 2005). Noticing alignment or misalignment between broad concepts of teaching and learning and a video segment was an active process that necessitated critical thinking skills (Yadav, 2008). Second, incorporating videos in case-based learning experiences also promoted repeated viewing which, in some instances, altered preservice teachers' notions of teaching and learning when coupled with reflection (Wang & Hartley, 2003). Finally, watching videos of classroom practice expanded preservice teachers' repertoire of pedagogical approaches and instructional techniques (Yadav, 2008).

In some instances, video-based case studies addressed needs within teacher education. Authors contended that preservice teachers often lacked a full understanding of the complexities inherent within the act of teaching (Hammerness et al., 2005). Their emergent knowledge of teaching and learning originated from experience as students in K-12 classrooms, personal beliefs, coursework, and fieldwork (Ertmer, 2005; Sykes & Bird, 1992). Consequently, preservice teachers were often deficient in their ability to apply research-based pedagogical approaches to real world situations (Hammerness et al., 2005; Shulman, 1986; Wang & Hartley, 2003). Video-based case studies provided instances for critical reflection and dialogue around actual classroom activities, especially learning experiences that incorporated technology.

The Flipped Classroom Approach to Instruction

Early studies conducted by numerous researchers articulated an instructional approach called “the flipped classroom” that altered entrenched classroom instruction processes (Baker, 2000; Lage et al., 2000; McCray, 2000). Also known as “flipping,” the “inverted classroom,” or a “flipped approach to instruction,” these scholars stated that a flipped classroom involved shifting traditional, didactic information delivery from a predominantly in-class experience to an activity that occurred outside of class, often in the form of watching videos that conveyed factual content (Bergmann & Sams, 2012; Herreid & Schiller, 2013; Pierce & Fox, 2012; Sams & Bergmann, 2013). By moving face-to-face lectures outside of the classroom, instructors who flipped their classrooms then freed additional time for hands-on activities like case studies, scenarios, lab experiments, problem-solving experiences, or discussions (Bergmann & Sams, 2012; Carlisle, 2010; Fulton, 2012a; Pink, 2010). Advocates of flipped classrooms contended that the instructional shift increased both the number and type of new learning opportunities that were possible within classrooms by capitalizing on the affordances of digital multimedia and its delivery potential. According to Sams and Bergman (2012), the importance of flipping was the redirection of attention from the teacher to the students when instruction was most opportune: together in the classroom. The flipped approach to instruction gained popularity in the past decade due to the innovative techniques pioneered by three people: Salman Kahn, Jonathan Bergman, and Aaron Sams (Bergmann & Sams, 2012; Pink, 2010; Sams & Bergmann, 2013; Thompson, 2011).

In 2004, Salman Kahn began creating short videos consisting of drawings with narrated instructions to help his 13-year-old cousin learn mathematical concepts that she struggled to understand. Because his cousin lived halfway across the country and she preferred videos because they were "less embarrassing than showing someone else her confusions," Kahn started posting his tutorials online (Thompson, 2011). The number of videos grew to a staggering 2,500 and what emerged was The Khan Academy. Now a non-profit institution with the backing of both the Bill and Melinda Gates foundation and Google, The Khan Academy became a repository for free instructional content that K-12 teachers borrowed when flipping classroom instruction (Thompson, 2011).

In 2007, two high school chemistry teachers in Colorado began experimenting with a flipped approach to instruction because so many of their students were missing classes due to extracurricular activities (Bergmann & Sams, 2012). The two teachers, Jonathan Bergman and Aaron Sams, provided a blueprint for what a flipped classroom might look like in a K-12 setting. With the help of companies like TechSmith, Bergman and Sams (2012) outlined how they approached the creation of the videos that their students watched at home as well as what transpired within the walls of the classroom. Their forthright depiction of the successes, failures, benefits, and drawbacks of flipping garnered followers from as far away as Washington, DC (Tucker, 2012). What emerged from Bergman, Sams, and Kahn's examples were a variety of formats for flipped instruction in K-12 classrooms and higher education courses.

The conceptual framework that grounded efforts to flip classroom instruction focused on active learning and how students increase their knowledge in a learning environment. An often-used definition of active learning in the literature base referred to it as:

> …any instructional method that engages students in the learning process. In short, active learning requires students to do meaningful learning activities and think about what they are doing. While this definition could include traditional activities such as homework, in practice, active learning refers to activities that are introduced into the classroom. The core elements of active learning are student activity and engagement in the learning process (Prince, 2004, p. 223).

This definition of active learning as conceptualized by modern researchers drew heavily on the work of John Dewey.

As early as the turn of the 20th century, Dewey wrote that a progressive educational environment was one that provided experiences that aroused curiosity and helped individuals during instances when an immediate outcome was unknown. Coupled with an interaction between learners, experiences, and the environment, he asserted that "intelligent activity" or engaging the students through mindful "doing" was the optimal precedent for learning (Dewey, 1938, p. 69). In this respect, simply introducing an activity into a classroom often failed to produce desired outcomes- what was needed was an activity coupled with a firm understanding of the key ideas to be learned through purposeful intentionality (George, 1996). Finally, Dewey emphasized that sole transmission of facts and discrete knowledge bases insufficiently prepared learners for higher order thinking and future endeavors (Dewey, 1938).

Extending Dewey's ideas, Bransford (2000) articulated that an effective classroom learning environment was one that was learner centered, assessment centered, and knowledge centered. Learner centeredness referred to "environments that pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting (Bransford, 2000, p. 133). His beliefs about classroom experiences also included the importance of providing both formative and summative assessments that gave feedback aligned to stated learning goals. Finally, knowledge centeredness was the need to help students increase their knowledge base in ways that aligned with best practices. Similar to Dewey's ideas and the previously stated definition of active learning, Bransford (2000) asserted that experiences should involve opportunities for students to explore, explain, extend and evaluate their understanding. He contended that existing curricula in history, mathematics, and science tended to overemphasize facts and memorization to the detriment of "doing." For example:

> …doing mathematics involves solving problems, abstracting, inventing, proving… Doing history involves the construction and evaluation of historical documents… Doing science includes such activities as testing theories through experimentation and observation (pp. 132-133).

Recent research built on the ideas of Dewey and Bransford, and the results indicated positive associated outcomes for active learning experiences.

Research Studies on Flipped Classrooms

The literature review uncovered approximately thirteen research studies that focused on outcomes associated with a flipped classroom approach to instruction (see Table A4 for a summary). Careful consideration was given to identifying examples of flipped approaches; instances when researchers examined either hybrid or blended learning approaches were evaluated to the extent that the methodology described "flipping" and not a reduction in seat time, face-to-face interaction, or any other form of compensation or comparison between learning modalities and media. For example, Frederickson et al. (2005) compared student learning outcomes and qualitative data sources from two sections of a statistics course for higher education students. One group received video-based lectures and the other received face-to-face lectures. Both sections, regardless of presentation mode, were required to meet at a regularly scheduled course meeting time; the only difference being that one watched videos and the other directly interacted with the professor to receive the lecture content that appeared in the video (Frederickson, Reed, & Clifford, 2005). Despite apparent academic rigor, examples like this were not considered instances of a flipped approach to instruction because students were required to come to class to either watch a video or receive a lecture in addition to meeting for laboratory experiences. Finally, only articles with an articulated research design that specifically detailed flipped instructional approaches and related outcomes were included despite a number of often-cited, peer-reviewed pieces extolling the virtues of flipping the classroom (Baker, 2000; Demetry, 2010; Dollar & Steif, 2009; Ladner, Beagle, Steele, & Steele, 2004; Papadapoulos & Roman, 2010; Water-Perez & Dong, 2012).

The identified research studies spanned a variety of publication types and subject areas with most focusing on courses in higher education. Since 2000, six research articles (Day & Foley, 2006; Foertsch et al., 2002; Lage et al., 2000; McCray, 2000; Pierce & Fox, 2012; Strayer, 2012), four conference proposals (Carlisle, 2010; Gannod et al., 2008; Toto & Nguyen, 2009; Zappe, Leicht, Messner, Litzinger, & Lee, 2009), and three dissertations (Johnson & Renner, 2012; Ruddick, 2012; Strayer, 2007) featured a flipped classroom approach with varying degrees of academic rigor. Interesting and noteworthy, almost all of the published pieces focused on some aspect of science, technology, engineering, or mathematics (STEM) in higher education; engineering was featured most often, followed by computer science, statistics, pharmacology, chemistry and business initiatives. The lone research study that presented results for K-12 students focused on a flipped instructional intervention for an elective course about Microsoft programs (Johnson & Renner, 2012). There were no published research articles that focused on preservice teacher education and flipped classroom approaches.

The most common tool used when flipping course content was some type of video recording. Whether it was a narrated PowerPoint (McCray, 2000), videotaped version of a live lecture (Day & Foley, 2006; Lage et al., 2000; Toto & Nguyen, 2009; Zappe et al., 2009), or a screencast (Gannod et al., 2008; Johnson & Renner, 2012), participants in nearly every study watched a recording outside of class prior to a face-to-face course meeting. There were two outliers that did not employ video as an instructional strategy in a flipped intervention; two research studies used an intelligent tutoring system called Assessment and Learning in Knowledge Spaces (ALEKS) in a higher education course on statistics (Strayer, 2007; Strayer, 2012). Instead of using videos to learn new content, ALEKS provided participants with successively more advanced statistical principles in the form of content descriptions and problems. ALEKS then assessed the participants' knowledge and either provided new content or remediation. Although the tool differed, the presentation of didactic information occurred outside of class. It should be noted that these published pieces, written by the same author, used a common data set and research design (Strayer, 2007; Strayer, 2012).

Although video recordings were often components of a flipped approach in published articles, the length of the videos varied across the studies. Day and Foley (2006) asked participants to watch 20-minute videos on computer science topics prior to coming to class. Similarly, researchers at Pennsylvania State University assessed students' perceptions of watching 20 to 30-minute video-based lectures in a flipped course on architectural engineering (Zappe et al., 2009). Survey results indicated that students preferred videos that were approximately 20 minutes in length, and most (92%) indicated that they watched the videos multiple times prior to the face-to-face meetings (Zappe et al., 2009). Toto and Nguyen (2009) also explored students' perceptions of a flipped instructional approach in an undergraduate engineering course. In lieu of flipping the entire course, the instructors analyzed the salient course concepts and chose specific weeks that were more conducive to video-based lectures. Survey results showed that the majority of students preferred video-based lectures that were no longer than 30 minutes (Toto & Nguyen, 2009). Finally, Ruddick (2012) examined differences in learning outcomes for 50 undergraduates in an introductory chemistry course taught in a traditional, lecture-style approach and two comparable courses that featured a flipped classroom method. Participants in the flipped course watched approximately 32 15-minute videos outside of class throughout the semester. The author concluded that any video used in a flipped classroom should be less than 20 minutes in length and that "in-class review of video material is necessary" (Ruddick, 2012, p. 28).

Assessing whether or not students watched new content from videos delivered in a flipped instructional format was also cited in the literature. For example, Foertsch et al. (2002) used online quizzes as a mechanism for measuring whether or not students viewed videos outside of class. Evaluations indicated that nearly 83% of the students would stop the videos to take notes, 89% would review a lecture during an initial viewing, and 67% would use the videos as review for traditional assessments. Toto and Nguyen (2009) also incorporated short quiz-like assessments as a way to see whether or not students viewed the videos outside of class. The authors commented that the quizzes were good organizers for what needed to be addressed during the in-class meetings. Finally, Ruddick (2012) articulated the strongest argument for the inclusion of quizzes saying that all flipped classrooms should take a video quiz to ensure that students are prepared for in-class activities.

Regardless of whether the studies incorporated quizzes or videos, almost all of the reported research featured classrooms that were entirely flipped. Students learned new information outside of class and then participated in a variety of activities during face-to-face meetings throughout the course of the learning experience. There were two exceptions. First, Johnson and Renner (2012) examined the effects of a flipped approach to helping high school students learn Microsoft products. Instead of flipping the entire course, the instructor employed a switching strategy during which portions of the curriculum were taught in a traditional manner and, at other times, students experienced a flipped instructional approach. Interesting and applicable, the high school teacher expressed frustration that established classroom norms made it difficult for the students to take ownership over their self-directed learning during periods when the curriculum was flipped. Instances of off-task behavior were higher when the classroom was flipped (Johnson & Renner, 2012). Second, Toto and Nguyen (2009) explored college-aged students' perceptions of a flipped instructional approach in an engineering course. Their study featured only two sessions during a fifteen-week semester that did not consist of a traditional lecture. The results showed a mixed response to flipped instruction. Participants preferred face-to-face lectures instead of the flipped classroom approach, but the additional freed time to engage in problem-solving activities helped students better understand course concepts. The authors also emphasized that careful planning and organization were critical to in-class activities during flipped course sessions (Toto & Nguyen, 2009).

Perhaps the most varied aspect of the flipped instructional approach was what occurred during face-to-face meetings when an instructor chose to move lecture-based content to an online format. Lage et al. (2000) reported that the instructor divided each in-class session into a short discussion period, a hands-on activity or lab that focused on the current topic, and a concluding small group session dedicated to open-ended review questions and worksheets. Due to the nature of the discipline and course (i.e., college-level class on business), McCray (2000) said that freed time during regularly scheduled meetings should focus on in-depth case studies or scenarios that require application of taught knowledge. Pierce (2012) also described a classroom that used case studies to help pharmacology students better understand the specified content. Whether in-class activities involved discussions or scenarios, nearly all of the identified studies highlighted some form of active learning (Day & Foley, 2006; Gannod et al., 2008; Zappe et al., 2009). Foertsch et al. (2002) advocated for collaborative problem solving with peers, and Carlisle (2010) used in-class time to answer questions, highlight examples, and provide the students with an opportunity to engage in hands-on lab work.

The stated purpose of the research and the type of data that was collected on flipped classrooms fell within two broad categories across all of the studies. A large majority of peer-reviewed articles examined students' perceptions of the flipped classroom approach (Carlisle, 2010; Foertsch et al., 2002; Gannod et al., 2008; Johnson & Renner, 2012; Lage et al., 2000; Pierce & Fox, 2012; Strayer, 2007; Strayer, 2012; Toto & Nguyen, 2009; Zappe et al., 2009). Learning outcomes were also cited as indicators of the effectiveness of the flipped classroom as an instructional approach (Carlisle, 2010; Day & Foley, 2006; Johnson & Renner, 2012; McCray, 2000; Pierce & Fox, 2012; Ruddick, 2012). Finally, one article focused on measureable viewing statistics from watched videos (Zappe et al., 2009).

Student perceptions. Overall, students' self-reported reflections on flipped instructional approaches were generally positive. In an economics course, Lage et al. (2000) found that students preferred the flipped classroom to traditional lectures, most of the students stated that they learned more in this format, and all of the activities contributed to their understanding of the content. There was also a significant difference between females and males when asked whether or not they preferred a flipped instructional approach; female students showed greater preference for flipping the classroom than their male counterparts. The researchers concluded that a flipped instructional approach might benefit underrepresented students like females in domains like economics that are traditionally dominated by males (Lage et al., 2000). Gannod et al. (2008) also found that students' self-reported feedback was positive when evaluating flipped approaches. Notable strengths for this instructional delivery included complete agreement (100%) with the helpfulness of the videos, strong agreement (93%) that students benefited from being able to search through the videos, and strong agreement (86%) that the flipped approach worked well. Finally, Foertsch et al. (2002) identified benefits of watching video-based lectures in an engineering course. According to the participants, the benefits of watching videos included an ability to self-pace one's learning, watch videos at a convenient time, and viewing lecture content at a time that was most conducive to learning.

There were also caveats to students' primarily positive perceptions. First, Foertsch et al. (2002) found a small subset of participants (36%) preferred live lectures because these face-to-face experiences enabled them to ask questions when they became confused, forced participants to take notes, and encouraged greater attention with minimal distractions. Additionally, Toto and Nguyen (2009) indicated that participants preferred face-to-face lectures instead of a video-based delivery, but the additional freed time to engage in problem-solving activities helped students better understand course concepts. In a course on architectural engineering, Zappe et al. (2009) discovered that there was almost total agreement that students felt like flipping the classroom was helpful but the vast majority also stated that they did not want every course meeting to occur in a flipped format. Interweaving traditional lectures with active learning exercises was the optimal course format.

Using a mixed methods approach, Strayer (2012) looked at students' perceptions of cooperation, innovation, and task orientation in both a flipped approach to classroom interaction and one that followed a traditional lecture-homework format. Unlike other studies, participants (N = 23) in the flipped classroom learned lecture content through an intelligent tutoring system called Assessment and Learning in Knowledge Spaces (ALEKS). ALEKS provided successively more advanced statistical principles once a student demonstrated mastery on previously learned concepts. For this group, in-class activities consisted of sample projects that required students to apply the principles learned in ALEKS in new ways. The traditional section (N = 26) listened to lectures and participated in question-and-answer sessions during class. They then completed a set of problems every two to three class periods. All of the students in both sections completed a survey at the end of the course designed to assess preferences and perceptions about the two types of instruction. On measures designed to assess the innovation and cooperation of the actual class, the results indicated that participants in the flipped classroom had statistically higher mean scores than those of the traditional section. According to Strayer (2012), the most significant outcome of the study was the realization that the connection between activities conducted outside of class must align with what occurred in-class. Quantitative and qualitative data sources indicated that indirect linkages between taught content in the ALEKS intelligent tutoring system and in-class activities caused a disjointed course structure that negatively affected students' attitudes. Conversely, the predictable nature of the lecture-homework section led to higher ratings on task orientation because these students knew what to expect during in-class and outside-of-class learning experiences (Strayer, 2012). This article reflected work done for the author's dissertation (Strayer, 2007).

Learning outcomes. While measures showed relatively positive student perceptions of flipping the classroom, learning outcome data from a number of studies indicated mixed results. All but one of the identified studies showed no learning outcome differences between a traditional, lecture-based course and one that received a flipped treatment (Carlisle, 2010; Day & Foley, 2006; Johnson & Renner, 2012; McCray, 2000; Ruddick, 2012). The single article that presented significant differences between control and treatment groups focused on an eight-week module for pharmacology students (Pierce & Fox, 2012).

McCray (2000) examined college-aged students' reflections on moving traditionally taught content to an online format in an introductory business course at

Wake Forest University. The research design for the study involved a treatment section consisting of 24 students and a control group of 26 students. The treatment group received lecture material through online audio- and video-based media. In-class time was spent participating in scenarios that replicated analysis of real-life issues. Conversely, the control group received all of the lecture content during class and worked on assignments outside of regular course meetings. Both the treatment and the control group completed three identical exams over the course of the semester. The results showed that students in the treatment group performed on par with the control group on the exams but that the freed time for the treatment group anecdotally led to a deeper understanding of the contextual nature of business problems (McCray, 2000).

Researchers at Georgia Tech studied differences between learning outcomes between a traditionally taught computer science course and one that featured a flipped instructional approach (Day & Foley, 2006). The research design featured a treatment group consisting of 28 students who watched 20-minute videos prior to each class meeting. The videos covered traditional, lecture-based content which enabled the instructor to focus on discussions and hands-on activities during in-class time. The control group consisted of eighteen students taught in a traditional lecture format during course meetings with additional project assignments given outside of the class. Both the treatment and the control groups received weekly homework questions in addition to a common midterm and final exam. Quantitative results comparing the two groups revealed that the treatment group statistically outperformed the control group on the homework assignments throughout the semester. In addition, mean scores on the midterm and final exam were greater for the treatment group but the results were not statistically significant.

Carlisle (2010) and her colleagues developed short YouTube videos based on lecture content in three sections of an introductory course on Java programming at the Air Force Academy. The three instructors asked students to watch the videos at home in lieu of spending in-class time on lectures. The instructors then used the freed time to answer questions, highlight examples, and provide the students with an opportunity to engage in hands-on lab work. The results indicated that the instructor who spent the least amount of in-class time lecturing on content covered in the videos taught students who scored the highest on the end-of-semester programming assessment. This group of students also reported more positive attitudes about the videos' capacity to convey necessary learned content. However, neither the assessment scores nor the attitudinal measures showed statistically significant differences between the three course sections. The author concluded that the lack of statistical significance was a result of a small sample size (Carlisle, 2010).

The lone study that examined high school students' perceptions and learning outcomes associated with traditional and flipped instructional approaches occurred in two elective courses that focused on Microsoft products (Johnson & Renner, 2012). The methodology included a treatment group of students ($N = 26$) that received direct instruction through screencast videos that were watched at home. This flipped classroom spent in-class time working on small projects with a partner. Conversely, the control group was directly taught by the teacher ($N = 26$), students worked on text-based tutorials during class, and they completed individual projects for homework. Student learning gains in the treatment and control were compared using a standardized assessment (IC3) at the end of specific modules. The results indicated that the difference between the treatment and control groups' scores on the final assessments was not statistically significant (Johnson & Renner, 2012).

Finally, Ruddick (2012) examined differences in learning outcomes between 50 undergraduates in an introductory chemistry course taught in a traditional, lecture-style approach and two comparable courses (N = 50) that featured a flipped classroom method. Participants in the flipped courses watched a number of 15-minute videos outside of class throughout the semester. Students then worked with a partner to complete assignments in class with the assistance of the instructor. Conversely, the traditionally taught section received in-class lectures and completed similar assignments for homework. All of the participants took similar quizzes, tests, and final exam. The results indicated that students' performance on the final exam was higher in the flipped course but comparisons with the traditionally taught sections were not statistically significant. However, student retention rates throughout the semester were significantly higher when the course featured a flipped classroom approach (Ruddick, 2012).

The research study with the strongest quantitative evidence supporting a flipped instructional model involved pharmacology students studying renal processes during an eight-week module (Pierce & Fox, 2012). Prior to beginning the module, the instructor administered a seventeen-question pre-assessment that emphasized desired learning outcomes. Instruction involved approximately four hours of videotaped lectures on dialysis therapy that participants viewed outside of class prior to course meetings. During class, enrolled students engaged in two real world cases that required them to apply learned content in a novel, multifaceted situation. The participants then took a post-assessment after completing the module. Pre- and post-assessment comparisons revealed statistically significant changes in participants' learning over the course of the module. The researcher also compared learning outcomes from the flipped instructional approach to a traditionally taught version of the identical module. Results indicated that participants in the flipped classroom module statistically outperformed the course that emphasized a lecture-oriented format.

CHAPTER 3: METHODOLOGY

In this study, elementary preservice teachers enrolled in one of two sections of a course about effectively integrating technology into K-12 classrooms and learning experiences. One section (treatment) was grounded in the TPACK framework and incorporated components of intentional teaching, video-based case studies, and a flipped approach to instruction (Hamre et al., in press; Koehler & Mishra, 2005; Koehler & Mishra, 2008; Koehler et al., 2007). The other section (control) followed a lecture-based, technocentric instructional model that focused on how to use a wide array of tools. The results of the study highlighted differences between the two sections on summative assessments as well as how the instructor's implementation impacted students' opportunities to learn about technology integration.

The research design included the following questions:

1. What differences exist between preservice teachers in the treatment and control sections on summative assessments (lesson plan outlines, final exam, course evaluation)?
2. How does the instructor's implementation of the curricula, his instructional practices, and the modes of assessment affect what learning opportunities are available in both sections of the course?
3. From the standpoint of the preservice teachers, what opportunities to learn do they experience in the treatment and control classes?

Research Design

The study used an explanatory, sequential mixed methods design to answer the study's three research questions (Creswell, 2009). The research design (see Figure B2) emphasized quantitative results from the first research question as a baseline to determine what, if any, differences existed between the two sections on summative assessments. Follow-up, qualitative analysis of field notes, interviews, and artifacts examined possible reasons for observed differences found in the quantitative results. The design built on the strengths and weaknesses of both quantitative and qualitative methods in an effort to better understand the constructs identified in the research questions (Creswell, 2008; Onwuegbuzie & Teddlie, 2003). With regard to the study, multiple data types allowed for more robust reflections on the complex structure of teaching, learning, and classroom environments (Ertmer, 2005; Koehler & Mishra, 2008).

The choice to use an explanatory, sequential mixed methods design was a reflection of the researcher's pragmatic paradigm that emphasized the value of both subjective and objective knowledge (Creswell, 2009; Teddlie & Tashakkori, 2003). Methodological decisions arose from what needed to be known and how best to uncover that information due to the contextual demands of the setting (Greene & Caracelli, 2003). The researcher's pragmatic paradigm aligned with the decision-making process outlined by Datta (1997):

> …[The] essential criteria for making design decisions are practical, contextually responsive, and consequential. "Practical" implies a basis in one's experience of what does and does not work. "Contextually responsive" involves understanding the demands, opportunities, and constraints of the situation in which the [inquiry] will take place. "Consequential" [means] ... that the truth of a statement consists of its practical consequences, particularly the statement's agreement with subsequent experience (p. 34).

Finally, this pragmatic worldview included both singular and multiple realities (ontology), a practical approach to data collection using objective and subjective processes based on how best to answer the research questions (epistemology), and the combination both quantitative and qualitative data (methodology) (Creswell & Clark, 2007; Guba & Lincoln, 1994).

Site Selection and Description

The study examined two sections of an undergraduate course on technology integration for elementary preservice teachers at an institution of higher education in a mid-Atlantic state. The site selection reflected convenient sampling procedures, and it was chosen for three primary reasons. First, the institution was geographically accessible and offered stand-alone courses on instructional technology for preservice teachers. Second, faculty members who oversaw the courses' instructional delivery agreed to vary both the teaching and requirements for the two different sections. Finally, two concurrent sections of the instructional technology course were offered to elementary preservice during the proposed research timeframe.

The selected institution offered an accredited, nationally ranked course of study in educational fields that ranged from elementary and secondary licensure programs to educational leadership. At the time of the study, the institution's teacher education program issued degrees in early childhood special education, elementary education, special education, health and physical education, and foreign language education. The instructional technology course in the proposed study was a requirement for all elementary preservice teachers enrolled in the teacher education program.

The course, Integrating Technology into Classroom Practices (ITCP),[1] was a two-credit, 15-week sequence of learning experiences designed to help elementary preservice teachers learn how to integrate technology into classroom practices. The two-credit designation was less than the three credits that students received for completing almost all of the other required courses in the teacher preparation program. ITCP met for two hours of face-to-face instruction each week. The two sections in the proposed study occurred on Tuesday evenings beginning at 5:00 PM (treatment) and 7:00 PM (control). Preservice teachers enrolled in ITCP prior to the beginning of the semester, so random assignment was not possible.

Participants

Instructor

One instructor, Brad Jenks, taught both sections of ITCP for elementary preservice teachers (see Table A5). Brad was a 29-year-old male who identified himself as White, non-Hispanic. He held a Bachelor's degree in Classical Civilizations and a Master's in Curriculum and Instruction. He was actively pursuing a Doctorate in Instructional Technology at the institution of higher education in which ITCP was taught. Brad completed 13 education courses for his undergraduate and graduate degrees on topics that ranged from educational theory to subject area methodologies in elementary classrooms. However, he only took one instructional technology course during his preservice training. Finally, his background included six years of public school teaching as a licensed lead teacher at the third-grade level. He possessed no prior higher education teaching experience.

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[1] Course and participant names are pseudonyms.

Treatment Section

There were fourteen enrolled preservice teachers (n = 14) in the treatment section, all of whom were female with an average age of 20-years-old (see Tables A6 through A9). The majority (11 total students) self-identified as White; there were two students who stated that they were White, Non-Hispanic and one said that she was Asian-Pacific Islander. All were undergraduate students enrolled in the institution's teacher education program. The participants were in their second or third year at the institution and were expected to graduate with a degree in education within two to three years. The average number of education courses taken prior to enrollment in the course was less than two (M = 1.79, SD = .70). All but one of the students indicated that they enrolled in the course because it was a requirement to successfully complete the teacher education program.

Few participants in the treatment section had any formal experience in K-12 settings. None of the participants were former elementary school teachers which was consistent with their age; all were two to three years removed from high school graduation. However, one participant stated that she had been an assistant teacher and another indicated that she had coached high school athletics.

While the participants in the treatment section lacked formal roles in elementary classrooms, many worked with children in supervisory capacities. Three participants indicated that they led after-school clubs for elementary students, 11 reported that they had taught in a K-12 classroom as a part of a course practicum, and six worked as a camp counselor or resident advisor. By far the most frequently occurring example of informal teaching experience was volunteering; 64.3% of the preservice teachers volunteered in an elementary classroom prior to enrolling in ITCP. Finally, one preservice teacher stated that she was a nanny during the summer, one was a Bible School leader at a local private school, and another worked for a daycare program and taught swim lessons for elementary-aged children.

Control Section

There were fifteen enrolled preservice teachers (n = 15) in the control section, and all were female with an approximate age of 20-years-old (see Tables A6 through A9). The majority (11 total students) self-identified as White. Four participants stated that they were Hispanic, African-American, Haitian, and White, Non-Hispanic respectively. All but one of the preservice teachers were undergraduate students in their second or third year at the institution. The lone outlier was pursuing a post-graduate Master's degree. Each one of the participants was seeking an education degree with licensure while enrolled in the institution's education program. The average number of education courses taken prior to enrollment was slightly greater than two (M = 2.07, SD = 1.16). Similar to the treatment section, all but one of the participants enrolled in ITCP because the course was a requirement to successfully complete the institution's teacher education program.

Very few enrollees reported formal teaching experience in K-12 settings. Nobody described being a former elementary school teacher, but one stated that she had been a teaching assistant and another served as a high school athletic coach. This was consistent with the participants' age and the amount of transpired time between their last degree and course enrollment. While they did not have extensive experience, a number of the preservice teachers in the control section worked with children in an informal role. Prior to the first ITCP class meeting, 11 participants served as academic tutors, nine were camp counselors or resident advisors, four taught after-school classes, and nine volunteered in classrooms. Additionally, eight participants indicated that they had either taught or worked in an elementary classroom as a part of a course practicum.

Intervention

The intervention involved modifying one of the course sections of ITCP based on a flipped classroom approach to instruction within the framework prescribed by intentional teaching. Conceptually, it was grounded in prior research about how to develop preservice teachers' TPACK in order to effectively integrate technology.

The course section that received the intervention was designated the treatment group. Prior to the start of the semester, the researcher used a number table to randomly assign the treatment and control conditions to the two sections; the section that met from 5:00 PM to 7:00 PM became the treatment group and the section that met from 7:00 PM to 9:00 PM was designated the control group.

Treatment Section

The intervention for the treatment group reflected three months of pre-planning prior to the start of the semester. It was created in an effort to implement a curriculum that embodied best practices in the field of instructional technology with added emphasis on the TPACK framework. The intervention included the following core characteristics based on iterative changes suggested by faculty and educators in multiple fields:

- Segmenting the course into four, three-week modules that focused on the core subject areas in elementary instruction: language arts, mathematics, social studies, and science (see Figure B3);
- Providing discipline-specific readings that described pedagogical approaches for teaching the four subject areas in elementary classrooms;

- Aligning all of the introduced technologies to the discipline-specific readings in an effort to directly connect elements of TPACK;
- Shifting technology-themed "how to" experiences from face-to-face, in-class activities to online modules using the flipped classroom approach to instruction;
- Incorporating microteaching experiences and video-based case studies as mechanisms for enhancing the realism of integrating technology into actual classrooms;
- Asking students to complete lesson plan outlines that covered the elements of TPACK in each subject area; and
- Grounding instruction in the intentional teaching framework by incorporating activities that required knowing, seeing, doing, and reflecting.

Both the researcher and faculty advisers reviewed the intervention with Brad prior to the first class to ensure that he understood how to implement the curriculum.

Control Section

The control section of ITCP followed a technocentric, lecture-based approach to learning about effective technology integration (see Figure B4). Although the control section covered elements of the TPACK framework, it was treated as something to be learned rather than a guiding, instructional philosophy. The control section's curriculum also included:

- Weekly class meetings that introduced a general set of technologies that were applicable to a number of subject areas in elementary education (e.g., weblogs, wikis, podcasts);

- In-class time spent on lecturing about technologies as well as practice learning how to use a particular tool;
- Inclusion of TPACK as an instructional touchstone throughout the semester;
- Readings that focused on broad trends in instructional technology;
- Completing four projects over the course of the semester; and
- Asking students to create lesson plan outlines that demonstrated core elements of TPACK in each subject area.

This "business as usual" approach to teaching with technology was a common model used by other ITCP instructors at the institution. Brad was also more familiar with this type of curriculum because it aligned with what he experienced as a preservice teacher during his teacher preparation program. Nevertheless, both the researcher and faculty advisers met with him to review how to implement the activities and instructional components for the control section.

Treatment and Control Section Similarities

There were three curricular elements that were common to both the treatment and control sections. First, both groups completed four subject-specific lesson plan outlines on scheduled intervals throughout the semester (see Supplemental Material C1). Each lesson plan outline covered a topic that was common to both sections, and all preservice teachers revised each original draft based on instructor feedback and taught content. Second, all of the preservice teachers completed the same final exam at the end of the semester. Finally, each participant provided feedback by responding to a course evaluation upon completion of the course. These three assessment measures were included in the quantitative analysis.

Access, Researcher Positionality, and Ethics

Access

The researcher gained access to the ITCP course and participants by following a series of sequential steps. This included:

1. Speaking with the faculty advisors who oversaw the identified sections. The researcher shared the intervention and the theoretical rationale with these individuals in addition to providing an overview to the instructor. Once agreed upon by key stakeholders, the researcher obtained IRB approval for the study.
2. Explaining the study's purpose to the preservice teachers during the first course meeting of each section. All of the participants agreed to participate by signing consent forms that granted the researcher access to any produced artifacts and assessments.
3. Obtaining material release forms that stated that all face-to-face meetings and interviews would be audio or video recorded. The material release forms provided options for how each participant wanted the recordings to be used, stored, and disseminated.

The information from the consent and materials release form was recorded in a password-protected spreadsheet. Copies of each signed document were given to all of the participants.

Researcher Positionality

The researcher was one of Brad's colleagues and an enrolled doctoral student at the institution. In addition to the participant-researcher roles in the study, Brad and the researcher interacted on a daily basis while participating in projects that were unrelated to the study. As a result of this close working relationship, Brad often spoke to the researcher about the study, course sections, and participating preservice teachers outside of the study parameters. However, the researcher was careful not to share any confidential or private information that was gathered during the course of data collection or analysis. The researcher also refrained from talking about preliminary conclusions or offering suggestions that would otherwise taint the implementation of either curriculum and what was observed. Finally, all of the informal conversations that occurred outside of the study between the instructor and researcher were not included in the data collection or analysis except where noted.

None of the preservice teachers knew the researcher prior to the start of the study. From the first class meeting onward, all course-related questions were redirected to Brad when preservice teachers approached the researcher. However, the researcher did answer study-related questions in addition to having candid conversations during individual interviews with randomly selected participants. Apart from class meetings and pertinent activities for the study, the researcher did not have direct contact with the preservice teachers except for occasional cordialities.

The researcher acted as a silent observer during all course meetings for both the treatment and control sections. Observation activities included writing field notes with a pen that simultaneously recorded audio as well as videotaping microteaching sessions in the treatment group. The researcher stood in a non-obtrusive area during most of the class meetings, occasionally moving throughout the space when opportunities to do so resulted in minimal disruption. There were only a few instances when Brad asked a nonstudy related question during class meetings; when this happened, the researcher offered a succinct reply and then promptly returned to observing the class.

Ethics

Confidentiality and privacy were protected in three ways. First, the researcher created a unique code for each participant that replaced all names on any data source. The list that linked participant names to the codes was kept in an offline, password-protected digital file, and the list was destroyed after analysis and final write-up documentation. The participant codes were replaced with pseudonyms for the final paper- only the researcher knew the identities of each participant. Second, digital data and resulting analysis were temporarily stored on a password-protected Internet platform (Google Drive) when electronic submissions of data were required. The researcher was the only person with access to submitted, confidential data. However, the researcher, instructor, and curriculum designers viewed results from artifacts and assessments that pertained to the preservice teachers' in-class performance. Finally, physical artifacts and hard copy transcriptions of digital recordings were stored in a locked cabinet after the researcher replaced identifying information with the aforementioned unique codes. Likewise, digital files were made anonymous and stored in secure, local spaces on the researcher's computer.

Data Collection and Analysis

Phase 1: Quantitative Data

The quantitative data and analyses guided the qualitative analysis and subsequent conclusions (see Figure B2 for an analysis model diagram). This occurred in a sequential manner that began by exploring the first research question to determine whether or not differences existed between the two sections on the participants' revised lesson plan outlines, final exam, and course evaluation responses (see Table A10 for a research question-data crosswalk).

The curricula for both sections included a number of quantifiable assessments that were not included in the statistical analyses. Participants in both sections received weekly quizzes on assigned readings. The control section also received a numerical grade from Brad on their submitted projects. Similarly, preservice teachers in the treatment section were assessed on their microteaching experience and follow-up reflection in addition to pre- and post-assessments on the math, social studies, and science case studies. Although all of the aforementioned assessments and artifact analyses contributed to the overall measurement of student learning throughout the semester, only the revised lesson plan outlines, final exams, and course evaluations were the same for both groups and valid data sources for comparison procedures.

Revised lesson plan outlines. The elementary preservice teachers in both the treatment and control sections completed four lesson plan outlines throughout the semester. Designed by the researcher with feedback from instructional technology educators, each lesson plan outline contained elements of a traditional lesson plan in addition to prompts that required an in-depth explanation of TPACK (see Supplemental Material C1). The assignment's instructional purpose was to have the participants think about each domain of learning in an elementary classroom, connect a subject-specific technology to the identified topic, and articulate the necessary knowledge constructs from the TPACK framework to successfully implement the lesson with students. Although the control section's curriculum did not emphasize TPACK throughout the semester, participants from this group received direct instruction about TPACK during the first class meeting. The control section also had a chance to ask questions and clarify misunderstandings when the lesson plan outlines were introduced.

The lesson plan outlines focused on the four subject areas in elementary teaching: language arts, mathematics, social studies, and science. The subject area, topics, and grade level were given to the preservice teachers at three week intervals throughout the semester. The topics included:

- reading fluency for a second-grade classroom;
- numbers and number sense in a kindergarten classroom;
- Virginia studies/reconstruction in a fourth-grade classroom; and
- forces, motion, and energy in a fifth-grade classroom.

In order to scaffold the participants' lack of classroom experience, Brad provided a collection of online resources through the course website that the participants could review if they did not understand the topic or elementary connection. The preservice teachers in both sections submitted an initial draft and then a final, revised copy after three weeks of instruction. Although the initial draft and the revisions were submitted to the instructor, only the revised lesson plan outlines were included in the quantitative analysis.

The revised lesson plan outlines were analyzed using a dichotomous scale designed to assess elements of TPACK in the artifacts (see Supplemental Material C2). The rubric outlined important constructs within the TPACK framework that were refined and adapted to fit the participants' inexperience with writing lesson plans and limited teaching familiarity. Each lesson plan outline was blind scored; the only identifying mark for both groups was a randomly assigned number given to each preservice teacher. Upon completion, each lesson plan outline was checked against the instructor's evaluation using the same rubric. When inconsistent scoring occurred, the artifact was reviewed a second time to reconcile the incongruent criteria assessment.

Two deviations occurred when analyzing the revised lesson plan outlines. First, while the same rubric was used to assess the lesson plan outlines, the instructor applied a 4-point evaluation for each criterion instead of a dichotomous scale. According to the instructor, the institution's requirements stated that a student could not receive a zero for a portion of a submitted assignment. To accommodate scoring discrepancies, the instructor's comments were reinterpreted from the 4-point scale to the dichotomous scale for the study. Face-to-face conversations happened when there was insufficient information to determine how to resolve the scoring changes. Second, some physical copies of the lesson plan outlines were unavailable due to the amount of time between data collection and analysis. The instructor's evaluation was included in the data corpus when a tangible artifact was missing.

In order to maintain the subject-specific nature of TPACK and technology integration, each group of subject area lesson plan outlines was treated as a unique dependent variable. Comparisons were made to determine if there were significant differences between the two sections on the total scores for the language arts, math, social studies, and science lesson plan outlines. Parametric and non-parametric statistical tests were considered when beginning the analyses. However, the data set contained a number of assumption violations for parametric analysis, so the Mann-Whitney U Test was performed on the revised lesson plan outlines. The SPSS statistical package was used for both the assumption tests and statistical evaluations. Significant findings were evaluated against a modified α (Holm Sequential Procedure) to control for multiple tests and family-wise error rate.

Final exam. At the end of the semester, the preservice teachers in both sections independently completed a final exam that was developed specifically for ITCP (see Supplemental Material C3). The final exam consisted of a number of open-ended questions designed around the intentional teaching model of instruction. It served as a culminating evaluation that required participants to apply all that they had learned in a manner that aligned with effective technology integration and TPACK.

The four questions on the final exam connected to one of three tasks in the Intentional Teaching framework. The questions included:

1. Defining TPACK in terms of the participants' experience and philosophy (Intentional Teaching: Know).
2. Describing a unique pedagogical approach for each subject area and identifying a technology that supported the stated instructional practice (Intentional Teaching: Know).
3. Watching a recorded kindergarten lesson and identifying different examples of technological, pedagogical, and content knowledge demonstrated by the teacher (Intentional Teaching: See).
4. Rating the teacher in the video-based case study using a TPACK rubric and justifying the evaluation with a clear explanation (Intentional Teaching: Reflect).

The fourth intentional teaching construct, Do, was not included in the final exam because the allotted time did not allow for microteaching or some other type of in-person performance assessment.

The final exam was revised twice before it was administered. Before the semester began, two subject matter experts in instructional technology refined the instrument and its scoring rubric to better assess the construct (TPACK) and ensure alignment with intentional teaching. One week later, two elementary preservice teachers and one technology coordinator pilot-tested the exam, and their feedback was used to alter the assessment and rubric. No statistical item analyses were conducted on the exam.
The rubric consisted of a hierarchical breakdown of important concepts for determining what participants understood and expressed in their responses (see Supplemental Material C4). Although there were only four total questions, each question contained multiple variable-response items that were evaluated on a 3-point scale. The levels within the scoring rubric were delineated with specific criteria and evidence so that the raters could consistently apply a value to what was written.

Before scoring all of the exams, both raters randomly selected two exams from each section to establish a baseline estimate of inter-rater reliability and general agreement. An initial intraclass correlation revealed strong absolute agreement after consultation and explanation of each rater's evaluation (average measures, intraclass correlation = .99). Follow-up evaluation of rater drift was also strong but less than initial convergence (average measures, intraclass correlation = .94). After blind scoring all of the exams, the two raters shared their exam score for each participant and discussed any discrepancies. The scores used in the inferential analysis were based on rater negotiations and general consensus about the participants' answers. An independent *t*-test was performed using the SPSS statistical package to determine if there were significant differences between the two sections on total final exam scores.

Course evaluation. The preservice teachers in both sections submitted anonymous answers to a common set of course evaluation statements at the end of the semester (see Supplemental Material C5). The purpose of the final course evaluation was to gather feedback from both groups about their feelings toward each course, their impressions of Brad, and their experiences throughout the semester. The statements were created by the institution and were ordinal in nature (Likert-scale) with the exception of one open-ended statement. All responses were collected and tabulated by the institution and anonymously dispersed as a matter of public record available to all members of the community.

The response options varied according to the nature of the statement on the course evaluation, and this determined how the data was handled. All but one of the Likert-scale items had five options from which to select, and the choices ranged from *Strongly Agree* to *Strongly Disagree*. The single statement that did not use the common Likert-type scale dealt with time spent preparing outside of class (see Supplemental Material C5, S2: Time). It had five response options that contained lengths of time. This question as well as all of the Likert-scale items were included in the quantitative analysis. Finally, participants' written reflections on the open-ended statement were recorded but not statistically analyzed. Responses to this statement were included in the qualitative findings and conclusions when appropriate and applicable.

Participants in the treatment group also answered four additional statements based on the course structure, feedback, and employed technologies (see Supplemental Material C6). Participant responses were incorporated into the findings when applicable. However, participants' responses to these statements were not included in the quantitative analysis because there were no matching items for the control section. Only descriptive statistics were reported for these special, treatment-only statements.

Each common Likert-scale item was evaluated as a unique dependent variable to determine if there were statistically significant differences between the two sections. The Mann-Whitney U test was used because of the ordinal nature of participants' responses. Significant findings were evaluated against a modified α (Holm Sequential Procedure) to control for multiple tests and family-wise error rate.

Phase 2: Qualitative Data

The second phase of data analysis involved qualitatively examining the data corpus for themes and trends that helped to explain the observed differences between the two sections on the three summative measures. Although data collection occurred concurrently throughout the semester, the qualitative analysis occurred after statistical tests were performed when the ITCP classes concluded. The decision to follow a sequential process beginning with the quantitative analysis arose out of the need to explain why statistically significant differences existed; qualitative evidence served an explanatory function that highlighted possible reasons for discrepant results. In this respect, qualitative procedures acted as a lens from which to view the two different sections, what transpired during class meetings, and participants' reactions to the curriculum and assessment measures. The final two research questions guided the second phase of analysis, and the primary data sources were interview transcripts and field notes (see Table A10). Artifacts were included in the analysis procedures when themes needed to be confirmed or disconfirmed.

Interviews. Semi-structured interviews were conducted with fourteen randomly sampled elementary preservice teachers- seven from both the control and treatment sections. Interviews were conducted outside of class at the midpoint and the end of the semester using a scripted set of questions (see Supplemental Materials C7 and C8). Each interview lasted approximately 20 to 30 minutes and was audio recorded and transcribed. The recorded interviews were deleted after transcription was completed, and identifiable information in the written transcriptions was replaced with a unique identifying number or pseudonym.

The instructor participated in a semi-structured interview at the beginning, middle, and end of the semester. Each interview lasted approximately one hour. The researcher used a scripted set of questions but deviated from the protocol when lines of inquiry needed clarification (see Supplemental Material C9). Each interview was audio recorded and transcribed prior to analysis. The recorded interviews were deleted after transcription was completed, and all identifiable information was replaced with a unique identifying number and the instructor's pseudonym, Brad.

Field notes. All course meetings for both the control and treatment sections were observed and audio recorded using a Livescribe smart pen. Field notes were rewritten following each meeting, and identifiable information was replaced with numeric codes in the re-written document. During the rewriting process, the researcher also noted emergent themes and documented them through analytic notes. At the conclusion of the study, all audio recordings and rewritten field notes were merged to form a verbatim transcript of each class meeting. These detailed artifacts served as a data source during the qualitative analysis.

Data analysis procedures. Transcripts and field notes were analyzed using a multifaceted approach that involved data reduction, data display, and conclusion drawing/verification (Miles & Huberman, 1994). These three analysis procedures were performed in a manner similar to the interactive model articulated in *Qualitative Data Analysis* (1994):

- Reducing the field notes, transcripts, and articles into meaningful, simplified forms that illuminated key themes in the data corpus (Data Reduction).
- Creating charts, graphs, or visualization to better understand the interrelationships between data sources (Data Display).
- Finding patterns or possible explanations for identified themes, and then testing these explanations for their confirmability (Drawing/Verifying Conclusions).

The three procedures occurred simultaneously in an iterative manner that involved moving from one process to another in order to generate, test, and analyze conclusions (see Figure B5).

Data reduction. The initial, anticipatory reduction involved categorizing all of the data sources and then applying a preliminary coding scheme to the interview transcripts and field notes. The objectives for the initial data reduction were twofold. First, categorizing all of the data sources simplified how codes were displayed and what conclusions might be drawn with respect to participants and the curricula. Second, applying a preliminary list of codes helped to codify differences between the two sections on the summative assessment measures. The combined categorization procedure and initial coding scheme reduced the data into a manageable set from which to identify and verify themes.

Categorizing data sources. All of the data sources that were included in the qualitative analysis were initially categorized according to whether the data was from a *Participant* or a *Field Note* (see Supplemental Material C10). Additional fields were applied to the two broad descriptors to further refine what was collected in the data sources. For example, *Section*, *Participant Name*, and *Artifact* type were added to the *Participant* descriptor. The *Field Notes* category contained *Meeting Week*, *Section*, and *Topic* fields. The categories and fields functioned as tools for sorting and displaying coded excerpts that pertained to the final two research questions.

Preliminary code list. A preliminary code list that reflected three broad lines of inquiry was generated prior to beginning any qualitative analysis (see Supplemental Material C11). In order to address the results from the first research question, a code for all of the significant findings from the quantitative analysis was created and included in the initial list. These codes were general and referenced the assessment measures, subject areas, and course evaluation statements (e.g., *S1: Diversity* for the first course evaluation statement). Second, codes for all of the activities that occurred within both section's curricula were added to the list. These codes served as flags for determining the impact of learning opportunities on enrolled participants. Finally, the TPACK framework and all of the curricular modifications (i.e., intentional teaching, etc…) were included.

Data reduction with first pass analysis. As a part of the initial data reduction, all of the interview transcripts and field notes were read and coded using the preliminary code list in the Dedoose software platform for qualitative and mixed methods data. This first pass analysis not only consisted of applying codes to the data sources but it also included writing and reviewing analytic memos (see Supplemental Material C12 for sample memos). These analytic memos were added to the data corpus and served as the basis for emerging themes and follow-up coding procedures. An expert in qualitative procedures reviewed the process and procedures used to complete the data reduction and first pass analysis.

At the end of the first pass analysis, frequency charts for coded excepts were generated within Dedoose and all of the analytic memos were reviewed. The charts, codes, excerpts, and memos were the foundation for a revised coding list and two more analytic readings.

Second and third pass data analysis. Using a revised code list based on the first pass analysis (see Supplemental Material C13), all of the interview transcripts and field notes were reviewed and re-coded two additional times in Dedoose. Similar to what occurred during the first pass analysis, charts and data displays were generated, new analytic memos were written, and granular codes were created in a recursive examination process. As themes emerged that explained the findings from the quantitative analysis, the revised lesson plan outlines, final exams, and course evaluation were reviewed to confirm the validity of any suggestive findings from the qualitative analysis. As a final step, all of the applicable themes were written and summarized as findings that either supported or failed to support the statistically significant results found in Phase 1.

Member checking and triangulation. The researcher engaged in member checking as a way to establish the validity of the qualitative findings (Creswell, 2007). This occurred during the data collection and analysis phases of the study. For example, both Brad and the preservice teachers were asked additional interview questions when emergent themes became apparent during the semester. These additional lines of inquiry (e.g., sarcasm, self-directed learning) were not a part of the pre-study interview protocol but were generated after field observations but before analysis. The supplementary questions provided evidentiary confirmation or disproval of the noted themes. In addition to member checking during interviews, the researcher presented summaries of key findings to Brad as well as faculty mentors. After receiving feedback from this form of peer review, the researcher revisited the findings to ensure that the account was accurate and aligned with prior research studies.

The qualitative findings were triangulated with the quantitative results when summarizing observations and key results. This primarily occurred when a theme emerged during the second and third pass analysis, and it consisted of a three-step process. First, frequency statistics and graphs were generated for each generated theme as a way of visually examining differences between the treatment and control sections. If the theme appeared significant and salient, the researcher then engaged in an iterative process of deconstructing the theme and checking for alignment with observed differences on summative, quantitative assessments. Finally, a decision to include the identified theme was made when the qualitative analysis revealed insights as to why one section outperformed the other on quantitative measurements. If the theme disconfirmed or failed to provide evidence for observed differences, the researcher noted the discrepancy as an analytic memo. Counterevidence was noted when appropriate in the results sections.

Validity Threats

There were potential validity issues inherent within study's research design. The salient validity threats and the strategies for minimizing these issues in the research design included the following (Creswell, 2007):

- "Obtaining unequal sample sizes for the qualitative and quantitative data collection" (p. 240). The study incorporated small, relatively equal sample sizes so that quantitative and qualitative differences were more applicable during analysis.
- "Collecting two types of data that do not address the same topics" (p. 240). Both qualitative and quantitative data collection procedures addressed each research question to the degree that this was possible.
- "Utilizing inadequate data transformation" (p. 240). Known data transformation procedures were a part of the analysis.
- "Not resolving divergent findings" (p. 240). Instances of divergent results were reported or the data was re-analyzed.

Ensuring the validity of the research design enabled the researcher to make more conclusive interpretations from the collected data.

CHAPTER 4: QUANTITATIVE ANALYSIS (PHASE 1)

What differences exist between preservice teachers in the treatment and control sections on summative assessments (revised lesson plan outlines, final exam, course evaluation)?

Revised Lesson Plan Outlines

Total scores on participants' revised lesson plan outlines were evaluated to assess what differences, if any, existed between the control and treatment sections. Comparisons were made between the preservice teachers' total scores on the language arts, math, social studies, and science summative lesson plan outlines- versions that reflected feedback and three weeks of instruction. Each collection of subject area lesson plan outlines was considered a unique dependent variable.

The type of statistical test used to assess differences was carefully considered. Only independent *t*-tests and equivalent nonparametric procedures were considered because these tests more accurately reflected the summative nature of the revised lesson plan outlines as well as the domain-specific understanding required for each subject area.

The null hypothesis was that there was no significant difference between the treatment section and the control section on the revised lesson plan outline scores for the language arts, math, social studies, and science subject area modules (H_0: $\mu_1 = \mu_2$). Conversely, the alternative hypothesis was that there was a significant difference between scores on the revised lesson plan outlines for the treatment and control sections in the four subject areas (H_A: $\mu_1 \neq \mu_2$). There were no assertions that one section would score higher than the other (two-tailed).

Assumptions

Prior to running any parametric or nonparametric statistical analysis, a number of assumptions were evaluated on the total scores for the revised lesson plan outlines. The evaluation included assessing the dependent variables for independence, normality, outliers, and homogeneity of variance.

Independence

Independence. Although no formal tests assessed the independence of scores across the treatment and control sections, the results were assumed to be an accurate reflection of each participant's performance on the revised lesson plan outlines. The instructor advised the preservice teachers on multiple occasions to not speak with participants from the other section about the type of instruction they were receiving or particular tasks each group was asked to complete. He also asked the participants to adhere to the University honor code when completing the lesson plan outlines, and this included stipulations that all work should be representative of each individual and not a collaborative group effort. It was assumed that the revised lesson plan outlines accurately reflected each individual's interpretation of the instructor's feedback and taught content but not intragroup or cross-section contamination or sharing.

Normality

Normality. Descriptive statistics revealed higher mean total scores for the treatment group on the revised lesson plan outlines for each subject area (see Table A11). In language arts, the mean for the treatment section (M_{Tla} = 11.79, SD_{Tla} = 1.48) was greater than that of the control section (M_{Cla} = 9.53, SD_{Cla} = 1.77). The same was true for math (M_{Tmath} = 12.43, SD_{Tmath} = 0.51; M_{Cmath} = 10.40 SD_{Cmath} = 2.06), social studies (M_{Tss}

= 11.21, SD_{Tss} = 2.19; M_{Css} = 9.20, SD_{Css} = 2.86), and science (M_{Tsci} = 11.14, SD_{Tsci} = 1.79; M_{Csci} = 9.80, SD_{Csci} = 2.78).

Indications of non-normal distributions were evident by the number of skewed and peaked values in the data set. Absolute *z*-scores for skewness and kurtosis were generated to assess normality (see Table A12), and these values were evaluated against the general expected value ($Z < 1.96$, $p = .05$) for small but normal distributions. The control section's total scores for the science revised lesson plan were negatively skewed ($Z = 2.24$, $p < .05$). Both the language arts ($Z = 2.36$, $p < .05$) and the social studies ($Z = 3.19$, $p < .05$) were negatively skewed for the treatment section. Finally, the social studies revised lesson plan outline for the treatment group was highly leptokurtic ($Z = 3.90$, $p < .05$). Each one of these cases (see Figures B6-B8) failed to reject the null hypothesis for normal distributions for skewness and kurtosis (H_0: Z < 1.96).

Shapiro-Wilk tests were also used to statistically assess the normality of the revised lesson plan outline scores for each subject area (see Table A13). Although commonly employed, Kolmogorov-Smirnov tests were not examined because of their sensitivity to extreme values which were present in most of the revised lesson plan distributions. Furthermore, Shapiro-Wilk tests were considered better indicators for testing the normality of data because they generally have more power.

The Shapiro-Wilk test statistics revealed significant results ($p < .05$) for nearly all of the revised lesson plan outlines. Only the control section's scores for the language arts, $W(15) = 0.89$, $p = .059$, and social studies, $W(15) = 0.92$, $p = .210$, were not statistically significant. Since small sample sizes have little power to reject the null hypothesis for normality, the significant results for all but two of the distributions indicated non-normal samples and problems with parametric data comparisons for all of the subject area lesson plan outlines.

Outliers

Outliers. A box-whisker diagram was created for scores on all of the lesson plan outlines to look for outliers (see Figure B9). The diagram revealed four outliers in the social studies and science revised lesson plan outlines for both the treatment and control sections (see Table A14). All of the outliers fell below the 1.5x interquartile range but were not extremely divergent (3.0x). It was concluded that the outliers in the control section's science lesson plan outlines and the treatment section's social studies lesson plan outlines were responsible for the negative skewness that was observed in the distributions.

Each instance was examined for miscoding by reviewing the scores on the physical artifacts. Each outlier was kept in the data set because each lesson plan outline reflected an accurate score and no coding errors were present. Further support for their inclusion was the observation that one preservice teacher was responsible for 50% of the outliers in all of the revised lesson plan outlines ($Score_{Css} = 2$; $Score_{Csci} = 3$); this student appeared to consistently do poorly which indicated a problem with performance and not the coding scheme or lesson plan outline assessment. The participant was a member of the control section.

Homogeneity of Variance

Homogeneity of variance. Levene's test was used to evaluate the homogeneity of variance for the revised lesson plan outlines in each subject area at an α level of .05 (see Table A15). The variances were not significant for the treatment and control sections on the language arts, $F(1,27) = .38$, $p = .54$, social studies, $F(1,27) = 1.25$, $p = .27$, and science, $F(1,27) = 1.037$, $p = .32$, revised lesson plan outlines. However, variances were significantly different for total scores on the math revised lesson plan outline, $F(1,27) = 27.90$, $p < .001$. This significant finding suggested a violation in the homogeneity of variance assumption for the math lesson plan outlines.

Mann-Whitney U Test

Preliminary exploration of the descriptive data revealed violations to a number of statistical assumptions for the math, social studies, and science revised lesson plan outlines. This included the presence of outliers, non-normal distributions, and a violation to homogeneity of variance. To address these issues, data transformation and nonparametric statistical procedures were considered as options to compare the scores on the revised lesson plan outlines. The Mann-Whitney U rank-sum test was ultimately used because of the extensive and varied problems with the impacted data samples.

For the subject area lesson plan outlines, the null and alternative hypotheses were re-stated as follows to fit the Mann-Whitney U test:

- H_0: The distributions for the control and treatment groups' scores on the lesson plan outlines for each subject area were equal.
- H_{A1}: The medians for the control and treatment groups' scores on the lesson plan outlines for each subject were not equal.
- H_{A2}: The mean ranks for the control and treatment groups' scores on the lesson plan outlines for each subject were not equal.

The new hypotheses aligned with the original objective of comparing lesson plan outline scores between the two sections while asserting that the distributions were equal (H_0).

However, two alternative hypotheses were postulated to address potential violations to the homogeneity of variance (median) assumption required for the Mann-Whitney U test. When the samples in the comparisons reflected a similar shape and were significantly different, medians were evaluated and reported (H_{A1}: $Mdn_1 \neq Mdn_2$). Mean ranks were reported when the dependent variable violated the homogeneity of variance assumption but were significantly different (H_{A2}: $M_{\text{rank1}} \neq M_{\text{rank2}}$).

Assumptions

Assumptions. Collected data from the revised lesson plan outlines met three assumptions for running the Mann-Whitney U test. First, each group of subject area lesson plan outlines was considered a single dependent variable measure at the continuous level. Second, section affiliation (treatment or control) served as a dichotomous, independent variable. Finally, there was no relationship between total scores for the two sections, nor was there a relationship between total scores within a single group.

Levene's test of homogeneity of variance at an α of .05 was used to test the fourth assumption that the distributions of scores were similarly shaped for each subject area between the two sections (see Table A16). Medians with adjusted *df* were used as the reference values instead of means as would be done for parametric procedures.

Levene's test produced non-significant results for the language arts, $F(1,25.51) = 0.21$, $p = .65$, social studies, $F(1,25.60) = 0.89$, $p = .35$, and science, $F(1,21.20) = 0.73$, $p = .40$. However, a significant Levene statistic was found for scores on the math lesson plan outline, $F(1,18.00) = 11.20$, $p < .05$. For the math lesson plan outline, mean ranks instead of median values were used to compare the two sections.

Results

Results. Calculation changes were made to the Mann-Whitney U tests because of the small sample size and poor distribution. Instead of the *asymptotic* method for arriving at significance, the Mann-Whitney U test was performed using the *exact* test for all of the subject areas (see Table A17 and Table A18 for results).

Although scores on the lesson plan outlines for each subject area were considered unique dependent variables, there were indications that time and practice might have influenced scores as the participants progressed through the semester. Consequently, a Holm Sequential Procedure was performed on the significance level ($\alpha = .05$) to minimize the chance of falsely rejecting the null hypothesis due to multiple tests or chance alone (Holm, 1979). This procedure was chosen because the Bonferroni test is often described as overly conservative when applied to small sample sizes (Rice, 1989). Revised confidence intervals were calculated and compared to the exact significances indicated by the Mann-Whitney U tests (see Table A18).

Language Arts Lesson Plan Outlines

Language arts lesson plan outlines. The Mann-Whitney U test revealed that the scores on the language arts lesson plan outlines for the control section ($Mdn = 10.00$) were significantly less than scores from the treatment section ($Mdn = 12.00$), $U = 30.00$, $z = -3.33$, $p < .013$, $r = -0.62$. The null hypothesis that the distributions for the control and treatment section were equal was rejected for the language arts lesson plan outlines. The medium effect size suggested a substantive difference between the two sections.

Close examination of the two samples revealed composition differences that possibly contributed to significant findings. As a class, the control section received 72%

of the maximum possible points on items that assessed content knowledge about teaching reading fluency. Conversely, the treatment section received 89% of the total possible points for content knowledge items. Articulating how reading fluency related to understanding was difficult for the control group; only ten of the fifteen participants were able to do so even after feedback from the instructor.

There were also marked differences in total possible points on items assessing technological knowledge. The control section received 67% of total possible points while the treatment section received 90%. Only seven of the participants incorporated learner-centered uses of technology in their lesson plan outlines. The control section also struggled to identify appropriate technology standards; nine of the 15 participants were unable to state National Educational Technology Standards for Students (NETS-s) that were relevant and appropriate.

Math Lesson Plan Outlines

Math lesson plan outlines. Due to the dissimilarity in distribution shape that was uncovered by the Levene test, the control and treatment group were evaluated using mean ranks. The Mann-Whitney U analysis revealed a significant difference between the treatment and control section's mean rank of scores on the math lesson plan outline. The sum of the average ranks for the control section's scores (M rank = 10.33, n = 15) was significantly lower than the sum of average ranks for the treatment section on the math lesson plan outline (M rank = 20.00, n = 14), $z(29) = -3.27$, $p < .017$, $r = -0.61$. The medium effect size suggested a substantive difference between the two sections.

Closer examination showed that six of the participants in the treatment section received all of the possible points on the math lesson plan outline (see Figure B10).

However, only one participant in the control section received the maximum score. Furthermore, the total scores for all of the participants in the treatment section reflected either the maximum or one missed item on the rubric.

The most apparent difference between the two sections on specific items in the lesson plan outline was the participants' articulation of appropriate NETS-s for technology tools used in their number sense lesson. Only two of the 15 participants in the control section were able to list a standard that was relevant to the technologies used in the lesson. Although notable, it was unclear from the lesson plan outlines whether or not this reflected a misunderstanding about the listed technology's function or an incomplete awareness of what each standard meant. Nine of the 14 participants in the treatment section received the allotted points for this item.

Social Studies Lesson Plan Outlines

Social studies lesson plan outlines. Total scores on the social studies lesson plan outline were significantly less for the control section (Mdn = 10.00) than for the treatment section (Mdn = 11.50), U = 54.50, z = -2.23, p = .025, r = -0.41. For this subject area, the null hypothesis was rejected with a medium effect size. The two group's median scores were significantly different, and participants in the treatment condition scored significantly higher than the participants in the control section.

Examination of the two samples revealed composition differences that possibly contributed to significant findings. As a class, the control section received 72% of the maximum possible points on items that assessed pedagogical knowledge about teaching the social studies topic, Virginia's reconstruction period. Conversely, the treatment section received 95% of the total possible points for pedagogical knowledge items.

Articulating pedagogical approaches and identifying appropriate assessments were difficult for the control group; only ten of the 15 participants were able to do so even after feedback from the instructor.

There were also marked differences in total possible points on items assessing technological knowledge. The control section received 63% of total possible points for technological knowledge as a class. However, the treatment section was only marginally better at 74%. The low combined total for the control section was partly attributable to poorly stated pedagogical approaches for technology integration; only seven students were able to provide a logical rationale for why technology assisted student learning in the social studies lesson plan outline.

Science Lesson Plan Outlines

Science lesson plan outlines. The Mann-Whitney U procedure revealed that scores on the science lesson plan outline for the control section (*Mdn* = 10.00) were not significantly different from the treatment section (*Mdn* = 11.50), $U = 74.00$, $z = -1.37$, $p = .18$. For science, the null hypothesis was retained; the distribution of scores on the science lesson plan outline were the same across the two sections.

The non-significant results of the Mann-Whitney U test reflected similar scores for measures of technological, content, and pedagogical knowledge on the science lesson plan outline. On items that assessed participants' content knowledge in the science lesson plan outlines, the control section received 78% of the maximum possible points as a class. The treatment group received 88% of the maximum possible points. As a class, the control section had 82% of the maximum points on items that measured pedagogical knowledge for teaching the science topic. The treatment section received 93% of the possible total points for pedagogical knowledge. The percentage difference in total possible points between the control section (68%) and treatment group (79%) was also similar on items measuring articulated technological knowledge. It was unknown if these descriptive statistics explained the similarity in median distributions between the two sections.

Final Exam

Participants' total scores on a final exam were analyzed to determine whether or not there were significant differences between the two sections. The final exam consisted of a number of open-ended questions designed around the *Intentional Teaching* framework. It also served as a culminating evaluation that required participants to apply all that they had learned in a manner that aligned with effective technology integration and TPACK.

The null hypothesis was that there was no significant difference between the treatment section and the control section on total scores for the final exam (H_0: $\mu_1 = \mu_2$). Conversely, the alternative hypothesis was that there was a significant difference between scores on the final exam for the treatment and control sections (H_A: $\mu_1 \neq \mu_2$). There were no assertions that one section would score higher than the other (two-tailed).

Assumptions

Four assumptions were evaluated prior to running the independent *t*-test on final exam scores. The evaluation included assessing the dependent variables for independence, normality, outliers, and homogeneity of variance.

Independence

Independence. Participants' performance on the final exam was assumed to be independent. The same exam was given to both sections on different days, and the instructor told the participants to refrain from discussing the details with their peers until final grades were reported to the institution. Additionally, all of the participants read and signed a University honor code statement stating that they had neither given nor received assistance on the assignment.

On the exam date, participants met together in a classroom on the institution's grounds. Each individual was seated in a space away from other classmates while completing the exam. Participants were told that they could use a computer or Internet-connected device only when instructed to do so in a question, but they could not use notes, files, or any external sources to help them answer any question. The instructor proctored the exam for both sections to help ensure the validity of the results from the assessment measure.

Normality

Normality. Descriptive statistics revealed different mean scores for the two sections on the final exam (see Table A19). The control section had a lower mean score (M = 46.93, SD = 12.01) than the treatment section (M = 59.50, SD = 6.10).

Visual inspection of P-P Plots indicated deviations from normal distributions for both sections (see Figures B11-B12). When the P-P Plots were compared to histograms, the divergence appeared less pronounced as indicated by kurtosis and skewness values (see Figures B13-B14). This was confirmed by calculating z-scores for skewness and kurtosis and comparing the reinterpreted numbers to the expected results. All of the absolute values for skewness and kurtosis were not significantly significant, *Z* < 1.96, *p* = .05 (see Table A20). On these measures, the distributions for the treatment and control sections appeared to be normally distributed.

Shapiro-Wilk tests were also used to statistically assess the normality of the distributions for both sections (see Table A21). The results for the control section were not statistically significant, *W*(15) = 0.93, *p* = .23. Likewise, the Shapiro-Wilk test was not statistically significant for the treatment section, *W*(14) = 0.97, *p* = .93. These results indicate that the distributions for both sections did not deviate significantly from a normally distributed set of test scores.

Outliers

Outliers. In order to identify outliers in both sections, a box-whisker diagram was created for the total scores on the final exam (see Figure B15). The diagram revealed two outliers in the control section, and both fell below the 1.5x interquartile range but were not extremely divergent (3.0x).

Homogeneity of Variance

Homogeneity of variance. Levene's test was used to evaluate the homogeneity of variance for total scores on the final exam (α = .05). The variances were not significantly different between the two sections, *F*(1,27) = 2.99, *p* = .10. This finding suggested that the homogeneity of variance assumption was not violated.

Results

After testing the assumptions for parametric data, an independent *t*-test was conducted to compare final exam test scores for the control (*n* = 15) and treatment (*n* = 14) sections. Inferential statistics revealed a statistically significant difference between the two groups, $t(27) = -3.51$, $p < .01$. Total scores for the control section ($M = 46.93$, $SD = 12.01$) were lower than the total scores for the treatment section ($M = 59.50$, $SD = 6.10$). The medium effect size ($r = -0.59$) indicated substantive results.

Using the rubric as a guide, frequency statistics were generated to examine how points were assigned to each question between the two groups. Although there were no distinguishing differences for the first question, ratings for the remaining three questions showed possible reasons for the observed values from the independent *t*-test.

Question 2

> **Question 2.** *Identify and describe a core pedagogical principle in each of the four subject areas. Explain how each pedagogical principle impacts learning in an elementary classroom by considering the readings and in-class discussions. Provide different sample technologies that connect to each subject area and pedagogical approach. Clearly connect the technology to the pedagogical approach in a written description.*

In language arts, the control section had a higher frequency of participants who were unable to identify an appropriate pedagogical approach. Four of the 15 participants in the control section could not identify a relevant pedagogical approach in language arts as compared to only one individual in the treatment section.

In math, five of the participants in the control section failed to articulate a technology that related to the stated pedagogical approach. Conversely, only one individual in the treatment section could not list a technology that connected to a pedagogy in mathematics. However, eight participants in both sections listed a technology that clearly connected to a pedagogical approach.

In social studies, five of the 15 participants in the control section were unable to explain the type of learning that a particular pedagogical approach addressed. This deficiency extended to identifying relevant technologies; five individuals could not connect a technology to any type of social studies pedagogy. There were no individuals in the treatment section who were unable to articulate the type of learning promoted by a pedagogical approach in social studies, and everyone identified appropriate technologies.

Finally, four of the participants in the control section were unable to connect student learning to a pedagogical approach in science teaching. When asked to state a technology that supported any scientific pedagogy, four individuals in the control section could not adequately offer an example. Conversely, all of the participants in the treatment section were able to articulate a science-based pedagogy that impacted learning as well as a technology that supported it.

Question 3

> **Question 3.** *Watch the video and identify elements of technological, pedagogical, and content knowledge by describing what you see in the appropriate column.*

Participants in the control section had difficulty correctly identifying and describing instances of content knowledge in the referenced video. Four individuals either misidentified or could not isolate examples, and five were unable to clearly articulate why their examples demonstrated content understanding. On the other hand, only one person in the treatment section misidentified and failed to properly describe content expertise.

Both sections recognized occasions when the teacher in the case study exhibited pedagogical knowledge. However, four of the 15 participants in the control section were unable to describe why their observation was an example of pedagogical knowledge. The entire treatment section showed that they could describe a pedagogy when they saw one.

The most apparent difference between the two sections dealt with identifying examples of technological knowledge. Nine of the 15 participants in the control section either misidentified or could not isolate examples of the teacher using her technological knowledge in the video. Everyone in the treatment group was able to correctly identify instances of technological knowledge.

Question 4

> **Question 4.** *Use the rubric to rate the teacher in the video on her ability to use TPACK to support student learning. Highlight (in yellow) the rating for each criterion. Justify each rating with examples from the video or what you know about teaching and learning with technology. Explain why a lower or higher rating is inappropriate based on what you know about teaching and learning and the mathematical content.*

Participants in the control section struggled to provide a justification for why a particular rating was given to the teacher in the video. When asked to provide a reason for a high, low, or intermediate rating on the alignment between curricular goals and technology, six of the 15 individuals in the control section were unable to do so as compared to zero from the treatment section. The same numbers applied to the overall justification for the TPACK rating; six individuals from the control section were unable to explain why the teacher either did or did not demonstrate cohesive TPACK in the lesson.

Course Evaluation

Participant responses to statements on a course evaluation were analyzed to determine whether or not there were significant differences between the two sections. Distributed at the end of the semester after the final exam, the course evaluation contained seven common Likert-scale items and one open-ended prompt developed by university administrators to assess quality of instruction (see Supplemental Material C5). All of the responses were collected anonymously and tabulated in the form of frequency distributions by the institution's IT department (see Table A22).

Each common Likert-scale statement on the course evaluation was treated as a dependent variable. The null hypothesis for evaluating responses was that there was no difference between the distributions for the treatment and control sections on each statement. The alternative hypotheses were as follows:

- H_{A1}: The medians for the control and treatment groups' quantified responses on each statement were not equal (H_{A1}: $Mdn_1 \neq Mdn_2$).
- H_{A2}: The mean ranks for the control and treatment groups' quantified responses on each statement were not equal (H_{A2}: $M_{\text{rank1}} \neq M_{\text{rank2}}$).

Two alternative hypotheses were initially stated to account for the distribution shape of the observed responses. When the two section's distributions were similarly shaped, medians were evaluated and reported. Mean ranks were used when non-significant Levene tests suggested dissimilar distributions. However, no predictions about directionality were made (two-tailed).

Finally, participants in the treatment section were presented with three additional Likert-scale items and one open-ended prompt that the control section did not receive. The Likert statements focused on unique aspects of the course construction, and respondents were asked to choose from options that varied from *Strongly Agree* to *Strongly Disagree*. The quantifiable results were examined using descriptive statistics because there were not comparable items for the control section. No hypotheses about the outcomes were made.

Mann-Whitney U Test

The Mann-Whitney U test was used to analyze what differences, if any, existed between the control and treatment sections' distributions of quantified responses to the course evaluation. This nonparametric procedure was selected because there was no clear rationale for reinterpreting the 5-point ordinal scale as levels of interval data despite some researchers' assertions that this was an appropriate approach (Sullivan & Artino, 2013; Boone & Boone, 2012; Norman, 2010; Carifio & Perla, 2008).

The decision to use nonparametric statistics also arose from the lack of construct-validity for variations between the ranked data; descriptors like "somewhat more positively neutral" would be required if means and standard deviations were evaluated (Jamieson, 2004; Kuzon, Urbancheck, & McCabe, 1996). Furthermore, the subjective nature of feelings that fell between levels like *Neutral* and *Agree* probably varied amongst the respondents and, consequently, was ill-defined. It was for these reasons that the nonparametric Mann-Whitney U test was used.

Assumptions

Assumptions. The course evaluation data aligned with a number of critical assumptions for performing the Mann-Whitney U test. First, the statistical analysis evaluated each statement on the course evaluation as its own dependent variable measured at the ordinal level. Second, there was a dichotomous independent variable representing the treatment and control sections. Finally, all participant responses were recorded anonymously and without influence from peers, the instructor, or the researcher. These three assumptions were met, in part, because of the research design and the manner in which the course evaluations were delivered to the participants.

The fourth assumption was tested using Levene's median-based test of homogeneity of variance ($p < .05$). This evaluation determined whether or not the distributions of quantified responses were similarly shaped for each statement. Medians with adjusted *df* were used as the reference values in the statistical calculations.

Levene's median-based test produced non-significant statistics for all but one of the statements on the course evaluation (see Table A23). The test results for the statement about the instructor's teaching effectiveness (S7: Teaching) was statistically significant, $F(1,23.87) = 9.00$, $p = .006$. Visually inspecting the histogram confirmed the conclusion that the shape was different for both sections on this statement (see Figure B16). As a result, mean ranks were reported for *S7: Teaching* while medians were used to describe significant results for all other statements.

Results

Results. Prior to running any tests, calculation changes were made to the Mann-Whitney U procedure because of the small sample size comparisons. Instead of the *asymptotic* method for arriving at significance, the Mann-Whitney U test was performed using the *exact* test for all of the statements (see Tables A24-A25)

Additionally, the Holm Sequential Procedure ($\alpha = .05$) was used to minimize false rejection of the null hypothesis due to multiple tests on the same data set (Holm, 1979). This procedure was chosen because the comparable Bonferroni test was considered overly conservative when applied to small sample sizes (Rice, 1989). Revised confidence intervals were calculated and compared to the exact significances indicated by the Mann-Whitney U tests (see Table A25).

Significant Findings

Significant findings.

S3: Learning

S3: Learning. Participants in the control section agreed less (*Mdn* = 4.00) than participants in the treatment section (*Mdn* = 5.00) when asked if they learned a great deal in the course, $U = 61.50$, $z = -1.91$, $p < .017$, $r = -0.45$. This statistically significant result reflected a medium effect size and a substantive finding.

Visual inspection of the frequency distributions indicated that different levels of agreement with the statement likely contributed to the significant results (see Figure B17). Overall, eight participants in the control section *Agreed* that they learned a great deal in the course. Nine participants in the treatment section *Strongly Agreed* and an additional five students *Agreed*. When combined with the *Neutral* responses, the control section frequencies appeared to denote a different degree of agreement towards the amount of learning that occurred during the course. However, both sections generally concurred that they learned a great deal regardless of the section.

S4: Worthwhile

S4: Worthwhile. When asked if the course was worthwhile, participants in the control section expressed less agreement (*Mdn* = 4.00) with the statement than participants in the treatment section (*Mdn* = 5.00), $U = 59.50$, $z = -2.56$, $p < .013$, $r = -0.46$. This statistically significant result reflected a medium effect size and a substantive finding.

The two frequency distributions reflected different levels of agreement and disagreement (see Figure B18). Although 63% of participants in the control section expressed some level of agreement with the statement, two individuals *Strongly Disagreed* and one person *Disagreed* that the course worthwhile. On the other hand, 93%

of the participants in the treatment section either *Agreed* or *Strongly Agreed* that their experiences made the course worthwhile. The small sample sizes made these results more apparent: Some participants in the control section did not agree that the course was worthwhile while nearly all of the treatment section indicated some level of agreement.

S5: Goals

S5: Goals. When asked if the instructor defined and adhered to course requirements, participants in the control section expressed less agreement (*Mdn* = 4.00) with the statement than participants in the treatment section (*Mdn* = 5.00), $U = 56.50$, $z = -2.72$, $p < .01$, $r = -0.49$. This statistically significant result reflected a medium effect size and a substantive finding.

Approximately 93% of participants in the treatment section either *Agreed* or *Strongly Agreed* that the instructor defined and adhered to the course's goals and requirements. In contrast, two participants in the control section *Disagreed* and one individual *Strongly Disagreed* with this statement. These responses, when combined with two *Neutral* replies for the control section, likely accounted for the significant difference that was observed in the inferential analysis (see Figure B19). There was greater variation amongst the control section as to the course's value as compared to a general level of agreement from the treatment section.

S6: Approachable

S6: Approachable. Participants in the control section expressed less agreement (*Mdn* = 4.00) than participants in the treatment section (*Mdn* = 5.00) when asked if the instructor was approachable and available outside of the classroom, $U = 51.50$, $z = -2.96$, *p* < .008, *r* = -0.53. This statistically significant result reflected a medium effect size and a substantive finding.

The frequency distributions for the two sections contrasted visually (see Figure B20). The most apparent observation was 12 participants in the treatment section *Strongly Agreed* that the instructor was approachable and available outside of class. The frequency responses from the control section varied; while the most frequently occurring reflections indicated some level of agreement, there were three *Neutral* and two *Disagree* replies. There was greater variability for participants in the control section as to whether or not the instructor was available and approachable outside of class meetings.

S7: Teaching

S7: Teaching. The degree of agreement about the instructor's teaching efficacy was statistically significant. The distribution of responses from participants in the control section reflected less agreement (*M* rank = 10.69) that the instructor was an effective teacher than did the distribution for the treatment section (*M* rank = 21.67), *U* = 35.00, *z* = -3.55, *p* < .007, *r* = -0.64. This statistically significant result reflected a medium effect size and a substantive finding.

The frequency distributions for the two sections showed different responses for the two sections (see Figure B16). All of the participants in the treatment section either *Agreed* or *Strongly Agreed* that the instructor was an effective teacher. Conversely, four of the responses for the control section either *Disagreed* or *Strongly Disagreed* when responding to the same prompt. Furthermore, only 50% of the respondents from the control section expressed some level of agreement with this statement. Although no claims were made about the median values or measures of central tendency, the two distributions were statistically different, and the treatment section expressed higher agreement about teaching efficacy.

Non-Significant Findings

Non-significant findings. Responses to two of the statements failed to achieve significance when evaluated against sequentially-created *p*-values. For the diversity statement (*S1: Diversity*), there was not a statistical difference between the control section (Mdn = 4.00) and the treatment section (Mdn = 4.00) on levels of agreement, U = 75.50, z = -1.91, p = .064. Likewise, there was not a statistical difference on levels of agreement between the control section (Mdn = 2.00) and the treatment section (Mdn = 2.00) on the statement about preparation time spent for each course (*S2: Time*), U = 112.50, z = -0.36, p = .859. The null hypothesis was retained for both of the statements.

S1: Diversity

S1: Diversity. When asked if the instructor made an effort to address diversity or equity, nine participants in the control section said that they *Agree* or *Strongly Agree* with the statement (see Figure B21). Thirteen participants in the treatment section reported that they either *Agreed* or *Strongly Agreed* as well. The similarity in frequencies for this response was believed to be the reason for the non-significant results for this dependent variable. As a whole, both sections responded with more agreement suggesting that the instructor did address diversity and equity in both sections.

S2: Time

S2: Time. The absence of statistically significant differences on *S2: Time* was likely due to similar responses across the two sections (see Figure B22). Nine participants from the control section and 11 from the treatment section indicated that they spent *1-3* *hours* preparing for the course outside of class. The remaining responses fell into the *4-6 hours* category for both sections except for one participant from the control section who spent *Less than 1 hour* preparing. Despite the apparent sameness, three preservice teachers from the control section wrote that they spent too much time working on course requirements given the course's two-credit designation- nobody from the treatment section expressed similar beliefs about the workload in the open-ended section of the course evaluation.

Treatment-Only Statements

The treatment section also received four additional statements which were not included in the inferential analysis because there were no matching items for the control section (see Supplemental Material C6). Three of the prompts contained Likert-scale options and one was an open-ended writing statement. Participants' written reflections on the open-ended statement were recorded but not statistically analyzed.

Unlike the common statements that both sections received, the special prompts were created by a university professor who served as an adviser and expert in the intentional teaching framework. Each one was designed to highlight aspects of the treatment section's course construction. Frequency distributions were generated for the Likert-scale statements, and the number of responses for each item were reported. All responses were collected anonymously.

Results

Results. When asked if the course structures and technologies increased the meaningfulness of the materials, participants expressed universal agreement (see Figure B23). Approximately 53% said that they *Agreed* with the statement and 47% said that they *Strongly Agreed*. However, it was unclear whether or not the structure, technologies, or some combination was the impetus for this response.

The frequency responses indicated less agreement when the statement asked if participants received more frequent feedback because of the introduced technologies (see Figure B24). Six participants answered with the *Neutral* option, five *Agreed* with the statement, and four *Strongly Agreed*. With approximately 40% of the responses falling into the *Neutral* category, the degree to which the technologies increased feedback opportunities was inconclusive despite the majority of participants expressing some level of agreement.

Finally, when asked if the course technologies increased face-to-face interaction, participant responses varied equally among three of the Likert-scale items (see Figure B25). Five selected the *Neutral* item, five *Agreed*, and five *Strongly Agreed*. Although 67% of the treatment section expressed some level of agreement, the relatively large number of *Neutral* responses indicated that there was some uncertainty as to whether or not the technologies increased interaction with either the instructor or their peers.

CHAPTER 5: QUALITATIVE ANALYSIS (PHASE 2)

The quantitative analysis indicated statistically significant differences between the treatment and control sections on the revised lesson plan outlines, final exam, and the course evaluation. To uncover possible explanations for these results, a recursive process of coding and analyzing field notes and interview transcripts was conducted. This qualitative analysis was guided by the second and third research questions.

Frequency data and relative alignment with the research questions were the two determining factors for identifying themes. When a relevant insight emerged from the data corpus, the researcher examined the theme for divergences between the two sections. This process resulted in identified topics that appeared important but were not notably different between the two sections. These instances were recorded and included when relevant to the subsequent discussion. However, most of the emergent findings featured dissimilar characteristics across the two groups of participants.

Research Question 2

> *How does the instructor's implementation of the curricula, his instructional practices, and the modes of assessment affect what learning opportunities are available in both sections of the course?*

Curricula

A component of the second research question involved examining the curricula that the instructor implemented in both sections. In the study, curriculum was defined as a purposeful and defined series of activities that were tied to both goals and related objectives (Wiles, 2009).

The instructor, Brad, taught two different course sections with similar learning objectives but vastly different curricular methodologies. The instructional goal in both sections was to increase participants' ability to effectively integrate technology in an elementary classroom. The mechanisms for increasing participants' technological efficacy varied according to the curricular approach to instruction; the control section focused on a technocentric, project-oriented approach, and the treatment section emphasized well-rounded TPACK development within the Intentional Teaching model of teacher education.

The implementation of both curricula reflected Brad's interpretation of what was necessary for novice, preservice teachers to learn new technologies. His beliefs about important elements in both the TPACK framework and the Intentional Teaching model informed what transpired in the treatment and, to a lesser extent, the control sections. As a result, what the participants gleaned from the curricula and their opportunities for learning were byproducts of Brad's approach to higher education learning.

Two themes punctuated Brad's approach to implementing the two different curricula. The first focused on Brad's belief in the importance of pedagogical knowledge. The second involved his expectation that preservice teachers in both sections engage in self-directed learning in order to understand how to use technologies. Both shaped the learning opportunities that Brad provided as well as what the participants experienced throughout the semester.

The importance of pedagogical knowledge. Brad held personal preferences about which curricular approach worked best with elementary, preservice teachers. During the first interview before meeting the participants, Brad asserted that the treatment section's curriculum was the best way to help novices learn how to integrate technology in a classroom setting. He cited the treatment group's well-rounded TPACK focus- especially pedagogy- as being preferable to the technocentrism in the control section. According to Brad:

> [I feel like the treatment section] will be more pedagogy- and technology-focused. We will be talking about how to use technology and the best practices for teaching. We are going to talk more about pedagogy. I think that's honestly where the discussion should be. In the treatment class, I feel like I will be teaching them more how to teach whereas the emphasis in the control class, I am just teaching them how to use a tool.
>
> I really do think that the treatment is the better way to do it…. [The control section] just isn't going to exist in the future. The class is going to look so much more like the treatment group and not the control group. [The best curriculum] is all geared towards the best teaching practices in my opinion. These kids don't know the best teaching practices for content. They can't know those yet because they are just not at that point in their careers or coursework.

Implied within Brad's statement was the importance of a technology-pedagogy connection that the treatment approach provided through its added emphasis on TPACK. This was especially important because, as Brad noticed, only one of the participants had enrolled in a methods course prior to beginning the class. Brad felt that the participants' notions of teaching and learning were undeveloped; what little they knew about best practices came from their experiences as students in K-12 classrooms that were decidedly teacher-centered and didactic.

While explaining his preference for the treatment section's curriculum, Brad unequivocally stated that pedagogical knowledge was essential to effective technology integration. Although he recognized that technology could be inherently engaging and transformative, knowing how to teach and understanding the ways that students learn was crucial. According to Brad:

> Adding technology to bad teaching practices doesn't make it better teaching practices. You just need to make sure that you are using it correctly otherwise it is not really relevant. If it is not improving your teaching, then you are not doing it in the right way. Or maybe you shouldn't do it. There are times when technology isn't always going to fit.

From Brad's perspective, understanding how to use technologies to support student learning was useless if paired with "bad" teaching practices. He expounded on this idea through an analogy about learning how to drive a car:

> You don't learn how to drive a car by just talking about the parts of the motor. I don't need to know how an engine works to learn how to drive a car. I need to talk about checking my blind spots, paying attention to the road. You know, the things that you are actually doing while driving.

Similar to knowing what to do when driving a motor vehicle down the road, Brad asserted that teachers needed to understand pedagogical approaches in order to effectively use a technology in an elementary classroom. He believed that simply understanding how to use a technology- knowing how an engine works- insufficiently prepared preservice teachers for the complexities of student learning in diverse classrooms.

Brad also favored the treatment section's organization because of the participants' lack of pedagogical experience with subject area methodologies. Practical field experiences and methods courses in language arts, math, social studies, and science were viewed as necessary prerequisites according to Brad. He spoke at length about the course of studies for the preservice teachers and what he perceived as a disservice the institution created by sequentially placing his course before many other education classes.

> I feel like [the participants] are lacking personalized direction. They don't know what they want to teach. It is easier for an in-service teacher to work towards integrating TPACK because they know the content that they have to teach. They also have the experience and the background [in terms of learning about] pedagogy.

> I would recommend [that the participants take this] course during the same semester that they are taking methods classes…. They could [also take] it during their student teaching so that then they can go in the next day and say, 'What do I do?' [I would make] it completely student-centered because that would really make it real. [It would be real] if these girls and guys showed up in class at night and said, 'Here is what we are doing. What can I do? Can I do something? How can I integrate technology into this?'

In the absence of general pedagogical awareness and subject area methods classes, Brad expressed a need to expose the participants to sound teaching practices in the sections that he taught. In his words, Brad wanted to show them "how you teach" with technology as opposed to "telling them about technology tools."

Brad's strongly held belief in the importance of pedagogy and subject area methodologies created personal guilt because of the way that he taught the control section. In a follow-up conversation after the study finished, Brad said that he felt that he was "selling his soul in the control section" because he knowingly implemented a curriculum that failed to meet the participants' learning needs and lack of pedagogical experience. Furthermore, Brad also perceived pressure to "deliberately act differently" for each class because of the research design, and this involved making decisions that he knew were not in the best interests of the participants (e.g., not emphasizing pedagogy in the control section when he knew that they needed this instruction).

Control section: Developing pedagogical knowledge. The research design and technocentric curriculum guided Brad's instructional activities as it applied to developing the preservice teachers' pedagogical knowledge in the control section. From the first class meeting onward, he explicitly told that group that it was "not his job to teach pedagogy" despite articulating a strong belief that pedagogical approaches were both necessary for effective technology integration and lacking in the participants' teaching repertoire. Addressing the class on the first day, Brad said:

> Pedagogy is how and why you teach something. You can't go into an elementary classroom and just lecture. There's different ways to do things. Good teachers use good pedagogy. Bad Teachers just don't use it at all.
>
> I am not here to teach you pedagogy. That's not my job. This is a teaching with technology class. You are going to get to your methods courses and they are going to teach you pedagogy. They will teach you how to teach something. I still have the textbook that my math [methods] teacher made me buy… It taught me 150 different ways to use a specific manipulative, and every day in class we would just sit there and play with different toys. We would figure out how to teach math with them. That's not what we're going to do in this class.

While Brad clearly stated that he would not directly teach specific pedagogical strategies, he did say that he would model "good pedagogy" and identify examples of "bad pedagogy" when appropriate during in-class meetings. After the preservice teachers discussed their thoughts to a question with a partner during the first meeting, Brad said the following to the class:

> I told you guys that I wasn't going to teach pedagogy but I am going to teach you things by example. What we just did is something that you will hear about a million times: It's called think-pair-share. It's where you have to think about something and then you have to talk about it in a small group. Then you have to share it aloud. This is a pedagogical strategy that I encourage you to try to find a way to incorporate it into some of your lesson plan outlines.

Modeling and identifying examples became the primary way Brad helped the control section participants develop their pedagogical knowledge.

Throughout the entire semester, Brad discussed pedagogical approaches twelve times during in-class meetings for the control section. More often than not, he referenced pedagogy in a manner similar to the aforementioned quote; Brad identified strategies that promoted student learning and examples that were less effective while showing the class a technology. These pedagogical snapshots were largely unplanned with no formal ties to a specific subject area. For example, Brad capitalized on a teachable moment during a discussion on blogging by addressing a less than ideal pedagogical approach that one participant experienced:

> Aubree: My other fear is that… and this all comes from personal experience so maybe it's up to me to reverse it. I've had teachers write the homework on the board and it will just say, 'See blog.' Well, I'm going to get home tonight and get in front of my computer and I am going to have 15 questions!
>
> Brad: I would venture to say that that is bad teaching. That's a bad use of technology and pedagogy. There's plenty of it! I am not using this [interactive whiteboard] for anything different then I was using that [projector] for. There are good ways to use technology and there's less good ways to use technology.

His hastily formulated pedagogical reflections on class topics often contained no mention of the word *pedagogy* or a clear alternative to what was described as either an exemplar or a non-example of sound teaching strategies. Control section participants were left to make the connection themselves, and this usually occurred by him stating that he was showing them a technology so that they could "talk about [the] technology and pedagogy aspect of it." However, Brad inconsistently offered pedagogical highlights during follow-up activities during a lesson. A debriefing session after participants learned how to use a digital comic strip tool during week 13 was the exception- over 50% of all identified references to pedagogy during the semester occurred during this discussion.

Apart from the first meeting and occasional references to pedagogy when discussing examples, participants in the control section explored pedagogical knowledge through their lesson plan outlines and Brad's feedback on those assignments. There was very little instruction or guidance when participants wrote their initial lesson plan outline and identified specific pedagogical approaches; Brad only told the preservice teachers the content area and grade level but made no mention of what pedagogies should be included to effectively integrate technology. As a result of the lack of direction and their limited classroom experience, most of the initial drafts involved teacher-centered, traditional activities that aligned with what the preservice teachers knew about teaching from being students in K-12 classrooms. Brad's feedback would often highlight this characteristic and make reference to why this was not the best teaching approach, but many of the participants would keep the core structure and retain the information delivery model that they understood.

Treatment section: Developing pedagogical knowledge. Separating instances of pedagogical instruction from what happened within the treatment section's curriculum was difficult for a number of reasons. First, the course organization was structured around a pedagogical approach for each of the four elementary subject areas. During each three-week module, participants learned about multiple technologies that supported a strategy that was identified as important for that content domain (e.g., science and inquiry). As a result, much of what Brad covered naturally led to discussions and connections to pedagogical knowledge, some of which were outcomes of grounding instruction in best practices for teaching. Second, Brad identified the participants' lack of classroom experience and nascent understanding of teaching as cognitive holes that needed to be addressed. He viewed pedagogical indoctrination into effective teaching practices as not only necessary but a required part of his role as an instructor. His strong belief in its contribution to effective technology integration resulted in greater emphasis on pedagogy when speaking with the preservice teachers in the treatment section.

How Brad introduced pedagogies to the treatment section followed a similar process for all of the subjects. Prior to beginning a new content area, he would assign a reading that focused on a single pedagogy that would serve as a throughline for the three-week module. The pedagogies included audience (language arts), multiple representations (math), primary sources (social studies), and inquiry (science). Brad would focus on one or two main technologies that supported the pedagogy for each subject area by spending the majority of a class period using the tool in activities. For example, all of the participants learned about *Puppet Pals* during the second week of the language arts module. Participants made animated videos using the puppet creation tool and then had a whole group discussion about how the activity related to rhetorical, informational, and social perspectives on writing for an audience. Additionally, Brad also covered supplementary tools in less depth throughout each subject area module. When studying language arts and audience, he also showed how digital storytelling using programs like *Windows Movie Maker* or *iMovie* could address both writing for audience and student engagement. Finally, Brad used his feedback on the lesson plan outlines as an opportunity to comment on pedagogical approaches that participants deemed particularly important in elementary instruction. This facet of his pedagogical instruction was similar to what occurred in the control section.

In addition to the module format which was grounded in subject-specific pedagogies, Brad also offered general strategies when appropriate and applicable. There were 33 instances when he talked about an additional pedagogical approach throughout the semester. Sometimes this occurred as a tangential discussion that paralleled the meeting's topic. For example, Brad spent time explaining differentiation when it arose during a lecture on multiple representations:

> Differentiation is when you target everyone in your classroom with different types of activities. It doesn't mean giving the smarter kids more work or giving the less intelligent kids less work. It's about giving them different kinds of work. Your higher students should be challenged and should be given higher level thinking activities while your struggling or emerging students can't quite handle those higher-level thinking activities. They might need more lower level thinking activities. Does anybody have an idea about what thinking at a low-level activity might be?

Differentiation naturally aligned with providing multiple representations of taught content to elementary students. At other times, questions from the preservice teachers prompted Brad to speak about general approaches for creating a classroom culture of learning. When a heated discussion about the election arose during the social studies module, Brad was able to tell the class how he would handle negative propaganda with students.

> Student: I have a question. How do you address the extremely negative political ads? It is going to come up especially during election years. How do you deal with those situations if they come up?
>
> Brad: You talk about it in a neutral way. You explain to them why [the candidates] are doing that. You tell them about propaganda and the smear campaign. You say that it is not the right thing to do. I think all of the candidates agree that it is not the right thing to do. You just explain that it is a part of the process- not the political process- the campaigning process. It is the job of the voter to find out what information is actually true.

These frequently occurring opportunities helped the preservice teachers learn that good instruction was more than just teacher-centered experiences.

The totality of the subject area modules, grounded pedagogies, and opportunistic moments when Brad discussed pedagogy was more robust in the treatment section of the course. It was consistent with his assertion that "pedagogy was the most important" component of the TPACK framework. It also aligned with his belief that pedagogical knowledge was decidedly lacking in the preservice teachers and should be a focus of in-class activities.

Self-directed learning and understanding technologies. A second recurring theme in both sections was Brad's reliance on participants to engage in self-directed learning to understand how to use introduced technologies. He implemented curricula that assumed a degree of student readiness for independent knowledge acquisition- what Grow (1991) described as self-managing learners capable of monitoring the known as well as how to find answers for the unknown. When paired with what might be described as more of a facilitator or consultant role, Brad placed the locus of control for what was or was not learned in the hands of the preservice teachers- especially as it pertained to technological skills and knowing how to use tools. This was a jarring experience for many of the preservice teachers who had grown accustomed to relying on the instructor to tell them what they needed to know and how they should gain that understanding (see Research Question 3). Brad only occasionally walked them through explicit "how to" steps. Instead, he expected students to make an effort to find the necessary information for themselves and ask questions when difficulties arose.

One reason why self-directed learning was prominent in both sections was because of what Brad believed the preservice teachers knew when they entered his classroom. Although he never unequivocally labeled them as *digital natives* (Prensky, 2001), Brad did state that he thought that the participants had developed technological knowledge because of their recent school and life experiences. During the first interview before meeting the preservice teachers, Brad said:

> A lot of them are going to have the experience of already having seen [technology] firsthand from the other side. These kids have only been out

> of high school for three years, and I was teaching with interactive whiteboards and iPods and personal response systems in that timeframe. They are going to likely have already seen these things and it's not going to be drastically different to them. I think that they are going to come in with a lot of base knowledge about some of this stuff. I don't know if I am going to spend much time with them telling them what a blog is, what a wiki is, or what podcasting is because they are going to know. They are going to have iTunes. They are going to have downloaded podcasts. Some of them may have taken online classes before in high school. It's just going to be very different than [what I experienced].

Brad framed both the in-class activities and the curriculum through this perspective: Much of his decision-making reflected choices that emphasized pedagogical strategies and examples (more necessary) over learning how to use technologies or tools (less necessary). This belief made self-directed learning a viable and appropriate route for learning how to use technologies. From Brad's frame of reference, participants needed to spend time learning the functional aspects of tools on their own instead of focusing on this aspect of TPACK during class meetings. The limited face-to-face experiences spread throughout the semester were better spent helping the teachers become "masters of pedagogy" rather than technically adept tool users- especially when Brad believed most of the preservice teachers entered as digital natives.

The curriculum also dictated the degree to which Brad relied on participants to engage in self-directed learning to acquire the skills to operate introduced technologies. In the treatment section of the course, participants were assigned online tutorials to watch and complete outside of class as a part of the flipped classroom component of the curriculum. These tutorials guided participants through the basic steps of using particular tools without explaining how the technology supported student learning in a particular content area or grade level. Brad allowed these tutorials to be a primary source of direct, tool-specific instruction in the treatment section curriculum with some exceptions. The treatment section's preservice teachers, in turn, were expected to watch the tutorials, self-monitor their own understanding and ability to operate a tool, and speak with Brad if questions arose from their own self-taught exploration. Although he occasionally spent time during class meetings demonstrating operational procedures, Brad did create a number of in-class activities that required participants to know how to use a tool in order to complete. The activities were often the only informal measure of whether or not preservice teachers in the treatment section could functionally operate introduced technologies.

Conversely, the control section's curriculum stipulated that the participants receive opportunities to see how technologies worked during class meetings. These instances of direct instruction were planned beforehand and aligned with the technocentric nature of the class. When these face-to-face experiences occurred, Brad often spent time guiding students through different facets of a tool as a whole class. He explicitly taught the preservice teachers what they needed to know; self-directed learning was neither necessary nor was it a required action for successfully understanding these explicit instructional sequences. Apart from these in-class tutorial sessions, preservice teachers in the control section were encouraged to teach themselves how to use tools that they might include in projects or lesson plan outlines. Brad provided very few resources, so the expectation was that the participants needed to engage in self-directed learning to independently understand how to use a tool.

Although the two curricula and Brad's beliefs informed how the participants engaged in self-directed learning in the two sections, what actually transpired throughout the semester was equally impactful. Brad's approach to introducing technologies and how to use tools differed across the two sections, and this affected how much self-directed learning was required by each group

Learning how to use technologies. In actuality, Brad used three different approaches when teaching the preservice teachers about how to use new technologies. By far the most frequently occurring, Brad showed the participants a tool himself, provided a few classrooms examples, and quickly demonstrated how to use the technology while participants watched. These quick *technology snapshots* often occurred during discussions or lectures with little to no time allotted for the preservice teachers to manipulate the tool themselves. The second instructional method involved an activity that required participants to know how to use a tool to produce some final product in a relatively short period of time. Brad employed these *technology activities* with both sections, and participants worked collaboratively in small groups as he floated around the classroom giving individual assistance. Finally, Brad provided in-depth, guided *technology tutorials* that explicitly covered steps for working with a technology. These instances happened either as in-class experiences or as online, "flipped classroom" tutorials (treatment section).

Brad's three different approaches to teaching functional technology skills- *technology snapshots*, *technology activities*, and *technology tutorials*- were coded within the transcripts for all of the class meetings for both sections. Frequency statistics revealed differences in the way Brad taught the two sections how to use introduced technologies, and this impacted the necessity of engaging in self-directed learning by the preservice teachers.

Technology snapshots. Technology snapshots were the most frequently occurring of the three identified instructional practices for teaching both sections teachers about new technologies. Acting as a brief glimpse into a potentially relevant tool, technology snapshots often occurred during Brad's lectures as a prelude to a whole class discussion.

In the control section, Brad engaged in this type of instruction 58 times as compared to only 40 instances in the treatment section. The prevalence of technology snapshots was notable and, at times, troublesome when it served as the only way that the preservice teachers learned how to use an introduced tool. Even when the curriculum outlined an in-depth, guided tutorial about a technology, Brad frequently reverted to simply showing a tool, manipulating its components himself, and then moving to a different topic. This was the case during the control section's class on interactive whiteboards. For the entire 2-hour meeting, either Brad or one of the preservice teachers manipulated a feature in the interactive whiteboard software while the entire class watched what was happening. By the end, nearly all of the preservice teachers had directly used one part of the software but nobody had experienced enough to begin to create a project or lesson plan outline from what was learned.

These technology snapshots also occurred during the treatment section- but those preservice teachers received the additional benefit of watching online tutorials at home as a supplementary learning experience (flipped classroom). The nature of the technology snapshots that exposed participants to new technologies- a superficial exposure to an available tool- required all of the preservice teachers to engage in self-directed learning if they wanted to incorporate what was discussed in a lesson plan outline, project, or microteaching experience. The treatment section just had access to more available resources in the form of online tutorials.

Technology activities. Brad also used in-class technology activities as an informal way of helping participants in both sections learn how to use specific tools. There were six distinct instances when technology activities were a component of the control section's class meetings and seven occurrences in the treatment section. In nearly all of the instances, the technology activities focused on a single tool and often lasted 30 minutes to an hour.

The activities varied, especially for the preservice teachers in the control section. This group worked on topic-agnostic tools like an Excel activity with Skittles and a comic strip made on a website called Bitstrips. Conversely, the treatment section's technology activities related to the pedagogical approach discussed in the subject area module; for example, preservice teachers examined science simulations for misconceptions when studying inquiry. However, in general, participants had flexibility in terms of working alone or with a partner, were able to ask peers questions, and received assistance from Brad as he circulated amongst the class.

Although Brad answered questions and provided instruction when appropriate, he acted as a facilitator during technology activities rather than someone who was imparting new information through direct instruction. Participants actively used the tool and discovered what was needed to operate a technology with minimal guidance. These instances of "doing" were frequently cited by participants in both sections as one of the most beneficial ways that they learned how to use a new technology (see Research

Question 3). Even more interesting was that almost all of the participants used one of the technologies that was explored in a technology activity in their assignment submissions.

Technology tutorials. Instances when Brad provided direct instruction on how to use technologies were infrequent and sporadic. In the control section, Brad provided technology tutorials in class approximately nine times over the course of the semester. Surprisingly, there were fourteen times when he did the same during the treatment section's class meetings. Regardless of section, these technology tutorials varied in terms of the amount of time that was spent instructing the preservice teachers on specific steps. However, nearly all followed a similar pattern: Brad showed them a small aspect of a technology as a whole class, the preservice teachers replicated what was demonstrated on their own computers, and he answered any questions before moving to a new topic. Sometimes what he covered was mundane- creating an account in VoiceThread- and at other times Brad showed more functional processes like performing mathematical functions in Excel. As compared to technology activities, all of the technology tutorials were succinct add-ons that supported other in-class instructional objectives.

Self-directed learning: The instructor's perspective. The range of instructional approaches that Brad used to teach students how to use new tools- from technology snapshots that required total engagement in self-directed learning to in-depth tutorials that required very little- impacted the two sections in different ways. The control section received more technology snapshots, experienced as many technology activities as the treatment section, and had fewer in-depth technology tutorials despite the technocentric curricular structure. Although not quantifiable, preservice teachers in this group likely engaged in more self-directed learning over the course of the semester than the participants in the treatment section who had the added benefit of “flipped classroom” online modules. Treatment section participants also had a higher frequency of technology tutorials and an additional in-class technology activity.

Paradoxically, Brad believed that both the treatment section’s curriculum and his instruction required preservice teachers in this group to engage in more self-directed learning than the control section. When asked how much he relied on participants’ ability to seek, find, and understand how to use technologies, Brad said:

> Well, at the beginning of the semester, the idea of the treatment group as I understood it, they were supposed to be learning about [technology] outside of class on their own… I was supposed to be providing them with learning experiences to [apply] that technological knowledge when they got to class. The control group, they were supposed to get the technological knowledge from me in class. I think in the treatment group I took advantage of that a little bit too much in that they still needed support and I didn't give it to them. I should have. There should have been time allotted in class to review it.

Although more review and additional direct instruction would have likely helped the treatment section, the control section actually needed even more guidance than Brad perceived based on what transpired in class.

Instructional Practices

Each section’s distinct curriculum provided a general structure for Brad’s approach to teaching the participants in the study. This blueprint was transformed by his unique personality and, in many ways, influenced the curricular enactment for both sections. The instructional practices that he employed, especially Brad’s sarcasm and adherence to self-directed learning, shaped what students did and did not learn. There were also indications that his style of instruction impacted the classroom culture in different ways for each class.

Sarcasm. An emergent finding in the study was Brad's sarcasm during class meetings. In order to delineate his discourse and use of language with the preservice teachers, sarcasm was defined as "...a mode of satirical wit depending for its effect on bitter, caustic, and often ironic language that is usually directed against an individual" or group ("Sarcasm," n.d.). Sarcasm played a prominent role in the field notes, course evaluation, and interviews for both sections in the study.

Brad uttered sarcastic comments, or what he called jokes, as a way to have fun with his students and lighten the classroom mood. He spoke about his use of jokes in the context of being both professional and knowledgeable; his reflections about jokes indicated that he wanted a teacher-student relationship where the participants thought of him as contributing valuable insights in a funny manner regardless of whether or not they liked him personally. From his perspective, the balance between imparting content and new knowledge (implicitly dry) in an engaging way (implicitly exciting) was important. According to Brad:

> I would like for them to view me as someone who at least knows what they are talking about. I don't care if they like me because I don't. They don't have to like me. They do need to have some respect for me in a professional context. With that in mind, I am very comfortable around people. I will make jokes that nobody thinks are funny- not me and not them. Well, I think that they are funny and usually I am the only one that is laughing at them! That is just something that I got used to [when teaching] third grade.
>
> I [am] going to make jokes with [the preservice teachers]. Maybe my target audience [will be] eight-year-olds. I am still there to have fun and that doesn't mean that I am having fun with friends. I am having fun with my students. You can still do that.
>
> Hopefully they saw that I knew what I was talking about. That is really all that matters… But beyond that, hopefully none of them are going to go out and write mean things about me. Hopefully they would say hello to me if they saw me in passing.

In the interview, Brad acknowledged that only he found the "jokes" funny and that few students actually laughed due to the type of humor or the intended audience. It should be noted that he did not recognize that his jokes were predominantly sarcastic. In this respect, Brad's sarcastic jokes were considered a negative aspect of his instructional practice.

Categorizing sarcastic language. Instances of sarcasm appeared throughout class meetings for both sections. Brad used sarcasm 69 times during ten class meetings for the control section (n = 10). In the treatment section, 54 sarcastic phrases were coded during 12 class meetings (n = 12). When normalized for unequal sample sizes, 58.2% of the sarcastic comments occurred in the control section and 41.8% in the treatment section. Of note was the fact that Brad used sarcasm the most during the first four class meetings for both the control (50 total utterances) and treatment (33 total utterances) sections.

After coding for instances of sarcasm in the field notes, each verbal exchange was categorized according to the focus or topic of the sarcasm in relation to the situation and setting. Six general themes emerged to form the structure for how Brad used sarcasm in the classroom. These included:

- Assignment Sarcasm: Instances when the instructor made a comment about an assignment or in-class activity (e.g., *"You made a website, you made a wiki, and you made a blog. You probably wondered why. You probably thought, 'This is stupid.'"*)
- Behavioral Sarcasm: Instances when the instructor made a comment about physical behavior or actions in the class (e.g., *"That was a good break. I gave you two and a half extra minutes for good behavior."*)

- Grade Sarcasm: Instances when the instructor made a comment about grades or some type of quantitative measurement associated with performance. (e.g., *"You will all fail for the day. I know that's all you care about: your grade."*)
- Incompetence Sarcasm: Instances when the instructor made a comment about academic incompetence or intellectual inferiority. (e.g., *"Alright, well, you are just incapable of learning."*)
- Sarcasm About Others: Instances when the instructor made a comment about a specific person or group of people. (e.g., *"I know that it is a woman's prerogative to change her mind, but I don't want you to send me a PDF."*)
- Sarcasm About Self: Instances when the instructor made a comment about himself or other individuals' perceptions of him as an instructor or person. (e.g., *"You are going to be in my class for another month so you can hate me… if you want."*)

Some of the categorized phrases contained code co-occurrences due to the complexities of the uttered statements. Consequently, the frequency of thematic examples was greater than actual instances of sarcasm (see Table A26).

Visual inspection of the frequency of each categorized sarcastic statement indicated differences between the two sections on two themes: *Assignment Sarcasm* and *Sarcasm About Others*. There were 15 instances of what was labeled *Assignment Sarcasm* in the control section but only 10 in the treatment section. Examples of *Sarcasm About Others* was also pronounced between the two sections; 20 instances occurred in the control section compared to only 13 in the treatment section.

While there were differences in the frequency of categorized sarcastic statements, the nature of what was said and the words that were used were dissimilar when closely inspecting sarcasm across the two sections. The most apparent divergences appeared when the phrases were labeled as *Incompetence Sarcasm*, *Sarcasm About Others*, or *Sarcasm About Self*.

Incompetence sarcasm. When Brad used a form of *Incompetence Sarcasm* with the control section, he usually commented on innate personal qualities that the participants had no way of changing. He often used terms like “stupid” and “terrible” to describe ideas. Brad also sarcastically replied to students’ questions with statements that emphasized the obviousness of what was being asked. For example:

> When explaining the type of feedback that the participants would receive from him after submitting the first draft of their lesson plan outlines, Brad said: “After the second version, I will give you more specific feedback. Things like, ‘This was a terrible Idea!’ I am not going to tell you that. But, do you understand what I'm trying to say?”
>
> As a way of encouraging participation in a whole class discussion, Brad said: “If you are horribly embarrassed about the fact that you got a D in Spanish 305 because the girl three chairs down from you is in that class and she got an A+ and you feel dumb, don't share your story. Share your neighbor's story.”
>
> While speaking directly to a student who asked a technology-related question, Brad said: “There are no wrong answers here except for the ones that aren’t right. I expect that the last [PowerPoint] slide probably told [you] the answers to this [question] so you should know. Good job.”
>
> After repeated questions from the whole class about the location of the final exam, Brad said: “There are two doors between my office and where the exam is. The room for the exam has two doors. You can enter through either.”

Although there were exceptions, Brad predominantly emphasized immutable characteristics of ideas, intellect, and awareness when using forms of *Incompetence Sarcasm* with participants in the control section.

Conversely, Brad uttered sarcastic phrases that were characteristically different during treatment section class meetings. These instances of *Incompetence Sarcasm* mostly focused on a lack of experience or some type of understanding that was not evident but could be developed with effort or time. For example:

> Addressing the observation that nearly all of the lesson plan outlines contained teacher-directed, didactic instruction, Brad said: "As much as you tried to make [your lesson plans] teacher-centered, teaching cannot just be one way- just the teacher standing up there and talking. There is going to have to be some student interaction." The students, in actuality, were not trying to create teacher-centered lessons but producing the only type of learning experience that their limited education background would allow.
>
> While discussing content knowledge in relation to TPACK, Brad said: "If you are an adult and you cannot master the content of an elementary school, you will fail. You will not recover from that sinking ship."
>
> Referring to a student, Katie, and a previous question that she had about a science simulation activity, Brad said: "Those of you who only spent ten minutes on [the simulation websites]... You guys should go and find some more things because you will not know how great these things are until you get in there and play with them. Think about what you might want to do with your lesson plans. I am not telling you how to incorporate it. Katie, here is me doing the research for you!"

Even though Brad occasionally used *Incompetence Sarcasm* in a manner that was similar to what was said in the control section, he generally referenced things that could be changed through work or increased exposure. Unlike the control section which emphasized innate qualities, treatment section participants could focus their attention on more effective teaching methods, develop their content knowledge, or do more self-directed research as a way of addressing the inadequacies implied by the sarcasm.

Sarcasm about others. The main difference between the way Brad used *Sarcasm About Others* in the two sections involved the tone that he ascribed to the statements. In the control section, the sarcasm was primarily negative in nature. He sarcastically spoke about others in an undesirable manner that highlighted bad traits or inferiorities. Sample phrases from class meetings included:

> While introducing himself to the participants on the first day, Brad said: "My name is Bradley Martinez Jenks, Jr. People called me Bradley out in the schools and it drove me crazy. I would always say, 'Brad!' People would laugh because kids are jerks."
>
> When students did not quickly begin to talk in small groups, Brad said: "Why do we want to use TPACK? Talk to your neighbors. I know that you hate each other, but you are going to have to talk to each other!"
>
> During a discussion about the first draft for the lesson plan outline and the low grades that he gave to the participants, Brad said: "This assignment is the floor and not the ceiling or anywhere else you are going to live. Unless you all are bottom feeders and you like to hang out on the floor and you see this grade and go, 'Awesome!'"
>
> When he did not have time to load a presentation before class started, Brad said: "I was hoping to have that [presentation] on the screen when you guys got here but you guys were all losers waiting for me outside the door."

In many respects, Brad's sarcasm about other people emphasized unfavorable characterizations and attributes during the control section meetings. Although the sarcasm implied that he did not really believe what he was saying, Brad spoke about the participants being losers and bottom-feeders within an undercurrent of dislike amongst the class.

Brad's sarcasm in the control section contrasted with the mostly positive phrases he used when talking about other people in the treatment section. Sample instances included:

> When talking about technology integration and the class's enrollment requirement for degree completion, Brad said: "You guys are all going to become great teachers through the methods courses because of the fact that you have it in your blood and you want to be [in this class]." This instance of sarcasm was notable because Brad understood that most of the participants enrolled in the class because ITCP was required for an

> education degree from the institution and not because they wanted to be there each week.
>
> During a discussion about his experience in elementary school, Brad said: “There are plenty of teachers that you will observe in your student teaching or doing your practicum or learning as a teacher, who just say, ‘I am not going to worry about technology!’ ...But, luckily, you are not going to be like that because you know about this awesome thing called TPACK.”
>
> As a participant was about to call on a room of her peers’ raised hands, Brad said: “Isn’t it nice to have friends in class? You have to be careful about that as a teacher because sometimes kids only pick their friends.”

Although there were negative and positive instances of *Sarcasm About Others* in both sections, Brad was often sarcastically optimistic when talking about other people in the treatment section. He spoke about how much the participants wanted to be in the class despite that fact that it was a requirement, the participants’ desire to use technology because of what they were learning, and the likeability of each individual person in the room.

Sarcasm about self. Similar to instances of *Sarcasm About Others*, a negative undertone permeated the statements that Brad used when he sarcastically spoke about himself with the control section. His comments indicated that he believed the participants did not look at him in a favorable manner because of his actions, personality, or knowledge. For example:

> During a discussion about the first draft for the lesson plan outline and the low grades that he gave to the participants, Brad said: “If you want to talk about how pissed off you are tonight about your grade with your friend in this section, go right ahead. Tell them how much you hate me. A couple of [the students] are applauding. Again, they don’t even know their grades.”
>
> Addressing an observation that some of the participants repeatedly asked the researcher questions, Brad said to the class: “They come to [the researcher to ask questions] all the time but they don’t come to talk to me. I really am an alright person.”

> After showing an interactive whiteboard activity that he had created as well as one that his wife had made, Brad said: "I was super proud of my [interactive whiteboard activity] but my wife told me it was crap. My stuff looks terrible compared to hers. But that's okay. Everybody has their own style as a teacher."

> When talking about social studies content knowledge and the TPACK framework, Brad said: "I could take [a third-grade assessment] but I would fail fourth grade. I do not know anything about Virginia history."

Conversely, Brad was generally positive when he sarcastically spoke about himself with the treatment section. He emphasized his empathy, knowledge, and instructional practices in tones that denoted prosocial, humanistic qualities. Sample quotes included:

> As a way of introducing the mandatory attendance policy during the first class meeting, Brad said: "Everything that I say will be so valuable that you will just want to be here. You will be sad if you miss class. You will need to be here and you will need to be participating. That will be 10% of your grade."

> At the beginning of a class meeting before introducing the meeting's topic, Brad reflected on seeing K-12 students boarding a bus: "I saw some kids getting on the bus this week and I almost started crying."

> When an interactive whiteboard activity did not work during a presentation, Brad said: "All right, let's just skip this page. I apologize. I wish that I could take credit for making this awesome thing but obviously now I won't because it is failing."

> Answering a participant's question about how to respond to a statement on the course evaluation, Brad said: "Oh, I guess that you have to answer all of them… Just make sure that you do good for me. That's okay to say, right?"

There were exceptions; Brad's self-directed sarcasm portrayed him in a positive and negative manner in both sections at different times throughout the semester. However, his collective use of *Sarcasm About Self* tended towards positive characterizations in the treatment section and more negative perspectives in the control section.

Control section: Reaction to sarcasm. Although no formal questions appeared on the course evaluation or interviews, participants in the control section offered unsolicited comments about Brad's discourse and language. Their reflections indicated differences in the way his words were interpreted. Nobody in the treatment section referenced discourse, sarcasm, or jokes in any of the interviews or course evaluation responses.

When asked to make comments or observations about the class on the course evaluation, three participants in the control section mentioned the tone and type of dialogue Brad used in class. These anonymous comments included:

> "...Overall, I felt that the instructor tended to speak to the students in a somewhat condescending tone especially if the students were not technologically savvy…"

> "..He was also very rude and sarcastic which made him unapproachable and cold. I bitterly regretted taking this class with him and wish I took it with another professor…"

> "...I thought Brad was a valuable teacher. He did not sugarcoat anything in regards to the teaching world, thus painting the true reality of what we face as teachers with technology. He maintained a professional attitude and offered a great sense of humor. His passion for teaching is evident…"

The varied responses to Brad's dialogue were inconclusive and not generalizable to the section as a whole.

One student, Eleanor, spoke about her interpretation of Brad's sarcasm and the way in which his dialogue affected her relationship with him. When asked if she had any comments or questions at the end of the final interview, Eleanor said:

> Eleanor: "My concern is that Brad had a knowledge of teaching elementary students but he didn't know how to teach college students. If that makes sense."

> Researcher: "Did you feel like his demeanor or mannerisms in class bothered you a little bit? Is that what I am hearing?"

> Eleanor: "Oh, yes. Definitely. Yeah."

> Researcher: "Was it the way that he spoke to you? Was it the way that he…"

> Eleanor: “Yeah. He is very sarcastic. Those kind of things. I felt like I was in high school a lot of times instead of being in a college class.”
>
> Researcher: “Did that lessen his professionalism for you?”
>
> Eleanor: “Yeah. I just feel like there are certain things that he would say, you know, when you would ask him questions or things that would make him, in a sense, unapproachable. His comments were very sarcastic and so that is what I felt. It was like your high school teacher who you are not going to say anything back to them. You are not going to say anything.”

It was unclear whether or not Eleanor’s reflection was a generally held sentiment among more of the control section participants. However, she made a point to speak about her feelings when asked to comment about her experience in the class.

Assessment

Both grades and the instructor’s feedback were important components of both sections’ curricula. At times, what Brad asked them to complete was interpreted by the preservice teachers as unfair and unreasonable, and they also expressed frustration over their grades and the amount of feedback given when they perceived assignments to be inadequately explained. While some of the negativity associated with assessment in both sections was attributable to the research design, Brad’s approach to assessing student learning impacted how the participants felt toward the course assignments and the grades they received.

Brad entered the semester believing that the enrolled preservice teachers were motivated to become better teachers and, as a result, willing to perform tasks that would improve their capacity to help students learn. As a part of the first interview, Brad reflected on how he perceived the entering students would react to his instruction and the curricula:

> I think that the preservice teachers will want to learn everything that I have to say to them as the instructor because this is their chosen path.

> They are there because they want to be there, especially in a college setting where they literally don't have to show up if they don't want to…. Preservice teachers are motivated to learn because it is what they want to do. I think that, for that reason, it should be even more critical that we are giving them things that they need to know. It's my job to prepare them to enter the workforce and use my experiences to prepare them as best I can.

This belief was due, in part, to Brad's approach to learning as a college student who studied education in a teacher preparation program: He was motivated to learn for learning's sake and not for a grade. However, Brad's impression of the preservice teachers' motivation changed as the semester progressed. Instead of feeling like professionalism and personal growth spurred the participants to excel, Brad thought grades were more important to the preservice teachers by the middle of the semester. During an interview, Brad said:

> They don't care about learning- they want to get good grades. Meanwhile, I am completely the opposite. I don't want to know my grade; I just want to learn the stuff so that I can be done and leave. It's troubling in that I realize now that I have done what I intended to not do. At the beginning of the semester, I was like, 'It should not be about you trying to please the teacher when you fix the assignments for a grade. It should be about what you learned.' Yes, it's troubling from a student learning…. standpoint.

As a quantitative measure, grades served as markers for the preservice teachers; for some, grades were indicators of performance on an assignment while others expressed that their grades reflected whether or not they would become good teachers. Some of this sentiment came from the first lesson plan outline in language arts during the third week; most of the preservice teachers received low grades when the assignment was returned to them. For many of the participants, ITCP was the first education class that they had taken and, when they did not earn a grade that they expected, voiced concern and frustration to Brad. This, in turn, prompted Brad to discuss grades often during subsequent meetings.

Over the entire semester of in-class meetings, Brad brought up grades or grading scales approximately 24 times in the control section and 31 times in the treatment course.

Although there were no discernible differences between the two sections in terms of frequency or what Brad said about grades, assignment scores motivated participants in the control section to revise and re-submit their lesson plan outlines. For these students, a low grade meant a greater need to incorporate Brad's accompanying feedback into a revised version. For example, Aubree never altered a submitted assignment based on what she learned in class or examples that she saw during in-class meetings. It was always a combination of her grade and Brad's comments. In total, six of the seven interviewees from the control section stated that it was their grade that motivated them to apply Brad's suggestions for improvement.

Interestingly, preservice teachers in the treatment section revised their lesson plan outlines for different reasons despite Brad mentioning grades more often during class. For example, Bianca re-wrote her math lesson plan outline because she felt like the activity in her original lesson plan "wasn't going to work" after experiencing some of the in-class examples that Brad discussed. Katie also changed her math lesson plan outline after learning more "methods" and pedagogical approaches that were better suited for teaching number sense in a kindergarten classroom. Finally, Melissa said that it was not her grade but the curricular modules that prompted her to consider any changes to a submitted lesson plan outline, especially towards the end of the semester when Brad provided less explicit feedback. In total, four of the seven participants who were interviewed said that grades were not the primary reason for altering the initial draft on lesson plan outlines.

Research Question 3

> *From the standpoint of the preservice teachers, what opportunities to learn do they experience in the treatment and control sections?*

Each section of preservice teachers articulated distinct feelings about the curricula and how it affected their capacity to integrate technology. Although common themes existed between both groups, inter-group differences were the primary focus of the qualitative analysis for the third research question. Methodologically highlighting dissimilarities uncovered contributing factors that likely affected differences on the summative assessments between the two sections. Midpoint and concluding interviews were the primary data sources used to understand the preservice teachers' perspectives on the curricular opportunities that promoted learning and growth.

Out of all of the participants' self-reported statements, four broad topics surfaced that highlighted different thoughts between the treatment and control section on their opportunities to learn about technology integration. These included:

- *Knowing: Course Readings*- Although neither section believed that the assigned readings played a prominent role in what they learned, the reasons why the articles were unhelpful varied. Preservice teachers in the control section felt the readings were unrelated to class topics whereas the treatment section participants thought that the texts were too narrowly focused on one technology or pedagogical approach.
- *Seeing: Classroom Examples, Case Studies, and Microteaching*- Preservice teachers from the control section asserted that seeing classroom examples of effective technology integration was a missing element in their curriculum. Similarly, most treatment section participants found that watching the case studies

and microteaching experiences promoted growth and understanding for a variety of reasons.

- *Doing: Projects and Microteaching*- Both sections stated that doing something with technology was one of the most beneficial aspects of the course. Preservice teachers from the control section felt that the projects were most helpful because these activities forced them to learn how to use an assigned tool. Treatment section participants strongly preferred microteaching due to the fact that it helped them actively use technology in a simulated classroom environment.
- *Breadth and Depth of Technology Exposure*- The two sections differed as to whether participants wanted to cover more technologies in less depth or fewer tools in greater depth.

Although it was unclear whether the variation across the two sections led to differences in performance on the summative assessments, the preservice teachers believed that the aforementioned topics influenced what they learned from the course curricula and their capacity to integrate technology into an elementary classroom.

Knowing: Course Readings

The assigned course readings acted as mechanisms for increasing participants' knowledge about technology integration in elementary classrooms. While all of the texts provided background and context for in-class content, the general characteristics varied for each section's readings. The control section received articles that were written for practitioners and covered basic examples of technology integration, trends in the field, and broad approaches to technology use in K-12 classrooms. The texts for the treatment section were different; participants in this group read pedagogically-based selections that were chosen by methods professors, some of which contained no references to technology. This purposeful differentiation resulted in mixed responses with regard to what participants learned as well as the overall usefulness of the readings.

Universal reactions to course readings. The preservice teachers' reactions to the assigned texts reflected both positive and negative feelings within the two sections. Overall, the frequency of negative statements was greater for both groups when participants were asked to speak about the readings during the interviews (see Table A27). Although there were slightly fewer positive statements in the treatment and control sections, the response frequencies for this type of statement were close to the number of negative statements. Close examination of the categorized comments about each curriculum's text failed to reveal clear trends. However, what was learned or not learned was different for participants in the treatment and control sections.

More often than not, participants in either section said that the readings were beneficial when the text included interesting examples. Samantha, a participant in the treatment section, felt like the readings legitimized what occurred during each class meeting. For her, reading about classroom experiences when a technology tool promoted student learning helped to affirm her belief that "this works." Irene also felt that the control section's articles were interesting when the text gave "you ideas on how you could [use technology in a lesson]." While often cited as a learning aid, examples from the readings were seen as secondary to other course activities like projects, microteaching, and case studies. Kinsley, for example, felt that the mental images from examples in the articles "were helpful but it [wouldn't have been] if the whole class had been based on the readings."

Although negative reactions to the readings were different across the two sections, themes emerged from the analysis: Control section participants found the assigned readings to be too unrelated to Brad's instruction and the treatment section participants felt that the readings were too narrowly focused on one tool or pedagogical approach.

Control section reactions to course readings. When participants in the control section held a negative perspective on the assigned texts, they most often stated that the readings were "not challenging" or unrelated to what Brad discussed during class. Some labeled the readings as "boring" while others had trouble recalling basic information like the reading's topic weeks after being assigned. According to Sophie:

> The readings haven't really done much for me. I don't know if all of them are extremely relevant…. I think it is more learning about the technology and then thinking of ways that they would be helpful in the class. That is really what helps me understand the technology and then think about its usefulness. The readings didn't really help that much but mainly because I get really bored by readings in general. I chose either to just not read them or read them very quickly and completely forget about them.

Aubree also found the readings to be irrelevant and misaligned with what Brad chose to do in class. From her perspective, Brad acted "like the readings really didn't matter" except for the quizzes that the participants would take during class. Consequently, Aubree chose to read the assigned texts when she needed a "break from other really intense homework assignments."

Positive reactions to the control section's readings were focused on specific articles that resonated with individual participants. During an interview, Irene stated that she benefited from articles on digital images and podcasts because "it was interesting seeing how other teachers [used the tools] which gave her ideas on how to use them." Likewise, Gabbie found the article on the estimation calculator to be valuable:

> I feel like the estimation calculator reading was definitely a good definition of integrating place value understanding with a piece of technology. But it was pretty complicated for me! I don't know how I felt about the estimation calculator. At the same time, I don't know if I could have come up with anything better to do with them to get them to have to estimate something first.

There was no evidence that a single article helped the majority of the preservice teachers in the control section. Ones that contained classroom examples or stories appealed the most to the participants. Additionally, none of the interviewees stated that the assigned readings, as a whole, impacted their capacity to integrate technology in an elementary classroom. The readings' primary value was as a primer or prelude for what would be covered the following week but did little to bolster overall knowledge.

Treatment section reactions to course readings. Participants in the treatment section often disliked the readings because they were perceived as being too narrowly focused on one particular technology or pedagogical strategy. As a novice teacher with no classroom experience, Katie felt that an emphasis on practical classroom strategies with a variety of tools would have been more beneficial for her. Ansley also stated that she "connected more with the ones that were not" directly tied to technology; she felt that the articles that had more explicit instructions on classroom management, approaches to teaching, and methodological activities better addressed her learning needs. Jane best summarized the feeling that the readings in the treatment section were not properly balanced in terms of diverse technologies coupled with related pedagogical strategies:

> I don't know if I would eliminate the readings necessarily, but I would make the readings more pedagogically and technology integrated. I feel like the readings are pretty much solely pedagogy and then separately we learn about the technology. It would be nice, similar to the case studies, if it was more integrated instead of me trying to piece together how the two work. [I would like the readings better] if they were presented as how the [technology and pedagogy] truly fit together.

Each article's specificity as well as the perceived lack of TPACK cohesion prevented some of the participants from "understanding how technology fit in an elementary classroom."

Unlike the control section, none of the interviewees expressed an affinity towards any of the individual articles. When a positive statement was made during the interviews, participants most often said that it was a classroom story or curricular example that made the reading worthwhile. According to Samantha:

> The readings have definitely helped me just because a lot of them have told little stories about what was successful in a classroom. Or [the readings] just give you a huge list of activities that you can try to incorporate and use some sort of technology. The readings were nice in that regard…

Melissa also stated that it was the practical, understandable classroom connections that increased her knowledge of how to think about technology integration in an elementary classroom.

Seeing: Classroom Examples, Case Studies, and Microteaching

Participants from both sections felt that seeing classroom examples of effective technology integration was an important, but sometimes missing, element that impacted their learning. Whether it was listening to Brad model a lesson that he taught to his elementary students, watching a video-based case study, or participating in a peer's microteaching experience, seeing how other people implemented technology in an activity contributed to their overall conceptualization of technology integration. For some of the participants, observing how a teacher handled troubleshooting issues with children was what they wanted to view. Still others wanted to see a technology that Brad discussed in an actual classroom in order to glean ideas for future replication. Regardless, seeing real examples of teachers using technology was a critical curricular aspect for the novice preservice teachers in the study.

Control section reactions to not seeing classroom examples. Watching case studies or participating in microteaching experiences were not included in the control section's curriculum. Most of the classroom snapshots of technology integration came from Brad's stories and model lessons, and a number of the interviewees found this instructional practice both entertaining and enlightening. Yet, some of the preservice teachers in the control section wanted more concrete instances that showed "students and teachers using" technology as evidence that it was feasible in an elementary setting. According to Eleanor:

> I want to see an elementary class doing it. I mean I guess they could [use technology] with a lot of scaffolding. You would have to help a lot. In a middle school or high school class, they have learned how to use the technology quickly and they can do it themselves. But, with an elementary class, you would have to really- you are only one person so you would have to be with everyone to help them out. I don't know how- I'm sure it's possible, but I don't know how to do it.

One of Eleanor's classmates, Sophie, echoed this statement; both participants felt like they needed to watch another classroom in order to see that it was possible to use technology with younger students. Sophie also stated that viewing classroom technology implementation would help to address her self-identified "fixed mindset" against elementary technology integration; she expressed that she was "going to fight it, tooth and nail." According to Sophie, observing a successful lesson with engaged students might alleviate her fears and promote change in "stubborn-minded individuals who really did not like the idea of using technology in the classroom."

Two other control section participants, Gabbie and Kinsley, wanted to watch classroom case studies so that they could better incorporate technologies that Brad introduced. Both recognized that their integration skills were undeveloped despite learning how to operate tools and demonstrating what they knew in projects and lesson plan outlines. For them, an in-depth understanding involved more than knowing where to click and reading about tool use in classrooms; Gabbie and Kinsley said that seeing carefully identified cases might be a useful way to glean teaching strategies and pedagogical approaches for implementing technologies like VoiceThread and iPods with elementary students. Gabbie went on to say that a field experience in an actual classroom would be very beneficial; witnessing practical, real activities involving students and teachers learning through technology was important. However, she was uncertain about how this might occur in the control section's curriculum.

Treatment section reactions to case studies. The curriculum for the treatment section included four video-based case studies, one for each of the elementary subject areas (see Table A28). Three of the case studies- math, social studies, and science- were developed specifically for the treatment section's modules. These case studies were delivered online with guiding questions and built-in assessments, and Brad assigned them as homework assignments but did not discuss them during class. The language arts case study was the only one that differed; Brad used a case study from Annenberg Media that the treatment section watched and discussed during one of the class meetings.

The most commonly stated benefit of the cases was that each one was a "real life example" that showed one teacher's approach to using technology in a classroom setting with multiple students. Watching another teacher integrate technology into an activity provided actionable steps that could be "stolen" and replicated in another classroom. In this respect, video-based case studies were considered to be the synthesis of technological and pedagogical knowledge. According to Jane:

> I think that it has been another medium through which we can see how technology is used. It does incorporate the pedagogy more than I think the readings [do.] I think that it is more of a combination of like, 'Hey, this is the material that we are going to use. Here are some instructional approaches about how to use it with the technology.' I guess it is more of a balanced approach. If we are reading about the pedagogy and then we are learning about the technology separate, [the case studies] are combining them.

This act of seeing a classroom served an especially important role for the participants who articulated this benefit; the video case studies provided a practical foundation from which to build the largely theoretical, context-agnostic activities that occurred during the course meetings.

Apart from the value of real life examples, participants from the treatment section also described how the case studies contributed unique understandings about technology integration and course objectives. Although these benefits were not widely held across all of the interviewees, each one was emphasized as being an important factor in overall satisfaction with the course as well as what was learned from the case studies. These included:

- The video case studies promoted greater reflection and deeper forms of thinking than other course activities. The embedded questions in the math, social studies, and science cases forced participants to consider things like "the teacher's role…. and asked for some deeper reasoning behind what the teacher was doing and why."
- The video case studies provided justification for including technology into a lesson because of the observed student engagement. Two of the participants, Liza

and Jane, both felt that seeing how students reacted to the technology was valuable because it made them realize that the students' "experience…. and perspective" was not wholly considered when developing lesson plan outlines.

- The video case studies showed authentic activities that excited the participants in ways that just learning about TPACK in class did not. Liza reflected on the science case that showed students making paper speakers by saying, "I think that the kids were actually creating something that could be used in the real world. The speakers actually worked…. I thought that was a really, really cool hands-on activity that combined all of the knowledge that they had into a project that had a real-world basis to it."

While promoting reflection was an intended objective for the video-based case studies, observing student engagement and seeing authentic activities were not identified as learning goals. However, each one would not have occurred without including cases into the treatment section curriculum.

Despite stated benefits, there were a number of ways that the case studies could have been designed to be more helpful for participants in the treatment section. First, some felt that there was not enough direct explanation about what to examine in the videos. Ansley felt that simply responding to prompts like "What questions would you ask?" after a video clip insufficiently supported her novice perspective on what was transpiring. Having never taught before and not having an opportunity to share possible questions made this "unhelpful." Second, multiple interviewees stated that the math, social studies, and language arts cases studies contained too many reflection questions. For Katie, answering all of the questions made the case study more about doing the assignment and less about "getting a full understanding" of TPACK and technology integration. Finally, Ansley and Katie both believed that they would have learned more if all of the case studies followed a format similar to the language arts video. Instead of having multiple clips punctuated by text, watching an entire lesson unfold would have given them better context and greater understanding than seeing snippets and interviews.

Treatment section reactions to microteaching. Observing classmates deliver a lesson during the microteaching activities was also a valuable opportunity to see technology integration and learn from peers. What was gleaned by the preservice teachers included both positive and negative teaching strategies and pedagogical approaches. According to Ansley:

> I would see examples of things and be like, 'Oh, I would not have chosen to do that. Or I probably would have done that.' I would also be like, 'Oh, wow, that really worked well in my mind but it did not work so well when teaching [during the microteaching].' Just seeing, I think, is the most beneficial part of the course.

Observing another novice preservice teacher do their microteaching, noting strengths and weaknesses in their pedagogical approach, and then engaging in a microteaching experience was beneficial. For Katie, watching the staged teaching scenarios helped her to grow her own knowledge about technology integration:

> I definitely enjoy the microteaching. As we got further in the semester, [watching others microteach] became more and more of the class and it was helpful to watch students use technology. It was really helpful to watch people like me try to teach- to see the problems that I might encounter and think about it. Then do it myself.

Not only did microteaching provide an opportunity for participants to use technology in a staged classroom environment, but it also enabled audience members to critically examine teaching practices that incorporate technology.

Doing: Technological Knowledge, Projects, and Microteaching

Actively manipulating tools under Brad's guidance, creating products that required comprehensive knowledge of tools and classroom settings, and engaging with taught content through microteaching were some of the most beneficial aspects of the two curricula according to the participants. These instances of "doing" helped the preservice teachers apply what they learned in a new context. The relative importance of doing something with a technology was evident in all of the interviews; none of the interviewees stated that this was unimportant or an ineffective aspect of the curricula despite varying responses as to whether or not participants liked specific activities (e.g., lesson plan outlines, projects, etc…).

Universal reactions to doing. Participants in both sections felt that there was an insufficient amount of direct instruction on how to use introduced technologies while directly manipulating the tools. There were six different instances when interviewees from the control section expressed frustration with the lack of structured, in-person assistance while "doing something" with new tools. Although only three statements reflected similar feelings in the treatment section, the frequency of these sentiments was notable given the small sample size for the interviews. When articulated, participants often stated their frustration with "the quick dips" into a technology without enough time to "play under somebody's supervision." They felt as if they were being "thrown into a technology" with the expectation that they could figure out the tool without explicit help. Stella, a participant in the control section, expressed her dissatisfaction with this instructional practice when developing her interactive whiteboard project:

> I wish we had more time in class to actually sit down and have Brad in there helping us go through [something like the] SMART Board. During

> our projects, we basically have to do everything on our own. It took me hours to figure out just the simple stuff in the SMART Board activities. I feel like doing that would be a lot more effective with my time. I wouldn’t have wasted so much time if he had gone over some of the basics in class and gotten a full class to work on the activity there.

These feeling likely arose from Brad’s emphasis on self-directed learning as well as his instructional practice of showing examples without providing hands-on use of the introduced technology. Nevertheless, preservice teachers in both sections wanted more direct, immediate instruction about how to use technologies that were featured in class.

Participants from both sections articulated that their confidence and capacity to integrate technology grew when Brad provided instruction on how to use a technology during class meetings. Jane, a student in the treatment section, stated that the “hands-on working with [technology]” impacted what she learned but that she did not spend enough time learning the tool when it was for homework. Furthermore, she admitted that there were times when she would turn in a lesson plan outline and have no idea how to use an included technology but she would still receive a good grade for the assignment. Similarly, Eleanor’s experience as a participant in the control section was negatively impacted by too few instances of direct, hands-on instruction about how to use a tool:

> It's kind of like I wouldn't really know how to go about even making [a lesson with a particular technology]. I mean, I understand the details of using something like virtual tours. You understand that but you don't really know how you would go about doing it in a sense…. I could explain what it would be about and I can probably see the overall view of it but I wouldn’t know how to do it. It's kind of like a play. You see it but you don't know everything that happens in the [background].

For Eleanor, Jane, and other preservice teachers, receiving in-person guidance on how to use a tool was a critical but missing element in their understanding of technology integration. Brad rarely spent in-class time on direct instruction around tool use or procedures; a lesson on how to use the interactive whiteboard was one of the few instances when this occurred. This was a philosophical decision according to Brad. He emphasized self-directed learning with both sections by giving the students online resources to help them gain the technical knowledge that he believed the participants were cable of understanding on their own.

Control section reaction to projects. Out of all of the activities that required some degree of "doing," developing a project that incorporated some pre-selected technology was the most beneficial assignment for participants in the control section. Eleven statements referenced the positive growth gained from making a project using an interactive whiteboard, blog, website, podcast, or video. For preservice teachers like Irene, projects offered an opportunity to personally explore a tool in order to determine what she did and did not understand about how to use the technology. When misconceptions arose during her self-directed learning, she would often meet with Brad during his office hours before submitting her final project. For others, creating projects instilled confidence because of Brad's emphasis on self-directed learning. According to Aubree:

> I think that the biggest things that the projects did was just give me confidence to know that, 'Okay. I know that I don't know how to do this but in 30 minutes I will.' I just had to play around. I think that was my biggest take away from having to do the projects.

Like Aubree, Gabbie also became increasingly comfortable with her own ability to figure out technologies without assistance as a result of being "forced to do [her] own research" in order to complete a project. For the control section, each one of the projects was a measure from which the participants could self-assess what they understood about how to use a technology- a finding that aligned with the technocentric nature of the curriculum.

Treatment section reactions to microteaching. During the interviews, preservice teachers in the treatment section stated that microteaching was one of the most influential factors that contributed to their growth over the course of the semester. The primary reason why microteaching impacted the participants was that this experience provided them an opportunity to act like a teacher in a simulated environment. For example, Bianca said that "doing the microteaching" shaped her understanding of technology integration because "she could read as much literature [about using technology in a classroom] but nothing is going to reinforce that knowledge as much as carrying it out" in a classroom. Like Bianca, Melissa felt that the microteaching captured the essence of technology integration more than writing lesson plan outlines because it more closely resembled what they were going to do as teachers: "teaching material through technology."

Breadth and Depth of Technology Exposure

A general curricular modification that was repeatedly broached during the interviews pertained to the number of technologies introduced during a class meeting. A number of participants in the control section felt that their learning would be enhanced with in-depth explorations of technologies for particular lessons or standards. They wanted more real-life examples that directly connected a tool to a learning objective rather than an "overview" that just focused on exposure. The control group participants expressed a need for contextualized exemplars that were more robust and could be used as models for assignments and projects. Conversely, a number of participants in the treatment section felt that Brad did not cover enough tools. Too much time was spent on one tool and, in some cases, activities like "playing games" that did not transfer to practical classroom applications. By adding smaller projects that required more hands-on use of multiple tools, some believed that they would be better able to address diverse learners with various pedagogical approaches. The differing desires for what was shown during class meetings for the two sections indicated the importance of balancing depth and breadth when providing instruction to novice elementary teachers.

Self-Reported Capacity to Integrate Technology

Participants in both sections were asked to reflect on what changes, if any, the course had on their capacity to integrate technology into an elementary classroom during each of the interviews. Their self-reported answers to this question served as another perspective on what was learned in each section apart from the formal summative assessments that measured skills, abilities, and understanding. Furthermore, the opportunities to learn about technology integration in each section likely impacted what the participants perceived as the benefits of the course.

All of the interviewee's responses to the question were categorized after initial identification. Five themes described all of the participants' self-reported ways that their capacity to integrate technology changed because of the course. These included:

- Awareness or Exposure: Changes in awareness or exposure to technologies that could be used in an elementary classroom (e.g., *"I think that, at the beginning of the semester, I would not have probably integrated technology into my lesson plans just because I didn't know about any of the things that are out there."*)
- Understanding of Effective Technology Integration: Changes in knowledge about what effective technology integration looks like in an elementary

classroom (e.g., *"I think that I have gained an understanding that it doesn't necessarily have to be a teacher standing up in front of a smart board- you can use technology in a variety of different ways in your classroom."*)

- Willingness or Openness to Use Technology: Changes in willingness or openness to using technology in an elementary classroom (e.g., *"I stepped back and just laughed at myself because I guess that at the top of the semester I would have really scoffed at the idea of technology…. [Now] I recognize the endless amount of options and possibilities."*)
- Tech Skills or Abilities: Changes in ability to use technology or the addition of new skills as a result of the course (e.g., *"I can effectively use a lot of the technologies that we discussed. It was nice to know different pedagogical approaches that could go along with those technologies."*)
- Qualified Statements: Instances when the participant stated one of the other four changes but qualified what was said with a caveat that was often negative (e.g., *"I wouldn't say that I am 100% comfortable with these new things that were introduced, but I would like to get more comfortable with them. I would like to use them in my classroom."*)

All but one of the responses reflected positive changes in the participants' capacity to integrate technology (see Table A29). However, a number of individuals qualified their declarations with a deficiency that prevented them from truly being able to integrate technology effectively.

There were seven statements from the control section that indicated that the course increased a general awareness of available technologies for elementary classrooms. Conversely, three responses from the treatment section reflected enhanced awareness or exposure to available technologies. This frequency response data, although relatively small, aligned with the curricular structure of the two sections; the control section had elements of a technocentric survey course while the treatment section curricula was more of an in-depth, subject-specific “deep dive” into specific technologies through the TPACK framework.

The frequency of responses indicating more willingness or openness to using technology was similar in the control section (nine statements) and treatment section (10 statements). Although not an indicator of differences, both participant groups said that the course generally caused a shifting mindset with greater consideration paid to technology tools in lessons and learning experiences. It was commonly reported that participants were averse to technology in elementary classrooms before the course but recognized the benefits of carefully selected tools upon completion.

Frequency counts for statements about increased technology skills or abilities were low for both sections. There were only two instances of a control section participant stating that the course increased their knowledge of how to use technologies. Only one participant from the treatment section referenced this as an outcome. This finding diverged from the curricular structure as it applied control section; that curriculum was designed to be a traditional, technocentric approach that emphasized how to use technologies. To some degree, however, the low frequency counts for the control section on this categorized response did align with Brad’s expectation for self-directed learning. He expected participants to increase their technology skills through provided resources and self-initiated discovery (i.e., increase their technology skills on their own). As a result, participants might have viewed themselves as the source of new tech skills and not the course curricula or instruction. However, no follow-up questions were asked of the interviewees when they responded with this type of categorized statement.

There were only two self-reported statements in the control section and three in the treatment section that indicated that the course increased the participant's capacity to effectively integrate technology in an elementary classroom. Across both sections, most of these categorized responses referenced an implied awareness of technological-pedagogical approaches like student-centered instruction, multiple representations, theories of child development, and cross-disciplinary learning. The emphasis on pedagogy in their responses fit with Brad's overarching belief in the importance of this domain in the TPACK framework. However, more responses for this category were expected because learning how to effectively integrate technology was an overarching goal for both sections.

Finally, eight responses from control section participants were categorized as qualified statements as compared to only two from the treatment section. When an interviewee spoke with a qualified statement, they often used a caveat that reflected some deficiency or lack of understanding. For example:

> "I wouldn't say that I am 100% comfortable with the new things that were introduced that I have never seen before but I would like to get more comfortable with them. I would like to use them in my classroom whereas, before this class, I would have said, 'Yeah, we are forced to use the smart board because everyone else is doing it.'"

> "I think that I am definitely more aware of technology that is out there and available to the teachers. I still think that I have a lot to learn about finding the right kind of technology to use in the classroom depending on the age and the subject."

> "I am more encouraged to [use technology] now but it still has big drawbacks. It's just like I know this textbook approach works for me and I

> don't think that it is gone. I don't think that 10 years out of, or however many years I've been out of elementary school, that has disappeared. It works for a reason."

The higher frequency of unsolicited qualifications in the control section indicated more trepidation or uneasiness when acknowledging that their capacity to integrate technology had changed as a result of the course. Interviewees from the treatment section responded with more certainty regardless of how or what prompted the changes.

Learning Opportunities and TPACK Development

The participants from both sections articulated different learning opportunities in each curriculum that impacted their technological, pedagogical, and content knowledge. The connections between curricular elements and the TPACK framework were as follows:

- Technological Knowledge: Both sections stated that learning how to use technologies by receiving hands-on, direct guidance from Brad was their preferred learning modality. Neither self-directed learning nor flipped classroom formats were instructional approaches that promoted high-levels of technological confidence or skill development. However, activities like projects and microteaching were beneficial because of the degree to which the participants had to know how to use included tools to complete each assignment.
- Pedagogical Knowledge: Whether watching a teacher in a video-based case study or listening to Brad's stories, classroom examples were effective mechanisms from which to glean teaching strategies and ideas about integrating technology. Participants in the treatment section also felt like

observing and participating in microteaching created instances of meaningful personal reflection on good teaching practices.

- Content Knowledge: Participants found texts to be worthwhile when course readings contained vivid accounts of teachers using technology to support student learning within specific content areas. However, there were conflicting beliefs about the benefits of spending too much time on a narrow aspect of one subject area and pedagogical approach (treatment) versus broadly covering more general, domain-agnostic technologies (control).
- TPACK: Doing something with a particular technology was what participants believed contributed to their growth over the semester. For the treatment section, engaging in microteaching captured the essence of technology integration because it required a well-rounded conceptualization of TPACK. However, there was not a comparable activity in the control section that promoted TPACK as a whole according to the participants.

Although a number of the interventions supported technological, pedagogical, and content knowledge development, very few participants indicated that their capacity to integrate technology (i.e., a reflection of overall TPACK) increased by the end of the semester.

CHAPTER 6: DISCUSSION

Technology and American Schools Revisited (1990-2010)

Prior research from educators and scholars suggested that American K-12 education failed to keep pace with technology's exponential alterations to industry, society, politics, and science in the past two decades (Friedman, 2005; Moeller, Powers, & Roberts, 2012; Zickuhr & Madden, 2012). Although prognosticators like Ray Kurzweil made sweeping predictions that correctly identified how technology eventually shaped sociological institutions, education remained largely impervious to technological innovations despite stated beliefs to the contrary (Kurzweil, 1990). Teachers and students continued to use emerging tools in ways that aligned with historically prevalent practices; snapshots of classrooms with technology-rich activities showed examples of new tools being substituted for old practices with minimal impact on learning (Cuban, 2013).

As a way to encourage professional growth and spark reform, the US government spent billions of dollars on educational technology and professional development opportunities (Bailey, Henry, McBride, & Puckett, 2011; Chaudhuri & Flamm, 2013; Nagel, 2011). Teacher preparation programs in higher education began offering stand-alone courses to bolster the transformative potential of technology in K-12 classrooms (Gronseth et al, 2010; Kleiner, Thomas, & Lewis, 2007). However, surveys of preservice teachers in teacher preparation programs found that most believed the offerings insufficiently prepared them to effectively integrate technology (Gray, Thomas, & Lewis, 2010).

Some researchers asserted that the efficacy of educational technology courses was stifled by both technocentrism and a general failure to encapsulate the complexities of teaching with technology (Harris, 2005; Harris, Mishra, & Koehler, 2009; Papert, 1987). As a result, forward-thinking educators began grounding educational technology courses in a framework that emphasized the interrelated knowledge types necessary for successfully incorporating technology into learning experience. This framework, TPACK, gained traction as a more robust, all-encompassing model for teacher preparation programs over the past decade and a half (Koehler & Mishra, 2005; Koehler & Mishra, 2008; Koehler et al., 2007; Mishra & Koehler, 2006).

Formal Contributions to the Instructional Technology Field

This study examined two sections of a course designed to help novice preservice teachers learn how to effectively integrate technology into elementary classrooms. One section (treatment) incorporated the TPACK framework, subject-specific technologies, principles of intentional teaching, and flipped classroom approaches to knowledge acquisition. The other section (control) followed a technocentric philosophy with heavy emphasis on general technologies and broad exposure. The results of the study showed statistically significant differences between the two sections on a number of measurements, and the possible reasons for what was observed arose from both the instructor's implementation of the curricula as well as the preservice teachers' experiences learning within the two sections. While significant differences existed between the two sections lending credence to the treatment curriculum's efficacy, the degree to which the findings supported the targeted interventions was tempered by Brad's instructional approaches, beliefs, and discourse.

Results from quantitative measures indicated statistically significant differences on summative measures; the treatment section scored higher on three of the subject area lesson plan outlines and performed better on a final exam (see Table A28 for a summary of findings from Phase 1 and Phase 2). These findings aligned with prior research on TPACK development which stated that module-based, direct training on specific technologies and pedagogies within content areas created the conditions for conceptual change for preservice teachers (An et al., 2011; Angeli & Valanides, 2009; Chai et al., 2010; Hardy, 2010; Lee & Hollebrands, 2008; Özmantar et al., 2010). However, it was unclear whether or not the treatment section's framework of subject-specific modules and carefully chosen pedagogies and tools were primary factors in the observed differences. In all likelihood, implemented interventions including video-based teaching cases, microteaching, and intentional teaching contributed more to TPACK differences between the two sections than did the course segmentation. Brad's varied use of sarcasm and his emphasis on pedagogy in the treatment section likely played a role in observed differences as well.

Previous studies examining the impact of video-based case studies on preservice teachers' learning indicated that the use of exemplars resulted in increased content and technological knowledge (Lee & Hollebrands, 2008). The current study did not analyze content and technological knowledge gains associated with implemented case studies, so no assertions were made as to whether or not significant findings were a result of this intervention. What was explored was the participants' reaction to video examples or the lack thereof; preservice teachers in the treatment section believed the video-based case studies contributed to their limited instructional repertoire while highlighting the fact that elementary teachers could integrate technology in meaningful ways. Control section participants also expressed a desire to see real-life examples of teachers using technology to teach students content. These self-reported beliefs did support past research on the value of video-based case studies in preservice teacher training: Visual examples provided a lens through which novices can witness the complexities of teaching while grounding theoretical concepts like TPACK in the practicalities of actual classrooms (Eggen & Kauchak, 1999; Greenwood et al., 2002; Shulman, Whittaker, & Lew, 2002).

Like video-based teaching cases, participants in the treatment section stated that seeing their peers' microteaching lessons provided valuable insights into teaching with technology. In some respects, observing microteaching in a whole class, face-to-face meeting was an unarticulated form of reflection; the preservice teachers not only examined their own simulated teaching but they also noted strengths and weakness of other participants' lessons. In the current study, microteaching was more than just making the abstract concept of technology integration more salient through "doing what teachers do" (Özmantar et al., 2010); it was an activity that jumpstarted thoughtful consideration of using technology to teach and support learning. Said differently, microteaching prompted a degree of assimilation and accommodation of taught concepts for novice teachers who had ill-informed, preconceived notions of what this should look like (Piaget & Cook, 1952).

Although the findings suggested that some of the curricular modifications influenced quantitative differences, not all of the employed interventions impacted learning as intended. First, course readings were perceived as ineffective, unrelated, and boring. This result was likely attributable to the course designers' poor instructional design decisions when selecting the readings and not a direct contradiction to the knowledge domain in the intentional teaching or TPACK frameworks. Second, the preservice teachers wanted more direct guidance while using technologies so that they better understood the functionality and processes necessary for inclusion into an elementary classroom. This belief was even emphasized by treatment section participants who received some technology instruction through videos in a flipped classroom format. Although prior research found that students often preferred the flipped classroom delivery approach in higher education settings (Lage et al., 2000; Gannod et al., 2008), the novice preservice teachers in the study felt that direct, hands-on instruction helped them understand more when learning how to use new technologies. Their preferences aligned more closely with studies that showed that college students valued opportunities to ask pertinent, just-in-time questions with minimal distractions (Foertsch et al. 2002; Toto & Nguyen, 2009; Zappe et al., 2009). Finally, neither section stated that their overall capacity to integrate technology dramatically changed by the end of the semester; most reported that they were more aware of available technologies and more open to considering emerging tools in their instruction. This finding was surprising given the theoretical background and planning that formed the treatment section; past research indicated that many of the interventions promoted significant TPACK growth in various forms (An et al., 2011; Chai et al., 2010; Hardy, 2010; Lee & Hollebrands, 2008; Özmantar et al., 2010; Wetzel et al., 2008).

Practical Contributions: Background Knowledge and Inexperience

When reflectively examining what was learned over the course of the study, one untested theme possibly explained the results: The treatment section and Brad's instructional practices were more successful in meeting the preservice teachers' learning needs, minimal background knowledge in education, and lack of experience. To some extent, the treatment section of ITCP was designed to embody best practices and supported frameworks that incidentally addressed the unique characteristics in the sample population.

The preservice teachers' inexperience with classroom teaching was inescapable throughout all facets of ITCP. They entered both sections with preconceived notions of what elementary education should look like based on their prior K-12 experience as students, and this impacted how the enrollees performed, what they produced, and the types of supports that were necessary to help them learn how to effectively integrate technology.

From the outset, much of what the preservice teachers believed good elementary instruction looked like manifested itself in the first lesson plan outlines, projects, and microteaching experiences: An overemphasis on teacher-centered content delivery through technology-enabled mechanisms. This belief surfaced again and again, regardless of whether the intended audience was primary students or the content was scientific inquiry. For most, the default instructional mode was to tell their future elementary students what they should know and be able to understand by presenting information on something like an interactive whiteboard or PowerPoint. Needless to say, the ghosts of Dewey (1938), Piaget (1952), and Papert (1987) would struggle to label much of what the participants created as optimal much less an appropriate way for elementary students to learn while at school.

The elementary preservice teachers weren't to blame for their uninformed conceptualizations of teaching and learning. Apart from not having taught in a formal capacity in an elementary school, most had not taken a single education course or learned about important theories of learning before beginning ITCP. When added to their misinformed beliefs about what constituted good teaching, it was somewhat surprising that more traditional, didactic examples were not produced. Nevertheless, the degree to which participants returned to this comfortable fallback approach was striking and apparent.

The participants' cognitive holes, inexperience, and their misguided notions of teaching and learning demanded a specific curriculum and carefully chosen instructional practices. In this respect, the treatment section's interventions and conceptual framework happened to meet the preservice teachers' learning needs more than the general, technocentric structure of the control section's curriculum. Developing their technological, pedagogical, and content knowledge was almost essential because each knowledge type was underdeveloped. The participants also needed to know effective instructional practices, see classroom examples of effective technology integration, engage in simulated learning experiences, and reflect on their work. In other words, their relative inexperience as novice teachers required a course format that addressed their missing background knowledge before they could realize technology's potential in elementary classrooms.

Whether it was the robustness of the "TPACK – intentional teaching" approach or simply collateral learning, what occurred in the treatment section addressed many learning needs. However, the curriculum might have resulted in better outcomes had the course developers followed a formal instructional design process when creating ITCP.

Instructional Design: ITCP

Months before the first Tuesday class meeting, a group of educators gathered to discuss how to change ITCP so that it aligned with current research and best practices for helping preservice teachers learn how to integrated technology. The discussions consisted of reflections on how instructors at the institution taught the class during prior semesters as well as more forward-thinking revisions that would enhance its effectiveness. Two tenured faculty members asserted that TPACK and intentional teaching were both promising and evidence-based frameworks from which to center ITCP. Collectively, the group along with past course instructors agreed that the course should evolve to embody these two frameworks. The treatment section's curriculum emerged from these conversations.

The treatment section of ITCP took its final form during the summer leading up to the new semester. Specific interventions like microteaching and video-based case studies were identified and unanimously selected for inclusion. The course designers consulted with the institution's methodology faculty and chose important pedagogical approaches and subject-specific readings for each three-week module. The instructions for the lesson plan outlines were developed and revised while, at the same time, a focused review of technologies occurred to ensure that any tools supported the pedagogies and content. Much thought and a lot of hours were given to the treatment section's final curriculum- all with the goal of providing the most engaging and effective experience to the preservice teachers who would eventually enroll in the course.

Although the course developers never stated that that they were using instructional design to modify ITCP's "business as usual" format, much of what transpired was a systematic process that aligned with the steps of instructional design procedures (Dick, Carey, & Carey, 2009). They informally assessed what occurred in ITCP prior to the start of the study, defined learning objectives and goals, and clarified what success would like in terms of the participants' performance. The group created assessment instruments that aligned with the target goals, settled on an instructional strategy, and selected the materials that supported learning. However, one phase in the instructional design process was not formally evaluated: Direct analysis of what the preservice teachers needed to assimilate and understand how to effectively integrate technology into an elementary classroom.

It would be untrue to state that the learners' needs weren't considered when developing the treatment curriculum. At least two instructors who taught iterations of ITCP were a part of the course design process, and they offered feedback on what entering students did and did not know about teaching and technology. The rest of the group also brought years of experience working with undergraduate and graduate students in the institutions teacher preparation program. The collective perspectives were informally applied to the treatment section's final form along with the consultation of methods faculty whose sole focus was subject-specific training. Yet, no former ITCP students or any of the enrolled participants were a part of what was ultimately delivered. Had a needs assessment or some other type of learner-environment analysis occurred, then many of the findings would likely have been predicted and the results either more or less pronounced between the two sections.

Conclusion 1: TPACK Development and Course of Studies

Prior research outlined a number of interventions that promoted TPACK development for preservice teachers. Some of the articles focused on instructional strategies like design-based tasks, research, and microteaching while others documented structural facets relating to course segmentation (Angeli & Valanides, 2009; Jang & Chen, 2010; Lee & Hollebrands, 2008; Koehler & Mishra, 2005; Özmantar et al., 2010; Wetzel et al., 2008). What was rarely studied was the preservice teachers' beginning knowledge and how the course was adapted to fit the enrolled students' learning needs. This extremely important line of inquiry was lacking in the current study because entering characteristics were never fully examined. However, evidence suggested that participants' inexperience and lack of background knowledge played an important role in their capacity to integrate technology by the end of the semester. This, in turn, impacted what they understood about TPACK and the ways that the treatment section's curriculum did and did not meet their needs.

As was previously stated, the preservice teachers entered ITCP with no teaching experience and very few education courses. The holes in their knowledge were wide and, in some domains, deep. Their created artifacts reflected a theoretically outdated understanding of pedagogy early in the semester. Most participants articulated that content knowledge only consisted of topics to know and not subject-specific ways of knowing. Finally, few neither knew how to use the introduced technologies nor did they know pedagogies or content that could be taught through them. Conducting a learner analysis that examined prior knowledge of TPACK and entry skills with technology would have likely led to more targeted instruction in all of these areas.

The learners' inexperience and lack of background knowledge made each discreet knowledge type- pedagogical, content, and technological- important learning objectives on their own. In order to begin to have some conceptualization of TPACK, they needed to be aware of different pedagogies, understand that content knowledge was more than the topic being taught, and be able to use technologies in optimal ways. In reality, most of the participants were unfamiliar with all three components of TPACK as well as the overarching concept, and the treatment section did a better job of addressing their deficiencies. This possibly explained why the control section was more focused on grades when deciding whether or not to make revisions to lesson plan outlines; grades, not what was learned about TPACK and technology integration, were the only indicators from which to make judgements about what they had learned in previous weeks.

Brad's overemphasis of pedagogical knowledge in the treatment section served that group well. Their growth in this domain over the course of the semester was evident; many asked questions about pedagogy-technology relationships during the interviews, and some of the last microteaching experiences incorporated more effective teaching methods like small group work and less teacher-led content delivery. However, with the exception of a few technology activities, Brad's approach for developing content and technological knowledge was less effective. Not only did he fail to explore the complexities of teaching subject-area domains using technology tools, but he also told both groups that "content was the easiest part" on many occasions (Control: seven statements, Treatment: nine statements) while glossing over how to teach difficult concepts like reading fluency and number sense. When it came to knowing how to use technology and what to expect when doing so with young children, Brad expected participants to learn it themselves. His overreliance on participants' self-directed learning was not how they wanted to learn unknown tools nor was it the best way to fully understand practicalities of teaching with technology for the inexperienced groups. According to the interviews, participants wanted and expected Brad's guidance and support when learning how to use tools, not online modules and flipped classroom approaches. Nevertheless, differences between the two sections on total scores for the revised lesson plan outlines indicated that the treatment section was better able to individually apply TPACK to specified topics. The lone exception was science where both groups performed similarly on subscales measuring content and pedagogical knowledge.

To some extent, open enrollment at the institution in which ITCP occurred prevented both Brad and the course developers to design instruction around the participants' inexperience and lack of prior knowledge. A number of participants joined the course sections during the weeks leading up to the first class which made it difficult to ascertain entering important entering characteristics. Although inferences could have been made based on the placement of ITCP in the sequencing of courses in the teacher preparation program (e.g., ITCP was one of the first course and, therefore, participants likely had little background), a robust learner assessment was impossible. A way of remedying this influential problem would have been to require participants to take ITCP after their methods courses or practicum placements. Doing so would have ensured greater understanding of pedagogical and content underpinnings necessary for developing TPACK. Said differently, Brad would not have had to emphasize each distinct knowledge type to the degree that he did if the participants had already completed some additional coursework in education. He could have focused on increasing the preservice teachers' technological knowledge and application of TPACK to classroom learning experiences.

Conclusion 2: Target Interventions, Don't Deliver Interventions

The absence of a formal learner analysis also impacted the efficacy of selected materials and interventions in the study. The notion that activities like microteaching and video-based case studies would help novice preservice teachers learn to effectively integrate technology was largely unverified at the institution where the study took place. Fortunately for the learners, a number of the instructional decisions made during the treatment curriculum's development were correct. The participants articulated that the microteaching was both beneficial and a favorite assignment, and they found the classroom examples in the cases studies to be valuable. However, some of what occurred was less impactful; students in the treatment section found the readings to be too narrowly focused and they also wanted more exposure to a wide variety of technologies.

Researchers who conducted the two identified studies on TPACK and microteaching found that participating in mock classroom experiences helped preservice teachers apply disciplinary knowledge to technology integration in a more applicable way (Jang & Chen, 2010; Özmantar et al., 2010). While this might have occurred in the current study, what participants reported as being the most positive quality of microteaching was simply acting like teachers and delivering a lesson with technology. With little experience and a predominantly naïve conceptualization of good instruction, the act of "doing" what a teacher does was the most apparent takeaway. The participants were too far removed from being teachers and they lacked the theoretical foundation to begin to truly apply disciplinary content knowledge much less transformative pedagogical approaches. Similarly, observing other people microteach helped the treatment section think through alternative forms of instruction at a nascent level. Knowing this, Brad might have spent more time outlining what pedagogical strategies the participants could use so that it was not merely a play-like experience. However, making these formative, instructional decisions would have required a better understanding of the preservice teachers' entering skills and knowledge- something a learner analysis would have uncovered.

For the preservice teachers, the case studies acted as windows through which to view carefully selected classroom examples of technology integration. This finding aligned with prior research that identified realistic classroom scenarios to be the most beneficial outcome from video-based case studies (Kurz, Batarelo, & Middleton, 2009; Nirula & Peskin, 2008; Sykes & Bird, 1992). Yet, participants stated that the way in which the videos were segmented and the number of reflection questions broke the flow of the case studies and prevented a more complete picture of what was transpiring. These self-reported reflections diverged from the suggestions of other educators who used video-based case studies in teacher preparation programs (Kale & Whitehouse, 2012; Kurz & Batarelo, 2010). One reason why the study's results deviated from past suggestions possibly related to what the preservice teachers wanted to glean from the videos: Instead of viewing the cases to better understand elementary technology integration, participants were also watching for examples of good teaching- and the questions and segmentation prevented a holistic understanding because of their inexperience in elementary classrooms.

The course readings and the number of introduced technologies were two aspects of both curricula that failed to fully support the preservice teachers' learning needs. In terms of the assigned readings, participants in the control section felt that the content was unrelated to Brad's instruction while the treatment section expressed dissatisfaction with the texts' narrow focus. This finding possibly related to a mismatch between the learner's expectations and the curricula. In the control section, preservice teachers indicated that they wanted in-depth examples of elementary technology integration and, when the texts provided marginally useful accounts of broad trends in educational technology, it was assumed that they found the presented information to be directionless. On the other hand, participants in the treatment section wanted to be exposed to more technologies; the readings for that group provided an even finer perspective on TPACK and individual technologies like The Estimation Calculator. With so much of Brad's instruction focused on so few pedagogies, technologies, and topic areas, participants might have felt like the readings were an unfulfilled opportunity to learn about more tools and ways of teaching different elementary topics.

Similar to *Conclusion 1*, analyzing the enrolled participants' background knowledge and prior teaching experiences would have enabled the course designers to tailor the curricula to better align with the enrollee's needs. Providing additional performance parameters for microteaching, using less segmentation in the case studies, and selecting more relevant readings would have likely resulted in more growth and learning.

Conclusion 3: The Instructor Profoundly Impacts the Students and Learning Environment

Brad came to the institution only weeks before the first ITCP class meeting. Although he brought a deep understanding of elementary education and years of teaching experience, he had not previously taught a course in higher education. The whirlwind of beginning a doctoral degree program, moving to a new city, teaching two courses to college students, and being a part of a research study was overwhelming by his own admission. The newness of the entire experience was not lost on the course developers or the researcher; efforts were made to make sure that Brad understood how to implement the two curricula and each one's myriad of interventions, instructional approaches, and activities. He even joined some of the final meetings with the developers and methods faculty members. However, Brad's wholehearted inclusion in the research study was counterbalanced with very little attention given to how he was going to interact with the preservice teachers. As it turned out, the way that he spoke to both sections likely contributed to the observed differences on course evaluations at the end of the semester. Had the instructional designers analyzed Brad's performance and teaching practices, then suggestions could have been made to ameliorate the sarcasm in his classroom discourse.

Brad's use of sarcasm was striking, and what he said differed between the two sections. In the control section, he uttered more sarcastic statements with negative undertones about himself and other people. He also sarcastically commented on immutable characteristics that were unchangeable. Although he was equally sarcastic with the treatment section, Brad's discourse was more positive.

It was unclear why there were glaring differences between the two groups in terms of the nature of Brad's sarcasm, only that there were distinctions that impacted the preservice teachers in the control section. It was hypothesized that a possible reason why Brad used sarcasm differently in the two sections was because of his general discomfort teaching the control section as prescribed by the research design. During the interviews, he indicated that he felt like he was doing the control section's participants a disservice by refraining from explicitly discussing pedagogical approaches and teaching strategies- a clear hole in their notions of teaching and learning. The negative sarcastic statements could have been an unconscious acknowledgement that Brad knew the participants were not receiving the necessary instruction for their growth, and that they likely did not view him in a favorable manner because of his unfair and ineffective teaching practices. His negative sarcasm towards this group might have acted like a self-confirming prophesy that he was unaware of their needs and, at times, callous and unapproachable. However, this explanation was purely speculative; follow-up questions were not conducted with Brad during the interviews to confirm or disconfirm this hypothesis.

Data from the course evaluation and interview transcripts indicated that there were some who felt that Brad's sarcasm made him unapproachable and created a climate where students were hesitant to speak up. Whether this also had an effect on participants' impressions of what they learned or the degree to which the control section was worthwhile was not tested or verified. However, researchers studying the use of sarcasm in college classrooms found that students viewed its use unfavorably (Torok, McMorris, & Lin, 2004). It appeared as if participants in the control section formed negative overall impressions based on the way in which Brad used sarcasm during class meetings.

Future Research

The observed findings from both analytic phases converged and diverged with prior research. What was learned supported curricular interventions and frameworks for instructional technology courses like the treatment section of ITCP. However, careful consideration must be given to key stakeholders as well as the format and structure of emergent course designs. Although not generalizable, the results offered suggestions for promising future approaches for helping novice preservice teachers learn to effectively integrate technology into elementary classrooms.

To fully examine future iterations of courses like ITCP, conducting studies on the following topics would help inform the instructional technology discipline:

- Scope and Sequencing of Instructional Technology Courses in Teacher Preparation Programs: Enrolled participants took ITCP before any other courses in the institution's teacher preparation program. Their inexperience and lack of background knowledge likely impacted the efficacy of the treatment curriculum. To this end, how do other teacher preparation programs place instructional technology classes in the course of studies? What's the optimal sequencing that capitalizes on new knowledge and increasingly important frameworks like TPACK?
- Instructional Design and Systematically Developing Instructional Technology Courses: ITCP failed to fully account for the participants' inexperience with teaching, technology, and the theoretical underpinnings that might have led to greater learning. To this end, do other teacher preparation programs conduct formal needs assessments when developing new courses with emergent

designs? How should instructional technology courses formatively assess and adapt to enrollees' entering characteristics?

- Intentional Teaching and Instructional Technology Courses: Participants expressed preferences for different components of intentional teaching. For many, "doing" and "seeing" were the most important aspects of the treatment section of ITCP. To this end, do other preservice teachers express similar feelings when engaged in an intentional teaching approach to instruction?
- Self-Directed Learning Expectations in Instructional Technology Courses: Brad expected participants in both sections to engage in self-directed learning whether or not they were ready for this type of instructional experience. Many reported that they would have liked to have more guided, hands-on support from the instructor. To this end, is this a sentiment expressed by more novice, preservice teachers in other institutions? As more technologies flatten the world and open new avenues for learning, does that shape preservice teachers' openness to learn on their own rather than from the instructor?
- The Format of Video-Based Case Studies: Although participants in the treatment section reported that they benefited from the included case studies, they were dissatisfied with the segmented presentation and numerous reflection questions. To this end, what is the optimal format for video-based case studies in courses like ITCP? Does background knowledge and teaching experience affect how video-based case studies should be presented to optimize learning?

Future research in these areas would likely enhance preservice teachers' capacity to integrate technology after completing courses like ITCP.

Limitations

One limitation in the study was the small sample size for both the treatment and control sections. There were 15 students in the control section and only 14 preservice teachers in the treatment section. Nobody was randomly assigned to either course section. Additionally, one potential participant unenrolled from the treatment section after two weeks. Per institutional guidelines, this student neither offered nor was she asked why she dropped ITCP which was a requirement for degree completion. Although the small sample size decreased the statistical power thus making the quantitative results more salient, the small sample negatively limited the generalizability of findings to larger populations. It was hypothesized that randomly assigning participants to either section or including more preservice teachers might have influenced the results and subsequent conclusions.

In addition to the small sample size, both sections of ITCP were homogenous in terms of the participants' gender, educational background, and teaching experience. All of the enrolled preservice teachers were female students who were entering the institution's preparation program for elementary teachers. Very few had taken an education course, and most possessed no formal teaching experience. Although these common characteristics enabled more valid comparisons when examining differences, all of the findings and conclusions were only applicable to similar populations of novice, elementary preservice teachers. Consequently, implications for a more diverse sample-one that reflected a wide range of participants with diverse backgrounds and experiences-was untenable and inappropriate.

The various frameworks and interventions in each curriculum also acted as limitations in the study. The control section was grounded in technocentrism, featured general readings and projects, and required more self-directed learning. Conversely, the treatment section's curriculum used TPACK and intentional teaching as omnipresent frameworks along with subject-specific readings and modules, microteaching experiences, video-based case studies, and flipped classroom technology tutorials. The dissimilarities between the participants' experiences prevented any logical conclusions about the impact of one framework or curricular intervention on student learning and quantitative differences. In other words, it was impossible to disentangle the multifaceted nature of the curricula and make causal inferences on elements like microteaching, projects, or readings.

The scheduled time for the weekly class meetings affected the instructor in a negative manner and, in all likelihood, impacted what was observed and recorded in the field notes. This study limitation arose because both sections met back-to-back on Tuesday evenings. The control section began at 5:00 PM and ended at 7:00 PM. The treatment section started immediately afterward and concluded at 9:00 PM. Unbeknownst to the researcher at the start of the study, Brad also sat in required courses for his doctoral degree program for most of the day before teaching ITCP. His responsibilities as a student coupled with outside research projects resulted in tiredness prior to teaching. During the final two interviews, Brad stated that he was worn out by the time the first students entered the room. He had little opportunity to do last minute tweaks to his lesson plans or address any participant concerns with assignment submissions, and this made him feel anxious. By 7:00 PM when the control section began, Brad admitted to feeling exhausted because of the non-stop, hectic Tuesday schedule. He also thought that the participants in the control section felt similarly. According to Brad:

> These girls are tired. They been in class all day long. They don't want to be there. I would never have signed up for class at 7 o'clock at night. Ever.

Both the scheduled meeting time and all the preceding events, both known and unknown, likely influenced what was observed in unintended ways. The degree to which all of the participants felt tired could have impacted engagement, and it might have caused Brad to be more caustic in his discourse than he would have otherwise been. Time might have also impacted quantitative assessments.

Finally, Brad told the preservice teachers that there were curricular differences between the two sections. Although he did not explicitly identify the various interventions to the preservice teachers, Brad did directly address the research design and study conditions. What he said to the participants was as follows:

> Treatment: "I am teaching two sections of this class. As you know, it's a part of the [researcher's] research. This course is being taught differently than the 7 o'clock section. You might have friends in that class. If you can refrain from talking to them about what you are doing in the class until after December 11th [when the course ends], it would probably help the research."

> Control: "You guys are in the second section of this class that I teach. As you may have discerned from the fact that you had to fill out a IRB form and sign your soul away, this class and my other class are both a part of a research study that [the researcher] is running. In that regard, you are doing things differently than the other group. You probably have friends in the other section. [I would appreciate it] if you didn't talk to them about what we did in class at least until after December 11th [when the course ends]."

Even though the instructor asked the participants to refrain from talking about the research design with the other section, interview data suggested otherwise. Stella, a preservice teacher in the control section, expressed that she thought it was unfair to have two sections taught in different ways. Stella believed that her section was more difficult than the treatment group's curriculum. Two participants in the treatment section, Jane and Bianca, also admitted to being curious about the two curricular approaches. Bianca stated that she had, in fact, talked to her friends in the control section about what each group was learning and the manner in which it was occurring.

Both Brad's formal discussion about the research design as well as the participants' informal conversations acted as limitations to the study. What occurred likely introduced the following validity threats (Creswell, 2008):

- *Diffusion of Treatments:* Some of the participants discussed the research design with members of the other section. As a result, the diffusion of interventions possibly spread across the two sections and created an internal validity threat. If this occurred, it likely impacted course evaluation results and reported feelings about the instructor and curriculum.
- *Compensatory Rivalry:* Because participants knew about differences between the two sections, then it's possible that the results of the quantitative and qualitative assessments might have reflected efforts to prove that one group learned more than the other.
- *Resentful Demoralization:* It was possible that the control group perceived that they received inadequate instruction and, as a result, performed in a manner that was not naturalistic.

It was unclear how the aforementioned validity threats influenced the results. However, there were indications that all were present during data collection.

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APPENDIX A: TABLES

Table A1

Research Studies About TPACK in Instructional Technology Courses

Author (Date)	Course Description	Assessment Measure(s)	Findings
An, Wilder, & Lim (2011).	Initial module on technologies followed by an online module about TPACK	Self-Report Questionnaire	Increased ability to incorporate TPACK into instruction
Angeli & Valanides, (2009)	Instructional design classes and labs with microteaching experiences	Performance-Based Tasks	Statistically significant growth on performance-based tasks
Chai, Koh, & Tsai (2010)	Project-based learning activities with an emphasis on pedagogical approaches	Self-Report Questionnaire	Increased ability to incorporate TK, PK, CK, and TPACK into instruction
Jang & Chen (2010)	Online course followed by field observations and microteaching experiences	Artifact Analysis, Video Recordings, & Interviews	Microteaching made technology integration real and applicable
Koehler & Mishra (2005, 2007)	Design-based tasks in an instructional technology course	Self-Report Questionnaire	Increased ability to incorporate TPACK into instruction
Lee & Hollebrands (2008)	Video-based case studies in a technology-focused math curriculum	Pre- and Post-Assessments	Statistically significant change in CK and PK
Özmantar, Akkoç, Bingölbali, Demir, & Ergene (2010)	Microteaching in a technology-focused math curriculum	Artifact Analysis, Video Recordings, & Questionnaires	Increased CK and TK

Table A2

Research Studies About Intentional Teaching

Author (Date)	Course Description	Assessment Measure(s)	Findings
Hamre, Pianta, Burchinal, Field, LoCasale-Crouch, Downer, Scott-Little (2012)	Course for early childhood teachers on literacy instruction using the Intentional Teaching framework	Classroom Assessment Scoring System (CLASS)	Greater knowledge and skill in detecting effective classroom interactions
Pianta, Mashburn, Downer, Hamre, & Justice (2008)	PD course for teachers of at-risk students that contained video-based case studies	Artifact Analysis	Increased ability to engage students with multiple representations

Table A3

Research Studies About Video-Based Case Studies

Author (Date)	Course Description	Assessment Measure(s)	Findings
Kale & Whitehouse (2012)	Course on technology integration with a video case on problems of practice in a classroom	Self-Report Questionnaire	Elementary preservice teachers demonstrated greater PK and CK than secondary preservice teachers
Kurz, Batarelo, & Middleton (2009)	Course on math methods for elementary preservice teachers	Self-Report Questionnaire	Preservice teachers valued video cases that showed a variety of students, diverse situations, analysis from experts, and classroom management approaches.
Kurz & Batarelo (2010)	No course stated; Study included elementary and special education preservice teachers	Self-Report Questionnaire	Preservice teachers valued video cases that modeled teaching techniques, contained multiple materials, and showed classroom management approaches
Sherin & Van Es (2005)	Course for math and science preservice teachers; After-school video club for in-service teachers	Discourse Analysis from Transcribed Artifacts; Artifact Analysis	Participating teachers focused on student thinking and salient events after watching video cases
Yadav (2008)	Course on literacy instruction for elementary preservice teachers	Interviews & Self-Report Questionnaire	Preservice teachers valued viewing scaffolds rather than watching video cases without guidance

Table A4

Research Studies About Flipped Classrooms

Author (Date)	Course Description	Assessment Measure(s)	Findings
Carlisle (2010)	Computer science course for undergraduate students with video-based lectures and in-class labs	Self-Report Survey	Participants read more and prepared more when presented with video-based lectures
Day & Foley (2006)	Course on human-computer interaction for undergraduate students with online lectures and in-class activities	Course Assignments, Self-Report Survey	Participants in a flipped classroom section scored higher on assignments and had more positive attitudes than participants in a traditional section
Foertsch, Moses, Strikwerda, & Litzkow (2002)	Engineering course for undergraduate students with online lectures and in-class problem-solving scenarios	Course Evaluation	Participants evaluated the flipped classroom approach as more useful and the instructor more responsive than traditional course formats
Gannod, Burge, & Helmick (2008)	Software engineering course with video-based lectures and in-class activities	Course Evaluation	Participants favorably viewed the flipped classroom approach
Lage, Platt, & Treglia (2000)	Economic course for undergraduate students with video-based lectures and in-class experiments	Self-Report Survey	Participants favorably evaluated the flipped classroom approach
McCray (2000)	Business course for undergraduate students with video-based lectures and in-class analytic scenarios	Course Exam, Course Evaluation, & Self-Report Survey	Participants favorably evaluated the flipped classroom approach

Pierce & Fox (2012)	Pharmacology course with video podcasts and in-class activities	Course Exam, Course Evaluation	Statistically significant gains in understanding and positive attitudes toward flipped classroom approach
Ruddick (2012)	Chemistry course for undergraduate students with video-based lectures and in-class problem solving activities	Course Assignments	Participants scored higher than traditionally taught peers on course assignments; Participants preferred shorter video-based lectures
Strayer (2007, 2012)	Statistics course for undergraduate students with online, intelligent tutoring system and in-class activities	Questionnaire, Field Notes, Interviews, & Focus Groups	Participants reported being more open to cooperative learning and alternative teaching approaches
Toto & Nguyen (2009)	Industrial engineering course for undergraduate students with video-based lectures and in-class activities	Questionnaire & Self-Report Survey	Participants preferred face-to-face lectures but felt the in-class activities were beneficial
Zappe, Leicht, Messner, Litzinger, & Lee (2009)	Architectural engineering course with video-based lectures and in-class problem-solving activities	Self-Report Survey	Participants favorably viewed in-class activities but preferred fewer flipped classroom instances

Table A5

Descriptive Data about the Instructor (Brad Jenks)

Field	Descriptive Information
Age	29-years-old
Gender	Male
Race	White, non-Hispanic
Degrees	B.A. in Classical Civilizations M.Ed. in Curriculum and Instruction
Expected Graduation	2015
Expected Degree	Ed.D. in Instructional Technology
Education Courses Taken	13 courses
Ed Tech Courses Taken	1 course
K-12 Years Taught	6 years
Grade Levels Taught	3^{rd}

Table A6

Demographic Frequency Data for Enrolled Preservice Teachers

	Treatment (*n* =14)		Control (*n* = 15)	
Descriptor	Number	Section %	Number	Section %
Gender				
Female	14	100%	15	100%
Race				
White	11	78.6%	11	73.3%
White, Non-Hispanic	2	14.3%	1	6.7%
African-American	-	-	1	6.7%
Hispanic	-	-	1	6.7%
Asian-Pacific Islander	1	7.1%	-	-
Other	-	-	1[a]	6.7%

[a]One student self-identified as Haitian

Table A7

Education Background of Enrolled Preservice Teachers

	Treatment (*n* =14)		Control (*n* = 15)	
Descriptor	Number	Section %	Number	Section %
Status				
Undergraduate	14	100%	14	93.30%
Graduate	-	-	1	6.70%
Graduation Date				
2014	5	35.70%	7	46.70%
2015	9	64.30%	8	53.30%
Highest Degree				
High School	14	100%	14	93.30%
BA or BS	-	-	1[a]	6.70%
Education Degree				
Pursuing	14	100%	15	100%
Enrolled	14	100%	15	100%
Goal Degree				
BA/MT	14	100%	14	93.30%
PG/MT	-	-	1	6.70%
Enrollment Reason				
Required	13	92.90%	14	93.30%
Other	1[b]	7.10%	1[c]	6.70%

[a]The student's previous degree was a B.S. in Psychology. [b]The student said, "I would like to expand my knowledge about technology and learn how to best implement it in the classroom." [c]The student said, "Technology is not my strong suit, but I recognize my students' need for it, as they will eventually compete professionally."

Table A8

Formal Teaching Experience of Enrolled Preservice Teachers

	Treatment (*n* =14)		Control (*n* = 15)	
Experience	Number	Section %	Number	Section %
Lead Teaching				
Yes	-	-	-	-
No	14	100%	15	100%
Assistant Teaching				
Yes	1	7.1%	1	6.7%
No	13	92.9%	14	93.3%
Administrative Jobs				
Yes	-	-	-	-
No	14	100%	15	100%
Coaching				
Yes	1	7.1%	1	6.7%
No	13	92.9%	14	93.3%
Serving as a Parent Aide				
Yes	-	-	-	-
No	14	100%	15	100%
Tutoring				
Yes	13	92.9%	11	73.3%
No	1	7.1%	4	26.7%
PD Facilitation				
Yes	-	-	-	-
No	14	100%	15	100%
Higher Ed Teaching				
Yes	-	-	-	-
No	14	100%	15	100%

Table A9

Informal Teaching Experience of Enrolled Preservice Teachers

	Treatment (*n* =14)		Control (*n* = 15)	
Experience	Number	Section %	Number	Section %
Student Teaching				
Yes	1	7.1%	-	-
No	13	92.9%	15	100%
After-School Teaching				
Yes	3	21.4%	4	26.7%
No	11	78.6%	11	73.3%
Teaching in a Course Assignment				
Yes	11	78.6%	8	53.3%
No	3	21.4%	7	46.7%
Camp Counseling or Serving as a RA				
Yes	6	42.9%	9	60.0%
No	8	57.1%	6	40.0%
Volunteering				
Yes	9	64.3%	9	60.0%
No	5	35.7%	6	40.0%
Other				
None	11	78.6%	15	100%
Other	3[a]	21.4%	-	-

Note. [a]Reported “Other” experiences included the following statements: (a) I have [acted as a] nanny [for] three boys during the course of three summers; (b) Bible study leader in local private high school; (c) I work as a swim coach for kids ages 6-18. I teach swim lessons for elementary school children. I work in a daycare (with kids ages 6 months-5 years) as a teacher's aide.

Table A10

Research Question and Data Source Alignment

Data Analysis	Research Question 1[a]	Research Question 2[b]	Research Question 3[c]
Phase 1: Quantitative Analysis		-	
Revised Lesson Plan Outlines	√	-	-
Final Exam	√	-	-
Course Evaluation	√	-	-
Phase 2: Qualitative Analysis			
Interview Transcripts	√	√	√
Field Notes	√	√	√

Note. [a]Research Question1: "What differences exist between preservice teachers in the treatment and control sections on summative assessments (lesson plan outlines, final exam, course evaluation)?" [b]Research Question 2: "How does the instructor's implementation of the curricula, his instructional practices, and the modes of assessment affect what learning opportunities are available in both sections of the course?" [c]Research Question 3: "From the standpoint of the preservice teachers, what opportunities to learn do they experience in the treatment and control classes?"

Table A11

Descriptive Statistics for Revised Lesson Plan Outlines

	N	Mean	SD	Variance	Kurtosis	Skewness
Control						
Language Arts (Cla)	15	9.53	1.767	3.124	0.434	-.959
Math (Cmath)	15	10.40	2.063	4.257	-1.206	-.624
Social Studies (Css)	15	9.20	2.859	8.171	1.505	-1.100
Science (Csci)	15	9.80	2.783	7.743	1.625	-1.300
Treatment						
Language Arts (Tla)	14	11.79	1.477	2.181	2.068	-1.410
Math (Tmath)	14	12.43	.514	.264	-2.241	.325
Social Studies (Tss)	14	11.21	2.190	4.797	4.505	-1.907
Science (Tsci)	14	11.14	1.791	3.209	-0.666	-.717

Table A12

Z-Scores for Kurtosis & Skewness on Revised Lesson Plan Outlines

	Kurtosis	SE of Kurtosis	Z-Score for Kurtosis	Skewness	SE for Skewness	Z-Score for Skewness
Control						
Language Arts (Cla)	0.434	1.121	0.39	-0.959	0.58	1.65
Math (Cmath)	-1.206	1.121	1.08	-0.624	0.58	1.08
Social Studies (Css)	1.505	1.121	1.34	-1.1	0.58	1.90
Science (Csci)	1.625	1.121	1.45	-1.3	0.58	2.24
Treatment						
Language Arts (Tla)	2.068	1.154	1.79	-1.41	0.597	2.36
Math (Tmath)	-2.241	1.154	1.94	0.325	0.597	0.54
Social Studies (Tss)	4.505	1.154	3.90	-1.907	0.597	3.19
Science (Tsci)	-0.666	1.154	0.58	-0.717	0.597	1.20

Table A13

Shapiro-Wilk Normality Test for Revised Lesson Plan Outlines

Lesson Plan Outline	Statistic	df	Sig
Language Arts (Cla)	.886	15	.059
Language Arts (Tla)	.811	14	.007
Math (Cmath)	.850	15	.017
Math (Tmath)	.639	14	.000
Social Studies (Css)	.922	15	.210
Social Studies (Tss)	.779	14	.003
Science (Csci)	.879	15	.045
Science (Tsci)	.872	14	.044

Table A14

Lesson Plan Outline Total Scores for Outliers Organized by Subject Area

	Control Section Outliers (Total Score)	Treatment Section Outliers (Total Score)
Social Studies		
Student 17	2	-
Student 6	-	5
Science		
Student 16	5	-
Student 17	3	-

Table A15

Levene's Test of Homogeneity of Variance for Subject Area Lesson Plan Outlines

	Levene Statistic	*df1*	*df2*	Significance
Language Arts	0.383	1	27	.541
Math	27.897	1	27	.001
Social Studies	1.254	1	27	.273
Science	1.037	1	27	.317

Table A16

Levene's Test of Homogeneity of Variance (Median) for Subject Area Lesson Plan Outlines

	Levene Statistic	*df1*	Adjusted *df2*	Significance
Language Arts	.208	1	25.505	.652
Math	11.199	1	17.998	.004
Social Studies	.894	1	25.602	.353
Science	.734	1	21.195	.401

Table A17

Ranked Data for the Mann-Whitney U Test on Subject Area Lesson Plan Outlines

	N	Mean Rank	Sum of Ranks	Median	Range
Language Arts					
Control	15	10	150	10	6
Treatment	14	20.36	285	12	5
Math					
Control	15	10.33	155	11	6
Treatment	14	20	280	12	1
Social Studies					
Control	15	11.63	174.5	10	11
Treatment	14	18.61	260.5	11.5	8
Science					
Control	15	12.93	194	10	10
Treatment	14	17.21	241	11.5	5

Table A18

Mann-Whitney U Tests on Subject Area Lesson Plan Outlines

	Language Arts	Math	Social Studies	Science
Mann-Whitney U	30.00	35.00	54.50	74.00
Z	-3.326	-3.269	-2.234	-1.371
Exact Significance (2-tailed)	0.000	0.001	0.025	.177
Holm Sequential P-Value	0.013	0.017	0.025	.05
Effect Size	-0.62	-0.61	-0.41	-

Table A19

Descriptive Statistics for Final Exam Scores

	N	Mean	SD	Variance	Skewness	Kurtosis
Control	15	46.93	12.01	144.21	-0.67	0.42
Treatment	14	59.50	6.10	37.19	-0.34	-0.07

Table A20

Z-Score Values for Skewness and Kurtosis on the Final Exam Distributions

	Skewness	Skewness Standard Error	Skewness Z-Score	Kurtosis	Kurtosis Standard Error	Kurtosis Z-Score
Control	-0.669	0.58	-1.15	0.418	1.121	0.37
Treatment	-0.342	0.597	-0.57	-0.066	1.154	-0.06

Table A21

Shapiro-Wilk Test Statistics for Final Exam Total Scores

	Shapiro-Wilk Test Statistic	*df*	Significance
Control	.925	15	.226
Treatment	.974	14	.928

Table A22

Descriptive Statistics for Course Evaluation Statements

	N	Mean	SD	Variance	Skewness	Kurtosis
Control						
S1: Diversity	16	3.44	1.094	1.196	-.692	.235
S2: Time	16	2.31	.602	.363	-.205	-.377
S3: Learning	16	3.81	.834	.696	-.397	.100
S4: Worthwhile	16	3.56	1.315	1.729	-.858	-.050
S5: Goals	16	3.69	1.195	1.429	-.910	.231
S6: Approach	16	3.81	.981	.963	-.547	-.390
S7: Teaching	16	3.19	1.328	1.763	-.585	-.665
Treatment						
S1: Diversity	15	4.13	.640	.410	-.103	-.127
S2: Time	15	2.27	.458	.210	1.176	-.734
S3: Learning	15	4.53	.640	.410	-1.085	.398
S4: Worthwhile	15	4.60	.632	.400	-1.407	1.264
S5: Goals	15	4.67	.617	.381	-1.792	2.625
S6: Approach	15	4.73	.594	.352	-2.273	4.785
S7: Teaching	15	4.67	.488	.238	-.788	-1.615

Table A23

Homogeneity of Variance Tests (Median) on Course Evaluation Statements

	Levene Test Statistic	*df1*	Adjusted *df2*	Significance
S1: Diversity	2.382	1	22.886	.136
S2: Time	0.954	1	28.642	.337
S3: Learning	0.177	1	28.992	.677
S4: Worthwhile	3.158	1	24.644	.088
S5: Goals	2.901	1	25.582	.101
S6: Approach	3.214	1	28.204	.084
S7: Teaching	8.995	1	23.873	.006

Table A24

Ranked Data for the Mann-Whitney U Test on Course Evaluation Statement Responses

Question	N	Mean Rank	Sum of Ranks	Median	Range
S1: Diversity					
Control	16	13.22	211.50	4.00	4
Treatment	15	18.97	284.50	4.00	2
S2: Time					
Control	16	16.47	263.50	2.00	2
Treatment	15	15.50	232.50	2.00	1
S3: Learning					
Control	16	12.34	197.50	4.00	3
Treatment	15	19.90	298.50	5.00	2
S4: Worthwhile					
Control	16	12.22	195.50	4.00	4
Treatment	15	20.03	200.50	5.00	2
S5: Goals					
Control	16	12.03	192.50	4.00	4
Treatment	15	20.23	303.50	5.00	2
S6: Approach					
Control	16	11.72	187.50	4.00	3
Treatment	15	20.57	308.50	5.00	2
S7: Teaching					
Control	16	10.69	171.00	3.50	4
Treatment	15	21.67	325.00	5.00	1

Table A25

Mann-Whitney U Tests on Course Evaluation Statement Responses

	Mann-Whitney U	Z	Exact Significance (2-Tailed)	Holm Sequential *P*-Value	Effect Size
S1: Diversity	75.500	-1.910	.064	.025	-
S2: Time	112.500	-.355	.859	.05	-
S3: Learning	61.500	-2.486	.014	.017	-0.45
S4: Worthwhile	59.500	-2.560	.010	.013	-0.46
S5: Goals	56.500	-2.718	.006	.010	-0.49
S6: Approach	51.500	-2.961	.003	.008	-0.53
S7: Teaching	35.000	-3.551	.000	.007	-0.64

Table A26

Instances of In-Class Sarcasm

Sarcasm Type	Control	Treatment
Assignment Sarcasm	15	10
Behavioral Sarcasm	11	10
Grade Sarcasm	6	10
Incompetence Sarcasm	10	7
Sarcasm About Others	20	13
Sarcasm About Self	12	13

Table A27

Frequency of Negative and Positive Statements about the Course Readings

	Positive	Negative
Control	3	4
Treatment	5	6

Table A28

Frequency Statistics for Positive and Negative Aspects of Implemented Case Studies

	Positive	Negative
General Reaction	5	2
Language Arts	2	
Math	6	
Social Studies	1	3
Science	5	

Table A29

Frequency Data for Participant Responses to Self-Reported Capacity to Integrate Technology

Statement	Control	Treatment
Awareness or Exposure	7	3
Willingness or Openness to Use Technology	9	10
Tech Skills or Abilities	2	1
Understanding of Effective Technology Integration	2	3
Qualified Statements	8	2

Table A30

Summary of Findings

	Control	Treatment
Research Question 1		
Revised Lesson Plan Outline		
Language Arts	Lower Total Scores	Higher Total Scores
Math	Lower Total Scores	Higher Total Scores
Social Studies	Lower Total Scores	Higher Total Scores
Science	Not Statistically Different	Not Statistically Different
Final Exam	Lower Total Scores	Higher Total Scores
Course Evaluation		
S1: Diversity	Not Statistically Different	Not Statistically Different
S2: Time	Not Statistically Different	Not Statistically Different
S3: Learning	Less Agreement	More Agreement
S4: Worthwhile	Less Agreement	More Agreement
S5: Goals	Less Agreement	More Agreement
S6: Approachable	Less Agreement	More Agreement
S7: Teaching	Less Agreement	More Agreement
Research Question 2		
Pedagogical Knowledge	1. Model Lessons and Examples 2. Little to no instructional emphasis	1. Embedded within Curriculum 2. Heavy instructional emphasis
Self-Directed Learning	1. Required for success 2. Little or no additional resources 3. Few In-Class Technology Tutorials	1. Required for success 2. Flipped classroom resources 3. Few In-Class Technology Tutorials

Sarcasm	1. Incompetence could not be changed 2. Negative sarcasm about other people 3. Negative sarcasm about the instructor	1. Incompetence could be changed 2. Positive sarcasm about other people 3. Positive sarcasm about the instructor
Assessment	Motivated by low grades	Motivated by factors other than grades
Research Question 3		
Knowing	Readings were unrelated or uninteresting	Readings were too narrowly focused
Seeing	1. Value in seeing classroom examples 2. Did not receive but wanted case studies	1. Value in seeing classroom examples 2. Received case studies 3. Value in observing microteaching
Doing	1. Doing was most valuable 2. Wanted more direct guidance while using a technology 3. Projects were favorite assignments	1. Doing was most valuable 2. Wanted more direct guidance while using a technology 3. Microteaching was favorite assignment
Technology Exposure	Received a breadth of tools but wanted depth	Received instructional depth with tools but wanted breadth
Capacity to Integrate Technology	1. Greater awareness of technologies 2. More willing and open to using technology 3. Little increase in technology skills or abilities 4. Few participants reported that their capacity to integrate technology increased 5. Less self-assured about what they learned	1. Less awareness of available technologies 2. More willing and open to using technology 3. Little increase in technology skills or abilities 4. Few participants reported that their capacity to integrate technology increased 5. More self-assured about what they learned

APPENDIX B: FIGURES

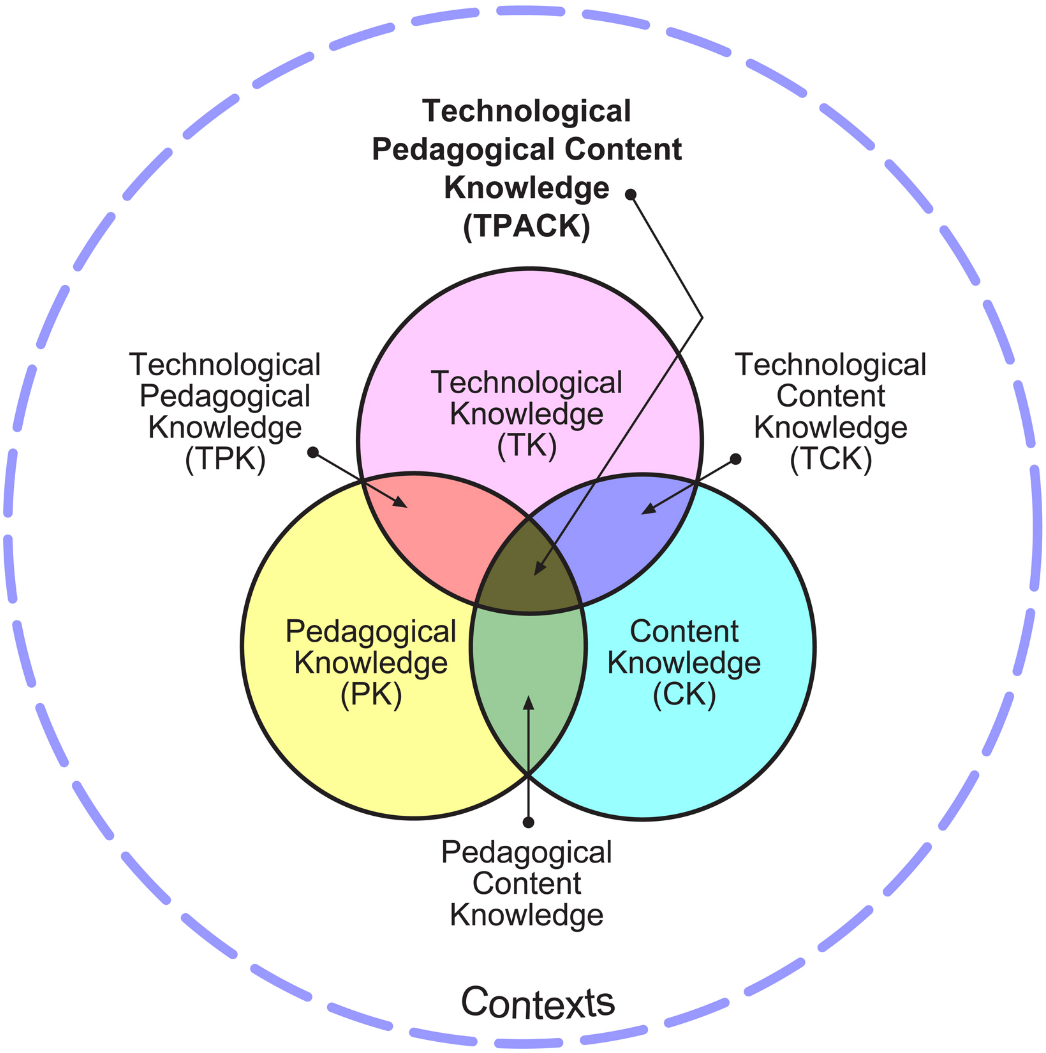

Figure B1. Graphical representation of TPACK and knowledge constructs. The image is reproduced by permission of the publisher, © 2012 by http://tpack.org.

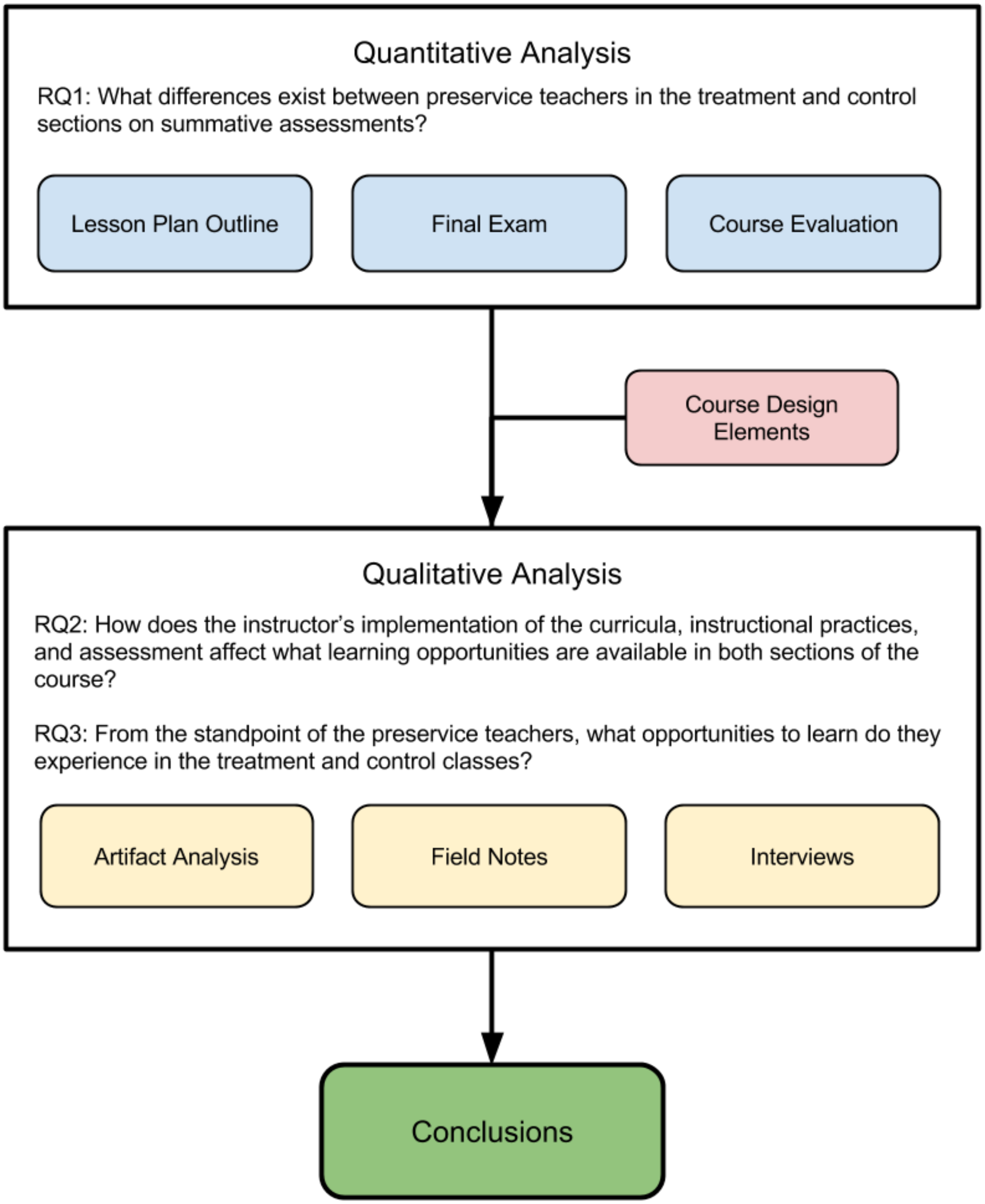

Figure B2. Research and data analysis flowchart.

		Week	Date	Grade Band	Content	Pedagogy	Technology	Homework
Intro / TPACK		1	08/28/12					Lesson Outline & Reading
Language Arts	Audience	2	09/04/12	K-5	Writing	Audience	Puppetpals	TK & Reading
		3	09/11/12	K-2	Digital Storytelling	Audience	Movie Maker or iMovie	TK & Reading
		4	09/18/12	3-5	Fluency	Audience	iRead	Post-Lesson Outline
Math	Multiple Representations	5	09/25/12	K-5	Multiple Representations Intro	Multiple Representations	SMART Notebook	Lesson Outline & Reading
		6	10/02/12	K-2	Early Counting	Strategies	NLVM	TK- Estimation Calculator & Reading
		7	10/16/12	3-5	Computational Estimation	Discourse	Estimation Calculator	Post-Lesson Outline
Social Studies	Primary Sources	8	10/23/12	K-5	Primary Sources Intro	Visual Discovery	Voicethread or Photostory 3	Lesson Outline & Reading
		9	10/30/12	K-2	People, Places, Environments	Exploration	Google Earth	TK & Reading
		10	11/06/12	3-5	Power, Authority, Governance	Reflection	Talkshoe	Post-Lesson Outline
Science	Inquiry	11	11/13/12	K-5	Inquiry	Inquiry Method	Phet	Lesson Outline & Reading
		12	11/20/12		TBD			
		13	11/27/12	K-2	Planets	Scale	Simulations	TK & Reading
		14	12/04/12	3-5	General Science	Guided Inquiry-Discovery	Concept Maps	Post-Lesson Outline
Exam		15	12/11/12					---

Figure B3. Semester overview and curricular structure for the treatment section.

	Week	Date	Assessment
Intro / TPACK	1	08/28/12	Lesson Outline & Reading
Google Products	2	09/04/12	Reading
Wikis & Blogs	3	09/11/12	Project 1 & Reading
Interactive Whiteboards	4	09/18/12	Post-Lesson Outline & Reading
Digital Audio 1	5	09/25/12	Lesson Outline
Digital Audio 2	6	10/02/12	Project 2 & Readings
Excel	7	10/16/12	Post-Lesson Outline
Digital Video 1	8	10/23/12	Lesson Outline & Reading
Digital Video 2	9	10/30/12	Project 3 & Reading
Primary Sources	10	11/06/12	Post-Lesson Outline & Reading
Mobile Devices	11	11/13/12	Lesson Outline & Reading
Internet Safety	12	11/20/12	Project 4 & Reading
Digital Images for Science	13	11/27/12	Reading
Project Presentations	14	12/04/12	Post-Lesson Outline
Final Exam	15	12/14/12	

Figure B4. Semester overview and curricular structure for the control section.

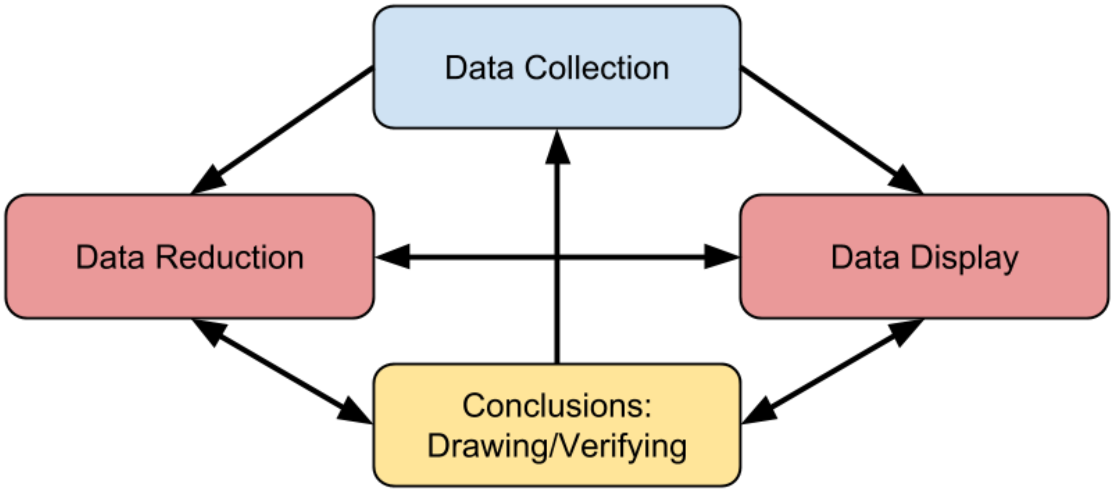

Figure B5. Qualitative analysis interactive model. The study followed an interactive model of qualitative analysis that included concurrent display, reduction, and conclusion drawing/verification activities (Miles & Huberman, 1994).

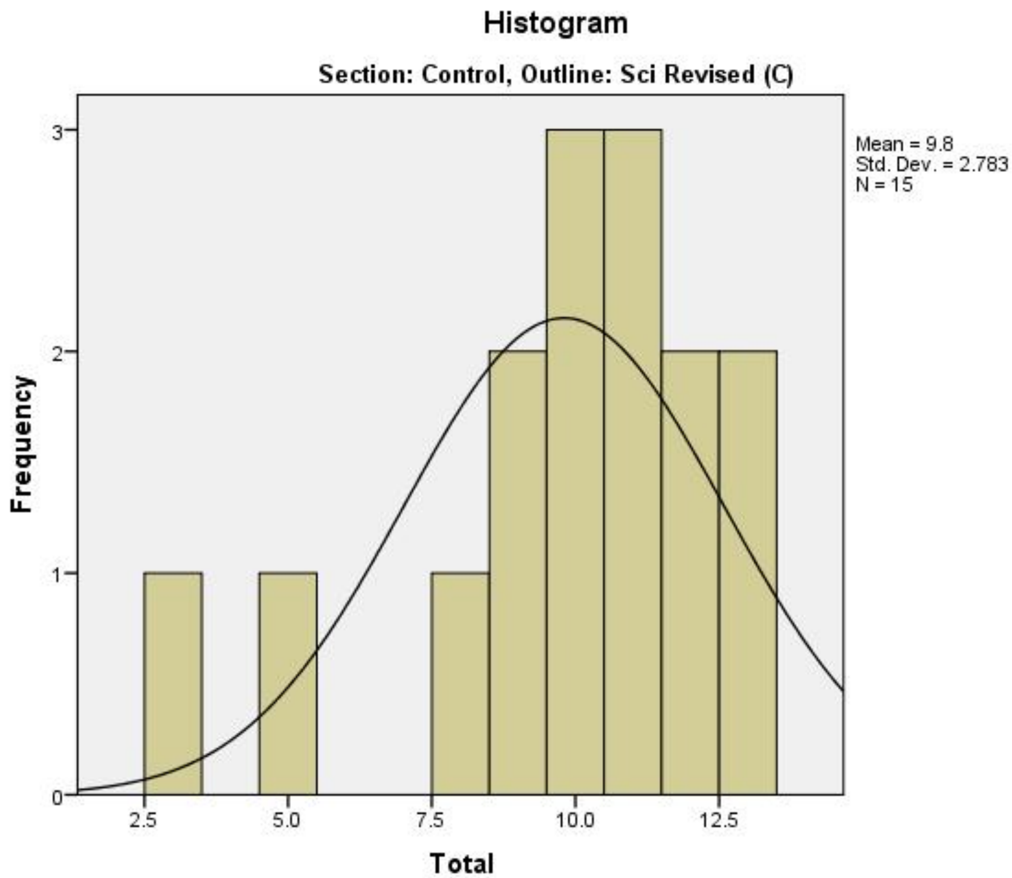

Figure B6. Histogram of total scores for the control section's revised lesson plan outlines in science.

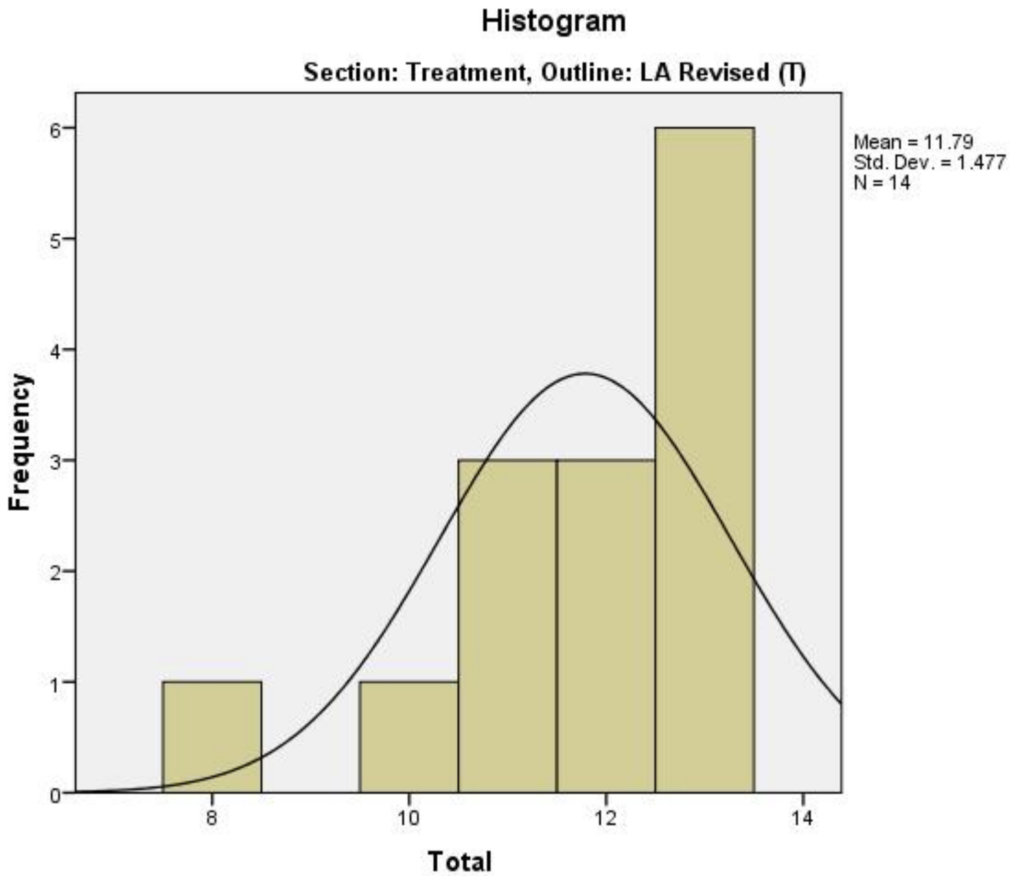

Figure B7. Histogram of total scores for the treatment section's revised lesson plan outlines in language arts.

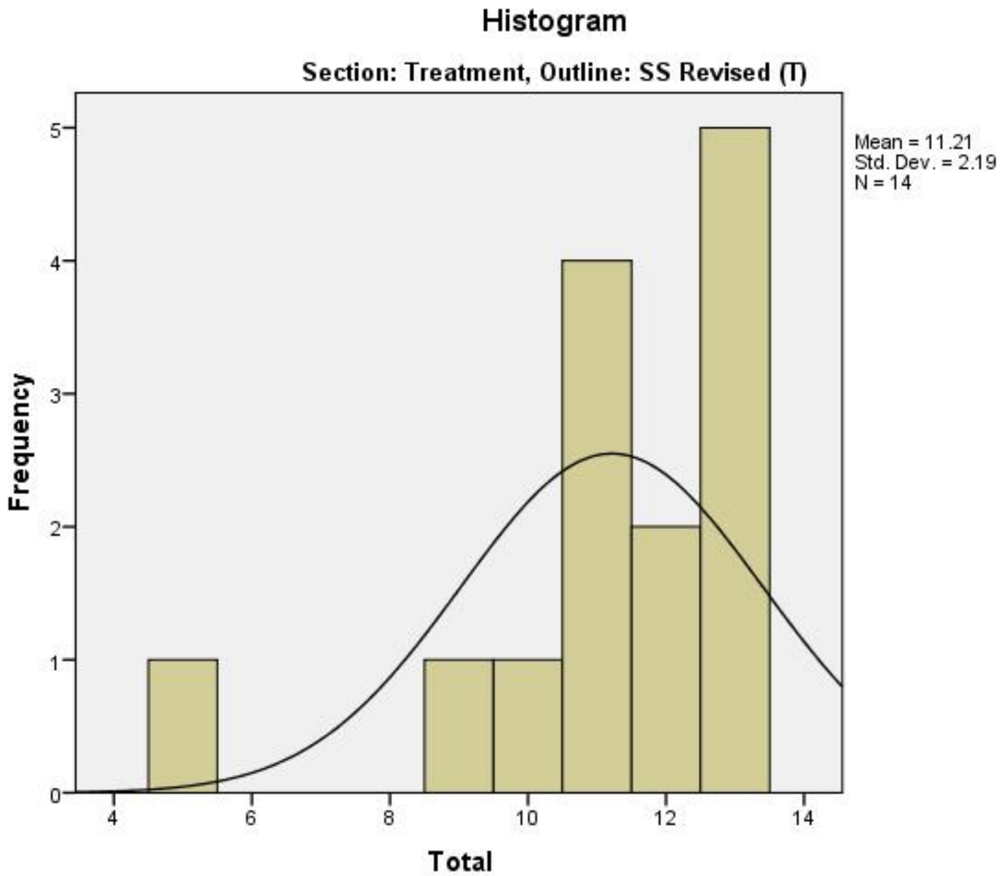

Figure B8. Histogram of total scores for the treatment section’s revised lesson plan outlines in social studies.

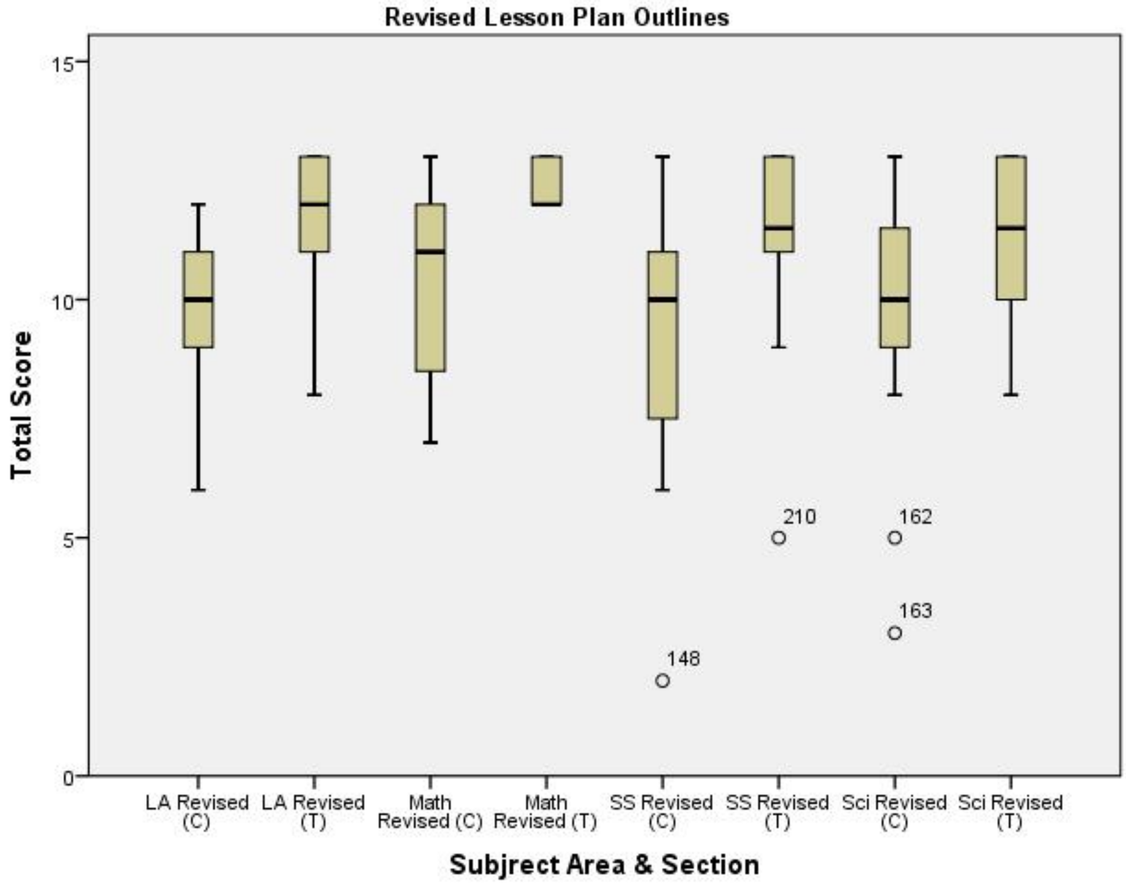

Figure B9. Box-whisker diagram of total scores on the revised lesson plan outlines.

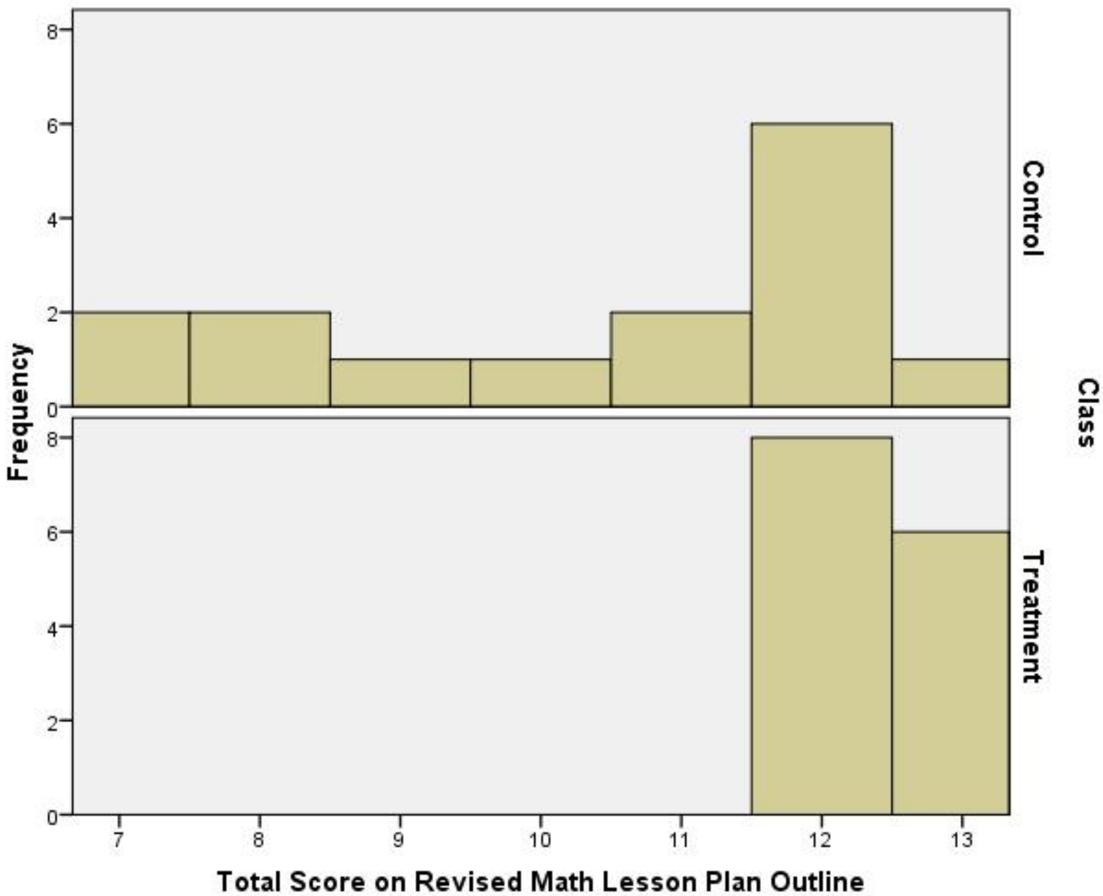

Figure B10. Frequency distribution of total scores for the math lesson plan outline.

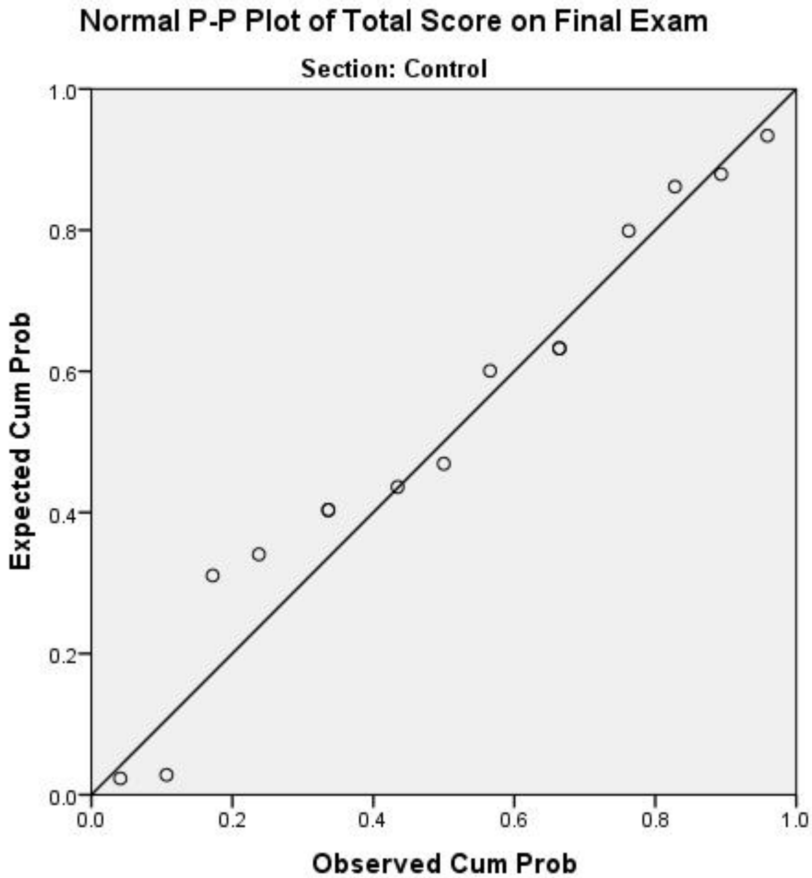

Figure B11. P-P plot of total score values for the control section on the final exam.

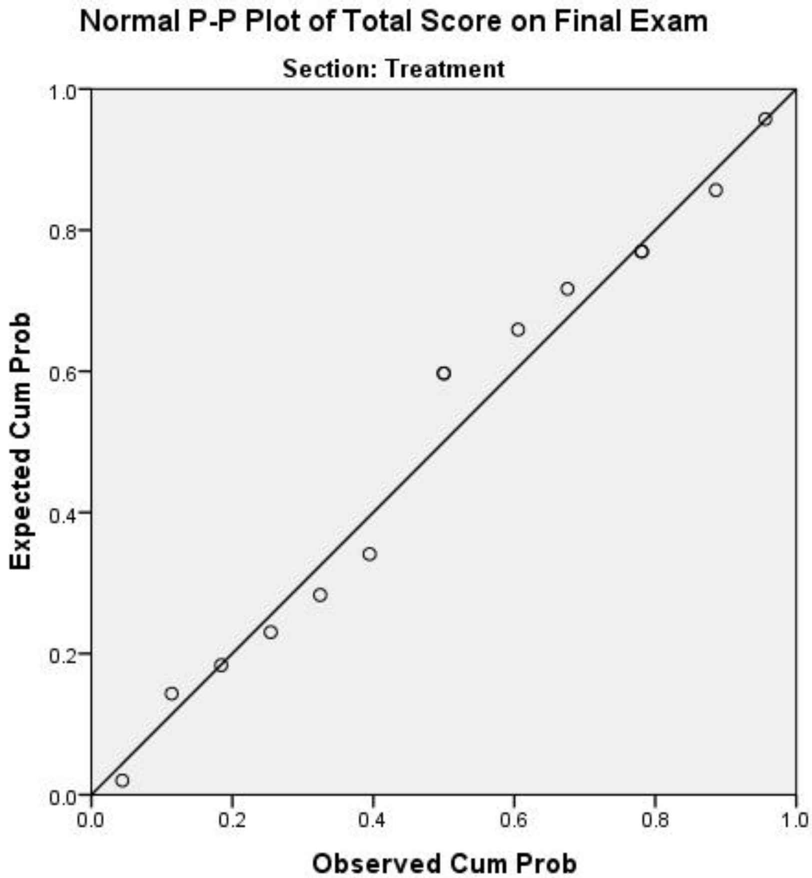

Figure B12. P-P plot of total score values for the treatment section on the final exam.

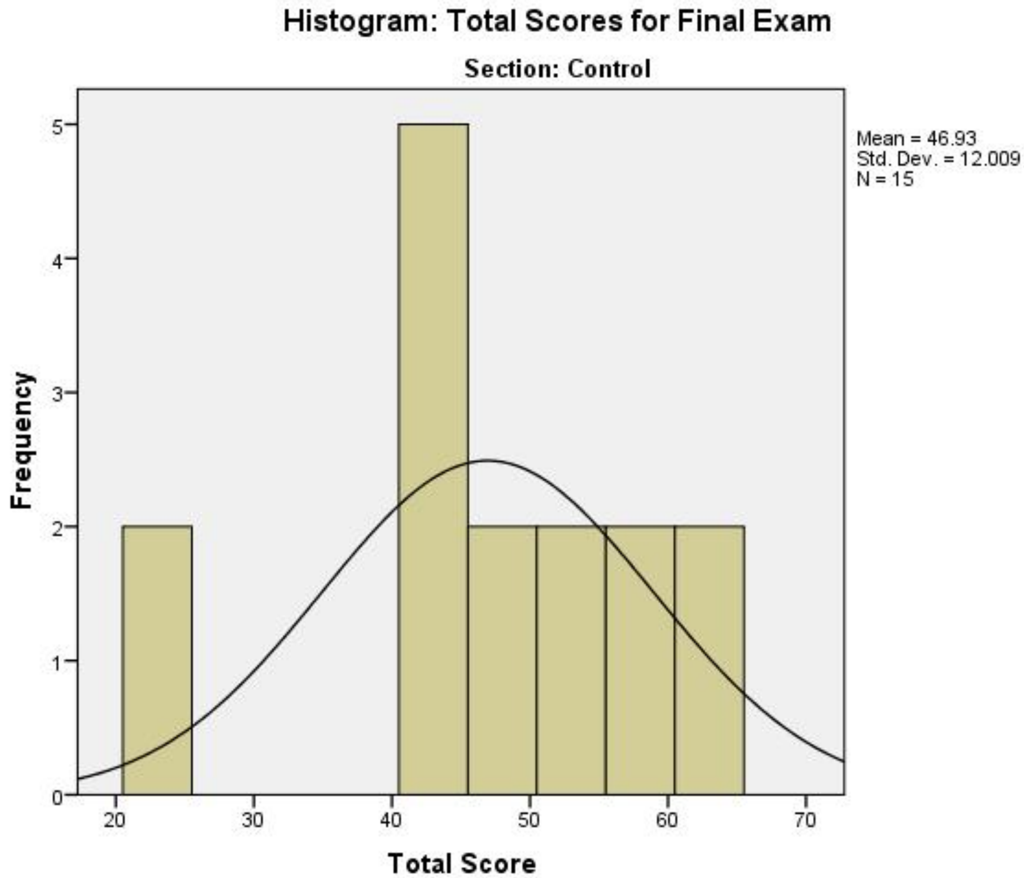

Figure B13. A histogram displaying the frequencies of total score values for the control section on the final exam.

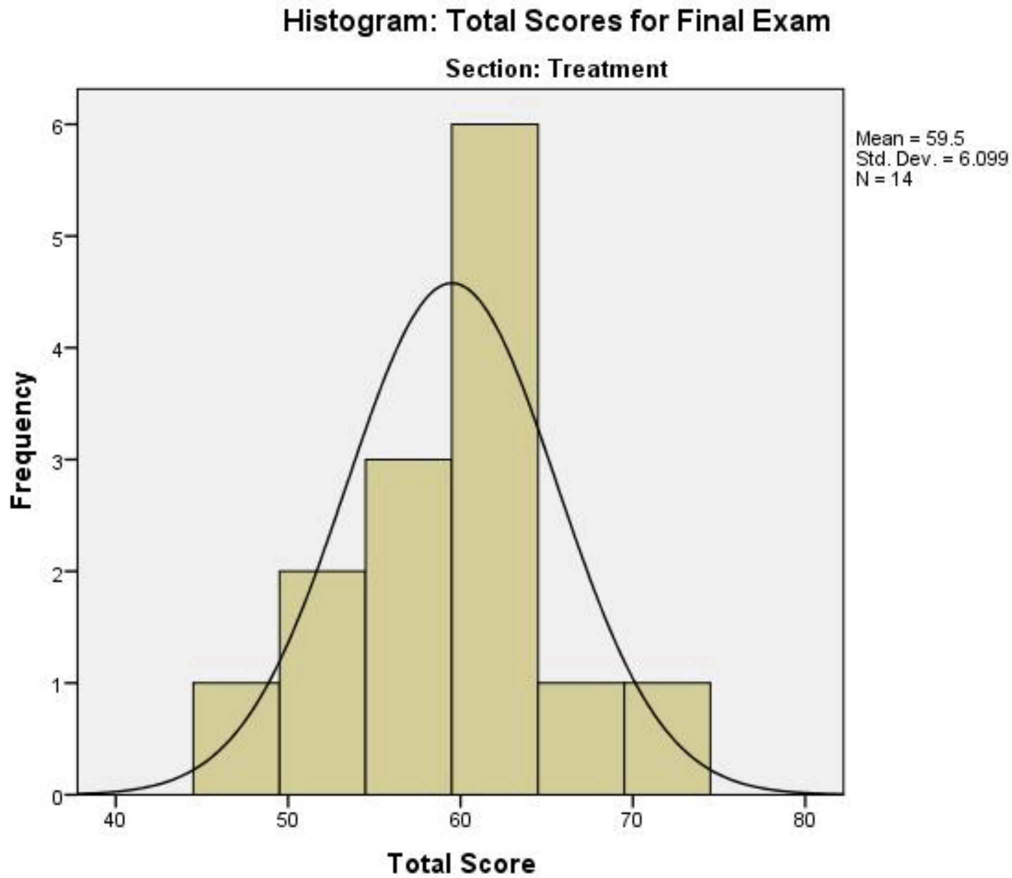

Figure B14. A histogram displaying the frequencies of total score values for the treatment section on the final exam.

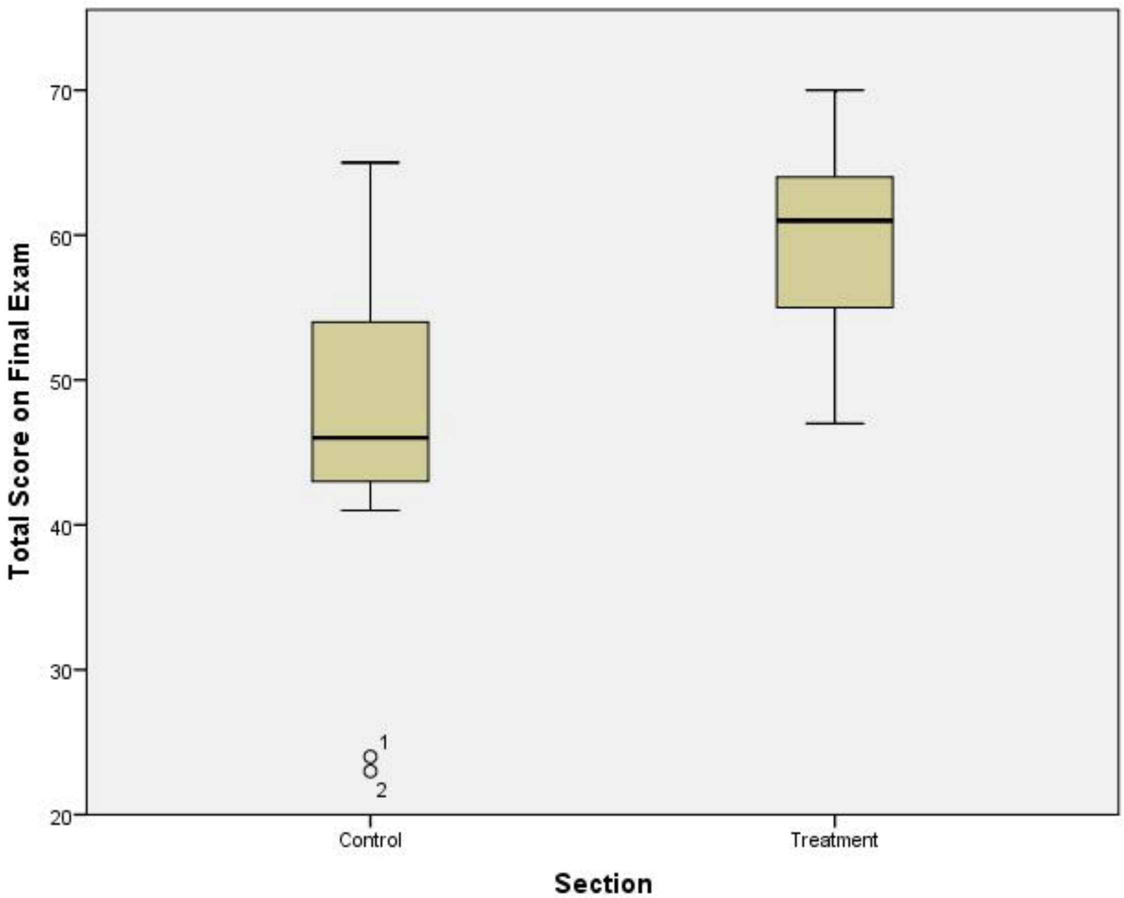

Figure B15. Box-whisker diagram of total scores on the final exam.

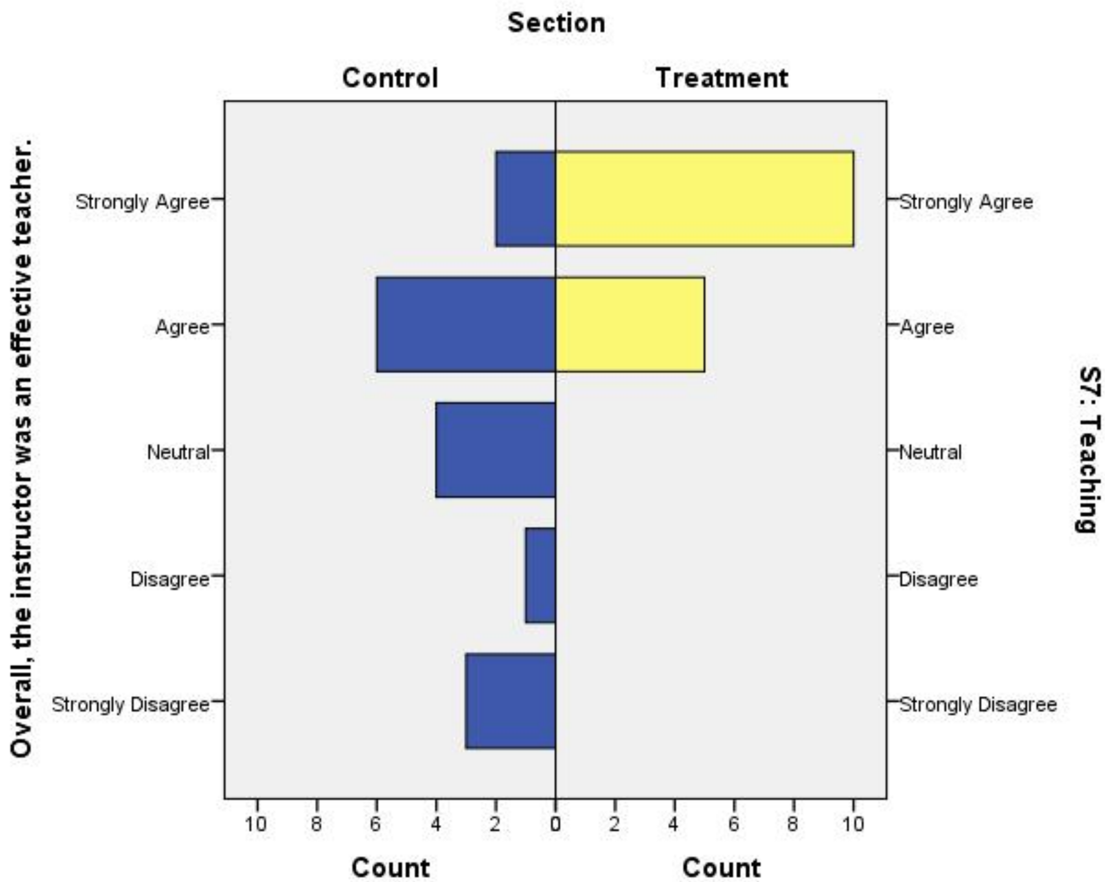

Figure B16. Frequency distribution for responses on S7: Teaching of the course evaluation.

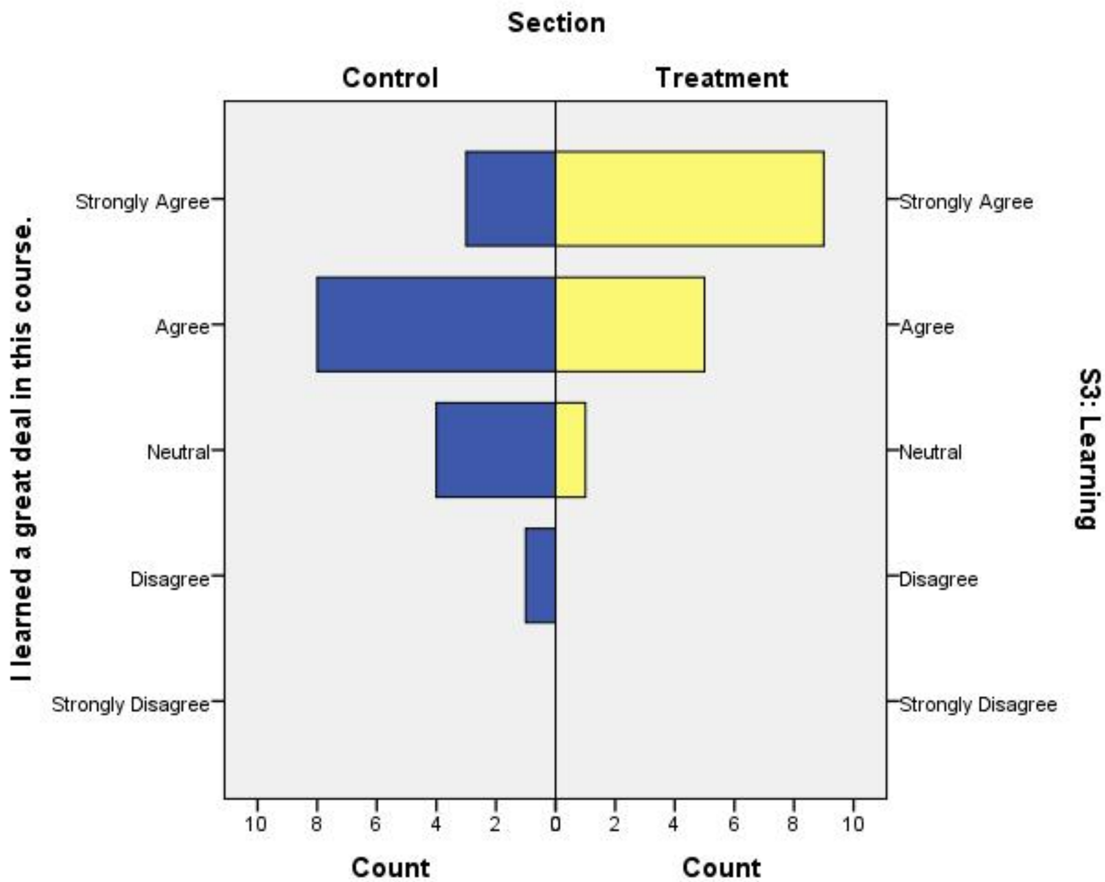

Figure B17. Frequency distribution for responses on S3: Learning of the course evaluation.

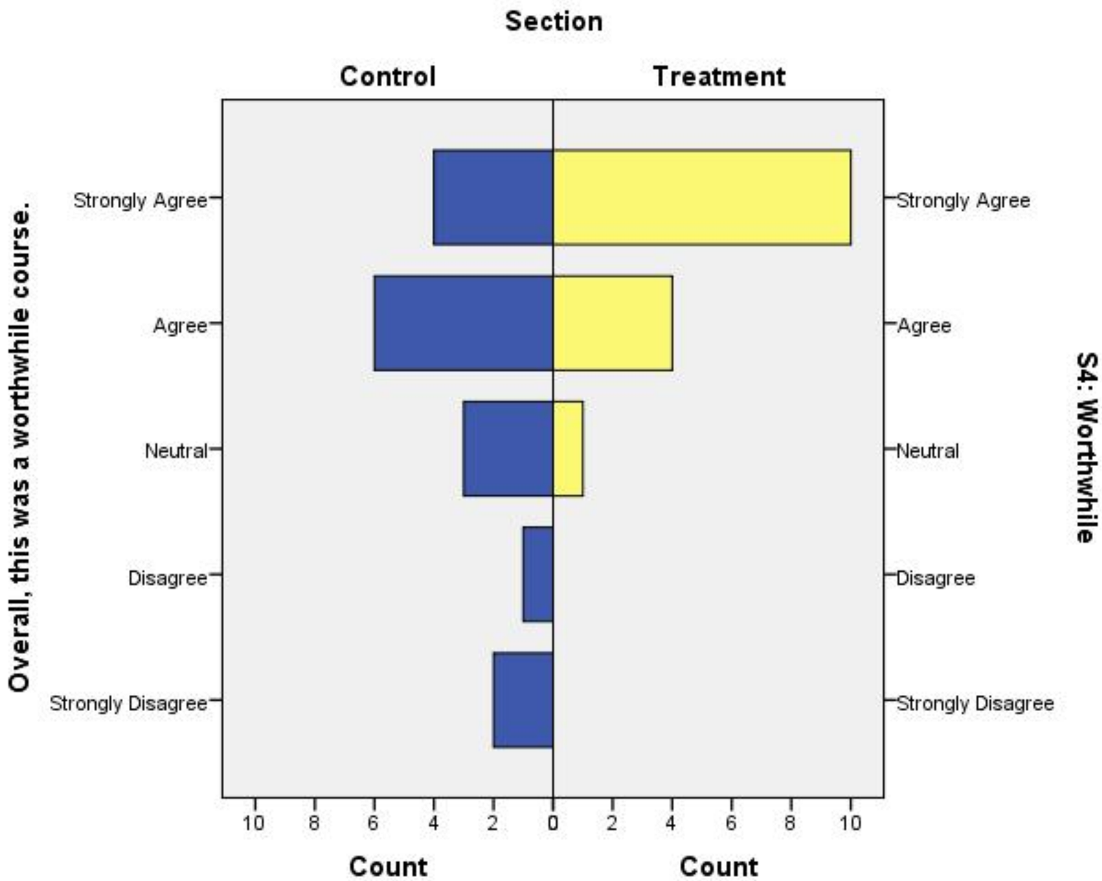

Figure B18. Frequency distribution for responses on S4: Worthwhile of the course evaluation.

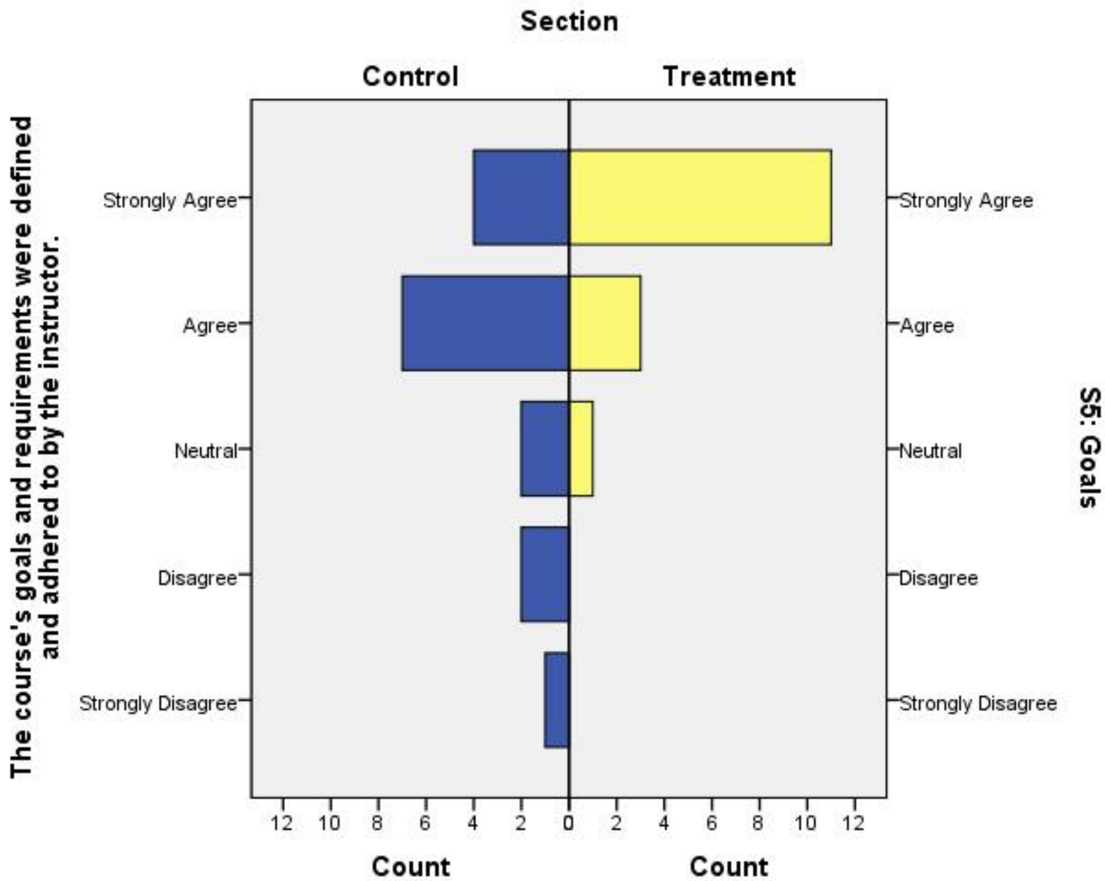

Figure B19. Frequency distribution for responses on S5: Goals of the course evaluation.

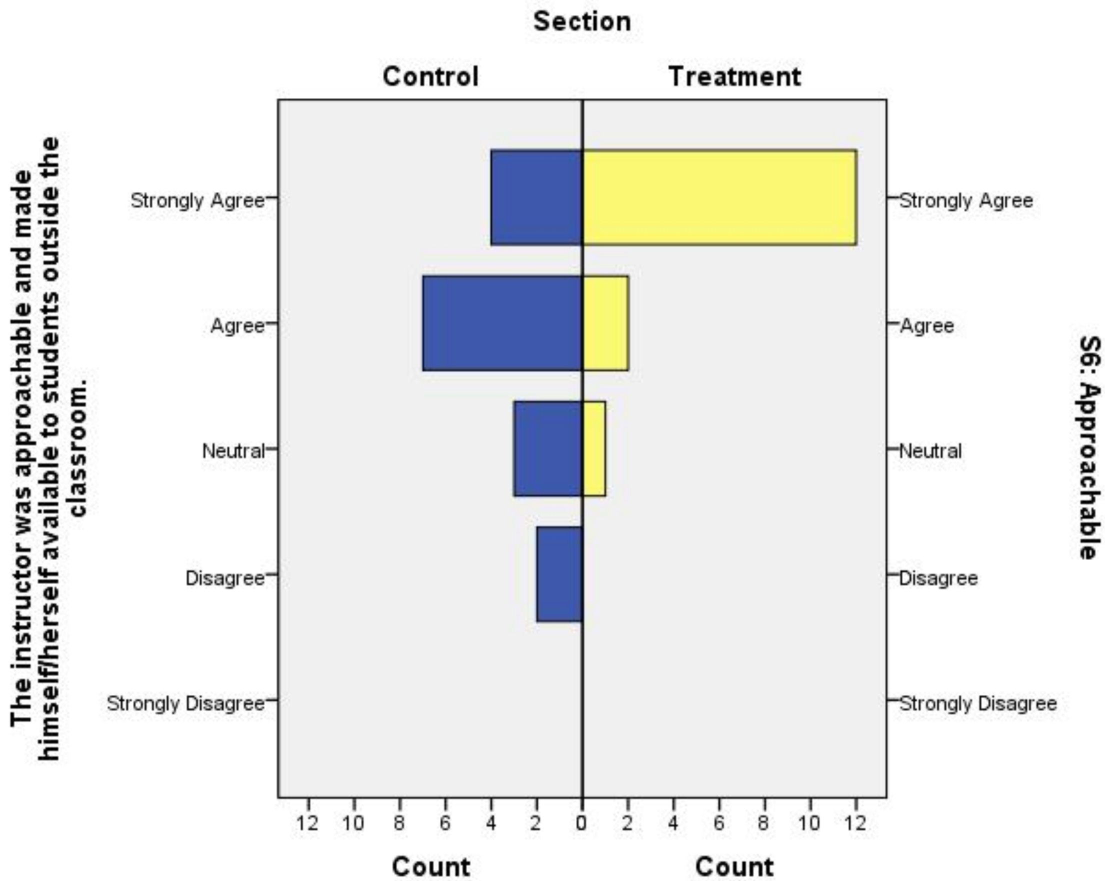

Figure B20. Frequency distribution for responses on S6: Approachable of the course evaluation.

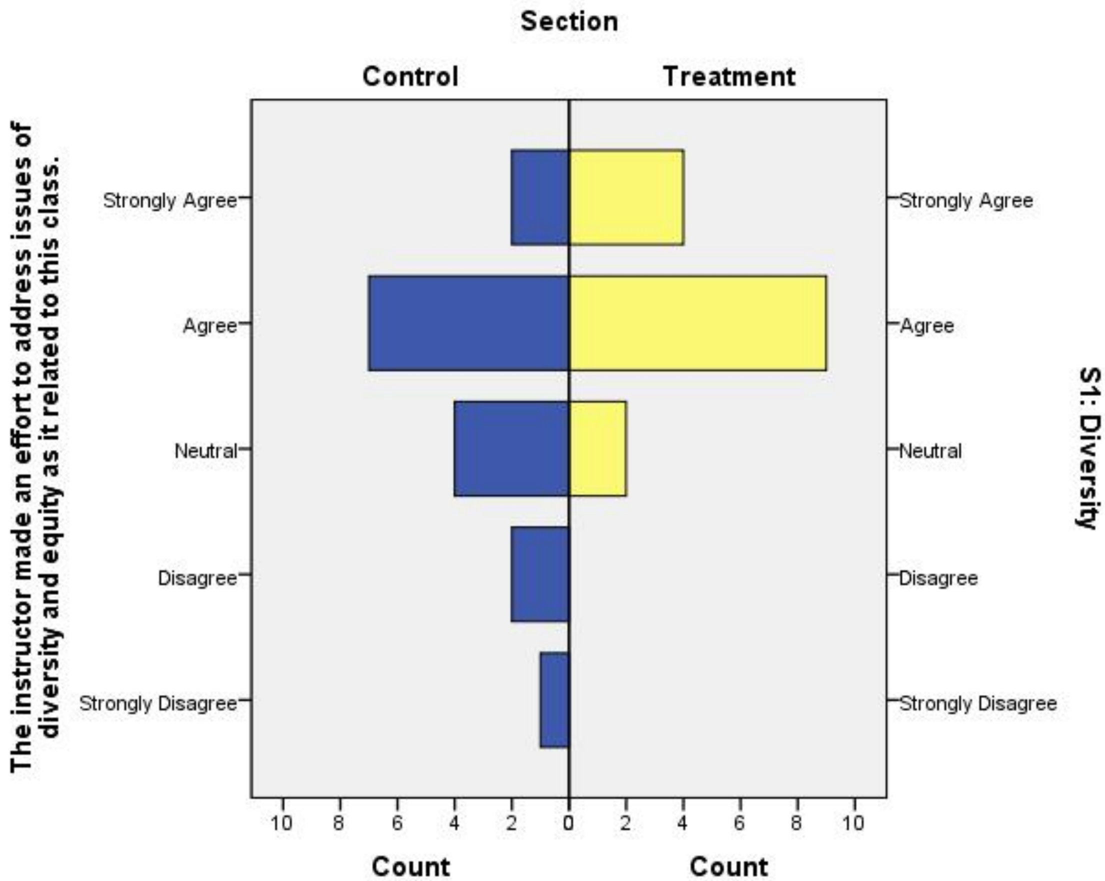

Figure B21. Frequency distribution for responses on S1: Diversity of the course evaluation.

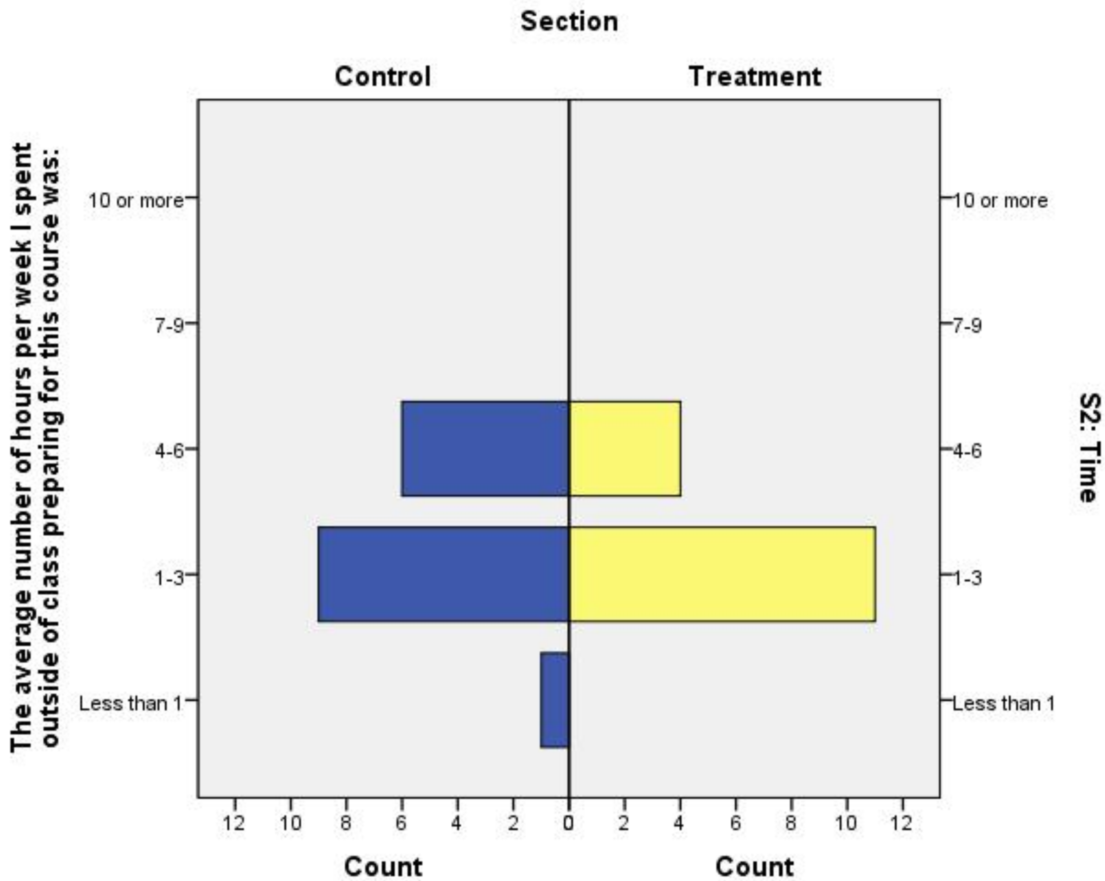

Figure B22. Frequency distribution for responses on S2: Time of the course evaluation.

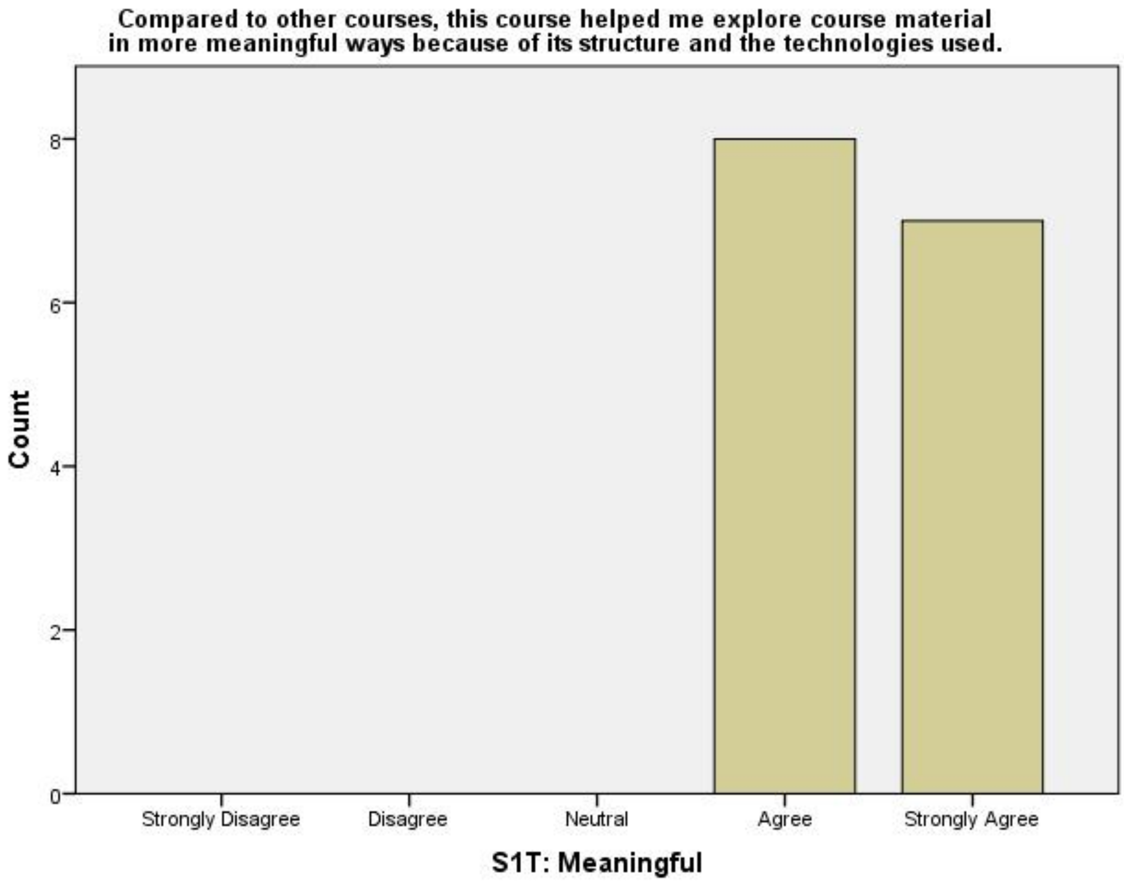

Figure B23. Frequency distribution for responses on S1T: Meaningful of the course evaluation. Treatment section only.

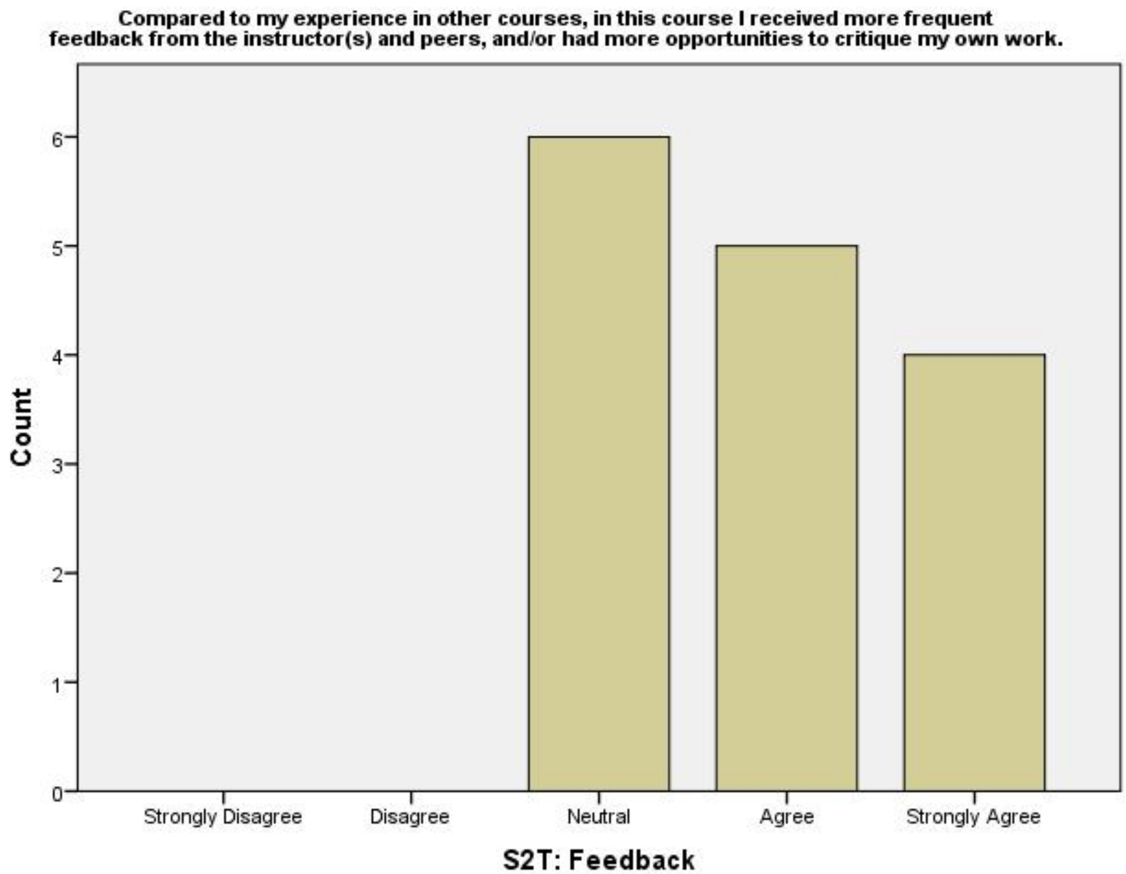

Figure B24. Frequency distribution for responses on S2T: Feedback of the course evaluation. Treatment section only.

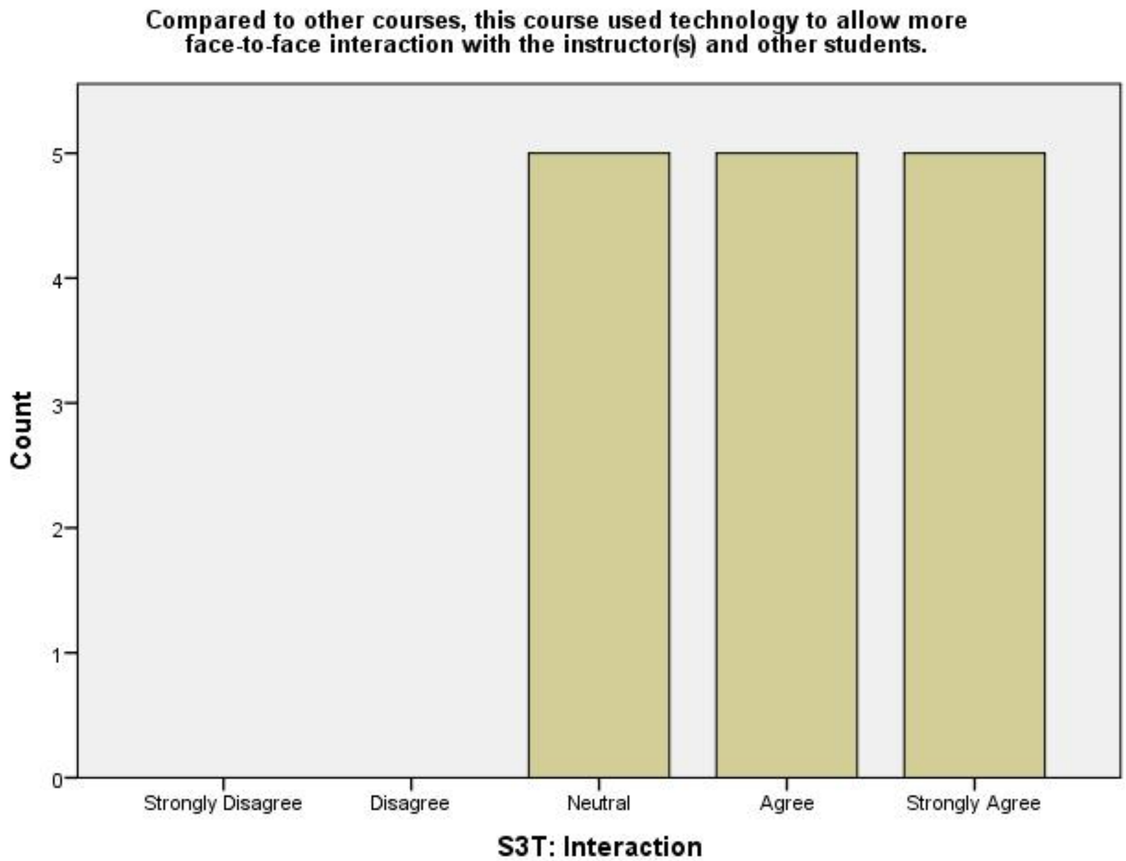

Figure B25. Frequency distribution for responses on S3T: Interaction of the course evaluation. Treatment section only.

APPENDIX C: SUPPLEMENTAL MATERIALS

Supplemental Material C1
Lesson Plan Outline

Directions: Develop a lesson plan outline that addresses the provided content. Assume that the lesson is for a class of approximately fifteen to twenty students.

Subject Area:
Content Topic:
Grade Level:

Content

1. Describe the topic in your own words. Please address the following bullet points in your description (1-2 paragraphs).
    - What is the topic?
    - Why is the topic important?
    - How does the topic relate to students' previous understanding OR future understanding?

2. List the relevant Virginia Standards of Learning that your topic addresses.

Pedagogy

1. What are the relevant pedagogical approaches or instructional strategies that you will use to address the content topic? Please address the following bullet points in your description (3-4 paragraphs).
    - Describe what will happen during the lesson. If you include references to worksheets or other supplementary files, consider including the files.
    - Describe the pedagogical approaches/instructional strategies and explain how each one addresses known methodological decisions for effective teaching and learning.
    - Will instruction take place as a whole class, small groups, or individually? Explain your rationale for the chosen interaction(s).
    - How will you document student learning (formative and summative assessments)?

Technology

- Describe the technology or technologies that you will use in the lesson. Please address the following bullet points in your description (1-2 paragraphs).
    - Describe the technology or technologies and include any relevant peripherals needed (e.g., computers, Internet, cameras).
    - In what ways are students learning "with" the chosen technology (student-centered)? In what ways is the use of technology teacher-centered?

- What preparations need to be made prior to implementing the proposed lesson outline?

- Complete the following table for any technologies used in the lesson plan outline. Please add rows if needed.

Technology	**Relationship to Pedagogy**

- List the relevant National Education Technology Standards for Students (NETS-s) that your topic addresses.

Supplemental Material C2

Lesson Plan Outline Scoring Rubric

		Appropriate	Inappropriate
Content	Topic	The content addresses a topic that is relevant to domain understanding and references an appropriate standard of learning.	The content fails to either address a topic that is relevant to domain understanding or lacks references to an appropriate standard of learning.
	Scope	The chosen topic sufficiently covers a single lesson period.	The chosen topic is either too broad or narrow in terms of a single lesson period.
	Importance	The topic's importance is explained as it relates to either the discipline and/or developmental stages.	There is either no or insufficient explanation of the topic's importance.
	Connections	The topic's description indicates how it builds upon prior understanding or scaffolds future understanding.	There is either no or insufficient description about how the topic builds upon prior understanding or scaffolds future understanding.
Pedagogy	Instruction	There is a clear set of procedures that covers what will transpire during the lesson.	The procedures are either unclear or there is insufficient detail to fully grasp what will transpire during the lesson.
	Approach	Pedagogical approaches are clearly and explicitly articulated in the context of instructional decisions and procedures.	Pedagogical approaches are either unclear or subtly articulated in the context of instructional decisions and procedures.
	Grouping	Grouping is clearly stated and aligns with an instructional rationale.	Grouping is either missing or unsubstantiated in terms of instructional decisions or procedures.
	Assessment	All phases of the lesson contain a clear from of assessment (formative-summative, informal-formal).	Some or none of the phases of the lesson contain a clear form of assessment (formative-summative, informal-formal).
Technology	Tech	There is a complete set of technologies necessary for implementing the lesson.	There is an incomplete list of technologies or insufficient detail in the description.
	Learning "with" tech	Teacher and student-centered uses of technology are clearly articulated.	Teacher and student-centered uses of technology are either unclear or absent from the description.
	Preparation	Obvious preparatory actions and technologies are included in the lesson.	Obvious preparatory actions and/or technologies are missing in the lesson.
	Tech - Pedagogy	The technology clearly relates to a pedagogical approach or instructional decision.	The technology unclearly relates to a pedagogical approach or instructional decision.
	NETS-S	All NETS-S standards are relevant and appropriate to the lesson.	Some or all of the NETS-S standards are irrelevant or inappropriate to the lesson.

Supplemental Material C3
Final Exam

1. What does TPACK mean to you?

2. Address the following statements by filling in the table below.
    a. Identify and describe a core pedagogical principle in each of the four subject areas.
    b. Explain how each pedagogical principle impacts learning in an elementary classroom by considering the readings and in-class discussions.
    c. Provide <u>different</u> sample technologies that connect to each subject area and pedagogical approach. Clearly connect the technology to the pedagogical approach in a written description.

Note: Writing "Interactive Whiteboard Software" insufficiently explains the sample technology (part c). Talking about specific elements of an Interactive Whiteboard Software program is sufficient provided there is a <u>clear</u> connection to the core pedagogical principle in the written description. Interactive Whiteboard Software may be used as the primary technology in only one of the subject areas.

Language Arts	a.
	b.
	c.
Mathematics	a.
	b.
	c.
Social Studies	a.
	b.
	c.
Science	a.
	b.
	c.

3. Watch the following video and identify elements of technological, pedagogical, and content knowledge by describing what you see in the appropriate column below.

https://www.teachingchannel.org/videos/counting-objects-and-ordering-numbers?fd=1

    a. Only include instances of technological, pedagogical, and content knowledge that appear in the video. Describe what you observe in the appropriate column and explain why your observation is an example of technological, pedagogical, or content knowledge.
    b. Provide the time (i.e., 00:00) in the video when you identified an example of technological, pedagogical, or content knowledge.

Note: You do not need to use all of the rows in the table. You may also include additional rows if you need more room.

Technological Knowledge	Time	Pedagogical Knowledge	Time	Content Knowledge	Time

4. Integrating TPACK: Use the following rubric to rate the teacher in the previous video on her ability to use TPACK to support student learning.
    a. Highlight (in yellow) the rating for each criterion.
    b. **Example Justification**: Justify each rating with examples from the video or what you know about teaching and learning with technology.
    c. **Rating Explanation**: Explain why a lower or higher rating is inappropriate based on what you know about teaching and learning and the mathematical content.

Criteria	4	3	2	1	Justification & Rating
Content & Technology	Technologies selected for use in the lesson are strongly aligned with one or more curriculum goals (content).	Technologies selected for use in the lesson are aligned with one or more curriculum goals (content).	Technologies selected for use in the lesson are partially aligned with one or more curriculum goals (content).	Technologies selected for use in the lesson are not aligned with any curriculum goals (content).	Example Justification (4b): Rating Explanation (4c):
Pedagogy & Technology	Technology use optimally supports an appropriate pedagogical approach.	Technology use supports an appropriate pedagogical approach.	Technology use minimally supports an appropriate pedagogical approach.	Technology use does not support an appropriate pedagogical approach.	Example Justification (4b): Rating Explanation (4c):

Technology Selection	Technology selection(s) are exemplary, given curriculum goal(s) and pedagogical approaches.	Technology selection(s) are appropriate, but not exemplary, given curriculum goal(s) and pedagogical approaches.	Technology selection(s) are marginally appropriate, given curriculum goal(s) and pedagogical approaches.	Technology selection(s) are inappropriate, given curriculum goal(s) and pedagogical approaches.	Example Justification (4b): Rating Explanation (4c):
TPACK	Content, pedagogical approaches and technology fit together strongly within the lesson.	Content, pedagogical approaches and technology fit together within the instructional plan.	Content, pedagogical approaches and technology fit together somewhat within the instructional plan.	Content, pedagogical approaches and technology do not fit together within the instructional plan.	Example Justification (4b): Rating Explanation (4c):

Supplemental Material C4
Final Exam Scoring Rubric

Question 1:

Criteria	**2**	**1**	**0**
Content Knowledge	Content knowledge is adequately defined through a definition or an example(s).	Content knowledge is incompletely defined through a definition or an example(s).	Content knowledge is not defined.
Pedagogical Knowledge	Pedagogical knowledge is adequately defined through a definition or an example(s).	Pedagogical knowledge is incompletely defined through a definition or an example(s).	Pedagogical knowledge is not defined.
Technological Knowledge	Technological knowledge is adequately defined through a definition or an example(s).	Technological knowledge is incompletely defined through a definition or an example(s).	Technological knowledge is not defined.
TPACK	TPACK is adequately defined through a definition or an example(s).	TPACK is incompletely defined through a definition or an example(s).	TPACK is not defined or inappropriately characterized.

Question 2:

	Criteria	2	1	0
Language Arts	Core Pedagogical Principle	The principle is a pedagogical approach that applies to the subject area. The description accurately explains the pedagogical approach.	The principle is a pedagogical approach that applies to the subject area. The description partially explains the pedagogical approach (key elements are missing).	The principle is not a pedagogical approach regardless of subject area appropriateness.
Language Arts	Core Pedagogical Principle's Impact on Learning	There is a clear connection between **the listed** pedagogy and the learning that it promotes.	There is a clear connection between **a** pedagogy and the learning that it promotes.	There is no clear connection between the pedagogical approach and learning.
Language Arts	Sample Technology's Connection to Pedagogy	The sample technology clearly connects to the pedagogy through the description.	The sample technology relates to the pedagogy but the connection is not clearly articulated.	The sample technology does not connect to the pedagogical approach.
Math	Core Pedagogical Principle	The principle is a pedagogical approach that applies to the subject area. The description accurately explains the pedagogical approach.	The principle is a pedagogical approach that applies to the subject area. The description partially explains the pedagogical approach (key elements are missing).	The principle is not a pedagogical approach regardless of subject area appropriateness.

Math	Core Pedagogical Principle's Impact on Learning	There is a clear connection between **the listed** pedagogy and the learning that it promotes.	There is a clear connection between **a** pedagogy and the learning that it promotes.	There is no clear connection between the pedagogical approach and learning.
Math	Sample Technology's Connection to Pedagogy	The sample technology clearly connects to the pedagogy through the description.	The sample technology relates to the pedagogy but the connection is not clearly articulated.	The sample technology does not connect to the pedagogical approach.
Social Studies	Core Pedagogical Principle	The principle is a pedagogical approach that applies to the subject area. The description accurately explains the pedagogical approach.	The principle is a pedagogical approach that applies to the subject area. The description partially explains the pedagogical approach (key elements are missing).	The principle is not a pedagogical approach regardless of subject area appropriateness.
Social Studies	Core Pedagogical Principle's Impact on Learning	There is a clear connection between **the listed** pedagogy and the learning that it promotes.	There is a clear connection between **a** pedagogy and the learning that it promotes.	There is no clear connection between the pedagogical approach and learning.
Social Studies	Sample Technology's Connection to Pedagogy	The sample technology clearly connects to the pedagogy through the description.	The sample technology relates to the pedagogy but the connection is not clearly articulated.	The sample technology does not connect to the pedagogical approach.

Science	Core Pedagogical Principle	The principle is a pedagogical approach that applies to the subject area. The description accurately explains the pedagogical approach.	The principle is a pedagogical approach that applies to the subject area. The description partially explains the pedagogical approach (key elements are missing).	The principle is not a pedagogical approach regardless of subject area appropriateness.
Science	Core Pedagogical Principle's Impact on Learning	There is a clear connection between **the listed** pedagogy and the learning that it promotes.	There is a clear connection between **a** pedagogy and the learning that it promotes.	There is no clear connection between the pedagogical approach and learning.
Science	Sample Technology's Connection to Pedagogy	The sample technology clearly connects to the pedagogy through the description.	The sample technology relates to the pedagogy but the connection is not clearly articulated.	The sample technology does not connect to the pedagogical approach.
	Different Technologies	All technologies are different.	Two common technologies.	Two or more common technologies.

Question 3:

	Criteria	2	1	0
TK	Instances	All of the instances clearly reference TK (if 4 or less total). If 5 or more instances, 2 or less don't clearly reference TK.	All but 1 of the instances clearly reference TK (if 4 or less total). If 5 or more instances, 3 don't clearly reference TK.	2 or more instances do not reference TK (if 4 or less total). If five or more, 4 or more don't clearly reference TK.
TK	Description	Of the instances that clearly reference TK, all of the descriptions clearly describe how the observation is an example of TK.	Of the instances that clearly reference TK, all but 1 of the descriptions clearly describe how the observation is an example of TK.	Of the instances that clearly reference TK, 2 or more descriptions do not clearly describe how the instance is an example of TK.
TK	Time Stamp	All of the timestamps are present and correspond to the described instance.	All but 1 of the timestamps are present and correspond to the described instance.	2 or more timestamps are either not present or do not correspond to the described instance.
TK	Quantity	4 or more instances of clearly referenced examples of TK.	3 instances of clearly referenced examples of TK.	2 or 1 instance(s) of clearly referenced examples of TK.
PK	Instances	All of the instances clearly reference PK (if 4 or less total). If 5 or more instances, 2 or less don't clearly reference PK	All but 1 of the instances clearly reference PK (if 4 or less total). If 5 or more instances, 3 don't clearly reference PK.	2 or more instances do not reference PK (if 4 or less total). If five or more, 4 or more don't clearly reference PK.

PK	Description	Of the instances that clearly reference PK, all of the descriptions clearly describe how the observation is an example of PK.	Of the instances that clearly reference PK, all but 1 of the descriptions clearly describe how the observation is an example of PK.	Of the instances that clearly reference PK, 2 or more descriptions do not clearly describe how the instance is an example of PK.
PK	Time Stamp	All of the timestamps are present and correspond to the described instance.	All but 1 of the timestamps are present and correspond to the described instance.	2 or more timestamps are either not present or do not correspond to the described instance.
PK	Quantity	4 or more instances of clearly referenced examples of PK.	3 instances of clearly referenced examples of PK.	2 or 1 instance(s) of clearly referenced examples of PK.
CK	Instances	All of the instances clearly reference CK (if 4 or less total). If 5 or more instances, 2 or less don't clearly reference CK	All but 1 of the instances clearly reference CK (if 4 or less total). If 5 or more instances, 3 don't clearly reference CK.	2 or more instances do not reference CK (if 4 or less total). If five or more, 4 or more don't clearly reference CK.
CK	Description	Of the instances that clearly reference CK, all of the descriptions clearly describe how the observation is an example of CK.	Of the instances that clearly reference CK, all but 1 of the descriptions clearly describe how the observation is an example of CK.	Of the instances that clearly reference CK, 2 or more descriptions do not clearly describe how the instance is an example of CK.

CK	Time Stamp	All of the timestamps are present and correspond to the described instance.	All but 1 of the timestamps are present and correspond to the described instance.	2 or more timestamps are either not present or do not correspond to the described instance.
CK	Quantity	4 or more instances of clearly referenced examples of CK.	3 instances of clearly referenced examples of CK.	2 or 1 instance(s) of clearly referenced examples of CK.

Question 4:

Criteria	2	1	0
Content & Technology: Example Justification	Example clearly justifies rating based on identified curriculum goals.	Example marginally justifies rating based on identified curriculum goals.	No example or example insufficiently justifies rating based on curriculum goals.
Content & Technology: Rating Explanation	Clearly explains why a lower or higher rating is inappropriate by referencing what is known about curriculum goals and technology selection.	Marginally explains why a lower or higher rating is inappropriate by referencing what is known about curriculum goals and technology selection.	No explanation or explanation insufficiently justifies why a lower or higher rating is inappropriate by referencing what is known about curriculum goals and technology selection.
Pedagogy & Technology: Example Justification	Example clearly justifies rating based on an identified pedagogical approach.	Example marginally justifies rating based on an identified pedagogical approach.	No example or example insufficiently justifies rating based on an identified pedagogical approach.

Pedagogy & Technology: Rating Explanation	Clearly explains why a lower or higher rating is inappropriate by referencing what is known about pedagogical approaches to teaching the mathematical content.	Marginally explains why a lower or higher rating is inappropriate by referencing what is known about pedagogical approaches to teaching the mathematical content.	No explanation or explanation insufficiently justifies why a lower or higher rating is inappropriate by referencing what is known about pedagogical approaches to teaching the mathematical content.
Technology Selection: Example Justification	Example clearly justifies rating based on known technologies in the content area.	Example marginally justifies rating based on known technologies in the content area.	No example or example insufficiently justifies rating based on known technologies in the content area.
Technology Selection: Rating Explanation	Clearly explains why a lower or higher rating is inappropriate by referencing what is known about known technologies in the content area.	Marginally explains why a lower or higher rating is inappropriate by referencing what is known about known technologies in the content area.	No explanation or explanation insufficiently justifies why a lower or higher rating is inappropriate by referencing what is known about known technologies in the content area.
TPACK: Example Justification	Example clearly justifies rating based on an understanding of TPACK.	Example marginally justifies rating based on an understanding of TPACK.	No example or example insufficiently justifies rating based on an understanding of TPACK.

TPACK: Rating Explanation	Clearly explains why a lower or higher rating is inappropriate by referencing what is known about TPACK.	Marginally explains why a lower or higher rating is inappropriate by referencing what is known about TPACK.	No explanation or explanation insufficiently justifies why a lower or higher rating is inappropriate by referencing what is known about TPACK.

Supplemental Material C5
Course Evaluation Statements for Both Sections

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1. **S1: Diversity**- The instructor made an effort to address issues of diversity and equity as it related to this class.
    - Strongly Agree (5)
    - Agree (4)
    - Neutral (3)
    - Disagree (2)
    - Strongly Disagree (1)
2. **S2: Time**- The average number of hours per week I spent outside of class preparing for this course was:
    - Less than 1 (hour)
    - 1-3 (hours)
    - 4-6 (hours)
    - 7-9 (hours)
    - 10 or more (hours)
3. **S3: Learning**- I learned a great deal in this course.
    - Strongly Agree (5)
    - Agree (4)
    - Neutral (3)
    - Disagree (2)
    - Strongly Disagree (1)
4. **S4: Worthwhile**- Overall, this was a worthwhile course.
    - Strongly Agree (5)
    - Agree (4)
    - Neutral (3)
    - Disagree (2)
    - Strongly Disagree (1)
5. **S5: Goals**- The course's goals and requirements were defined and adhered to by the instructor.
    - Strongly Agree (5)
    - Agree (4)
    - Neutral (3)
    - Disagree (2)
    - Strongly Disagree (1)
6. **S6: Approachable**- The instructor was approachable and made himself/herself available to students outside the classroom.
    - Strongly Agree (5)
    - Agree (4)
    - Neutral (3)
    - Disagree (2)
    - Strongly Disagree (1)

7. **S7: Teaching**- Overall, the instructor was an effective teacher.
    - Strongly Agree (5)
    - Agree (4)
    - Neutral (3)
    - Disagree (2)
    - Strongly Disagree (1)
8. Please make any overall comments or observations about this course.

Supplemental Material C6
Additional Course Evaluation Questions for the Treatment Section

1. **S1T: Meaningful**- Compared to other courses, this course helped me explore course material in more meaningful ways because of its structure and the technologies used.
   - Strongly Agree (5)
   - Agree (4)
   - Neutral (3)
   - Disagree (2)
   - Strongly Disagree (1)
2. **S2T: Feedback**- Compared to my experience in other courses, in this course I received more frequent feedback from the instructor(s) and peers, and/or had more opportunities to critique my own work.
   - Strongly Agree (5)
   - Agree (4)
   - Neutral (3)
   - Disagree (2)
   - Strongly Disagree (1)
3. **S3T: Interaction**- Compared to other courses, this course used technology to allow more face-to-face interaction with the instructor(s) and other students.
   - Strongly Agree (5)
   - Agree (4)
   - Neutral (3)
   - Disagree (2)
   - Strongly Disagree (1)
4. Comment on how the course structure and activities, including the use of technology, affected your learning.

Supplemental Material C7
Interview Questions for Randomly Selected Participants from the Treatment Section

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Midpoint Interview:

1. In your own words, what does TPACK mean?
    a. What are the three elements?
    b. How do the 3 different elements work together?
2. What does an effective use of technology in a lesson look like?
    a. What is an example?
    b. What is the pedagogical knowledge needed to teach this lesson?
    c. What is the content knowledge needed to teach this lesson?
    d. What is the technological knowledge needed to teach this lesson?
        i. How would you ensure that either you or the students had this technological knowledge?
3. In what ways have you changed, if at all, over the course of the first half of the semester in terms of your capacity to integrate technology?
    a. What aspects of the course do you attribute any changes to? For example, you have had specific readings, you have learned about technology through online modules, you have watched video cases, you might have taught a mini-lesson, you have created lesson plans…
4. How would you change the course so that it better prepared you to integrate technology in the classroom?
    a. What aspects of the course would you keep?
5. The course is based on what is called an Intentional Teaching model. In this model students are given content that they should know, they see exemplars of teachers through case studies and readings, they reflect on what they learn, and they actually do through microteaching and lesson plans.
    a. Think about this model: know, see, do, reflect. Which one of these elements has been most impactful if at all? Why?
    b. Which one of these elements has been lacking if at all? Why?
6. What questions or comments do you have that I have not asked or covered?

Concluding Interview:

1. I am going to read a statement that includes a blank and I want you to fill in the blank with the first thing that comes to mind. “Technology _________ learning.” How would you fill in the blank?
2. What does it mean to “effectively use technology to support teaching or learning?”
3. What are the most important aspects of using technology in an elementary classroom?
4. What process did you go through when developing your lesson plan outlines throughout the semester?
    a. How did you match the content with the pedagogical approaches?
    b. How did you decide on the technologies that you used in your lesson plan outlines throughout the semester?

    c. To what extent did you revise your lesson plan outlines after going through the in-class experiences?
5. To what extent have the readings helped you think about integrating technology if at all? Why?
6. If I asked you to rate what happened in class on a scale from 1 to 5 with 1 being the lowest and 5 being the highest, what rating would you provide? Why?
7. Microteaching
    a. When you were planning for your microteaching, what was of utmost importance?
    b. Why did you decide to use SMART Notebook during your microteaching lesson?
    c. One thing that I noticed during all of the microteaching lessons was almost everyone used the technology in a whole class scenario. Why do you think this was the case?
    d. Imagine yourself being a teacher who has five years of experience in an elementary classroom. How would the "future you" assess your microteaching lesson?
8. Case Studies
    a. To what extent have the case studies helped you think about teaching with technology?
    b. To what extent did the videos in the case studies shed light on teaching with technology?
    c. Were any of the case studies particularly helpful? Unhelpful? Why?
9. In what ways have you changed, if at all, over the course of the semester in terms of your capacity to integrate technology?
    a. What aspects of the course do you attribute any changes to? For example, you have had specific readings, you have learned about technology through in-class sessions, you have created lesson plans…
10. How would you change the course so that it better prepared you to integrate technology in the classroom?
11. What questions or comments do you have that I have not asked or covered?

Supplemental Material C8

Interview Questions for Randomly Selected Participants from the Control Section

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Midpoint Interview:

1. In your own words, what does TPACK mean?
    a. What are the three elements?
    b. How do the 3 different elements work together?
2. What does an effective use of technology in a lesson look like?
    a. What is an example?
    b. What is the pedagogical knowledge needed to teach this lesson?
    c. What is the content knowledge needed to teach this lesson?
    d. What is the technological knowledge needed to teach this lesson?
        i. How would you ensure that either you or the students had this technological knowledge?
3. In what ways have you changed, if at all, over the course of the first half of the semester in terms of your capacity to integrate technology?
    a. What aspects of the course do you attribute any changes to? For example, you have had specific readings, you have learned about technology through online modules, you have watched video cases, you might have taught a mini-lesson, you have created lesson plans…
4. How would you change the course so that it better prepared you to integrate technology in the classroom?
    a. What aspects of the course would you keep?
5. What questions or comments do you have that I have not asked or covered?

Concluding Interview:

1. I am going to read a statement that includes a blank and I want you to fill in the blank with the first thing that comes to mind. "Technology _________ learning." How would you fill in the blank?
2. What does it mean to "effectively use technology to support teaching or learning?"
3. What are the most important aspects of using technology in an elementary classroom?
4. What process did you go through when developing your lesson plan outlines throughout the semester?
    a. How did you match the content with the pedagogical approaches?
    b. How did you decide on the technologies that you used in your lesson plan outlines throughout the semester?
    c. To what extent did you revise your lesson plan outlines after going through the in-class experiences?
5. To what extent have the readings helped you think about integrating technology if at all? Why?
6. If I asked you to rate what happened in class on a scale from 1 to 5 with 1 being the lowest and 5 being the highest, what rating would you provide? Why?

7. To what extent have the projects helped you think about integrating technology if at all? Why?
8. In what ways have you changed, if at all, over the course of the semester in terms of your capacity to integrate technology?
    a. What aspects of the course do you attribute any changes to? For example, you have had specific readings, you have learned about technology through in-class sessions, you have created lesson plans…
9. How would you change the course so that it better prepared you to integrate technology in the classroom?
10. What questions or comments do you have that I have not asked or covered?

Supplemental Material C9

Interview Questions for the Course Instructor

Initial Interview:

1. Please describe your background as a K-12 teacher.
2. What is your general philosophy of education?
3. Please describe your background in terms of helping teachers or adults learn how to effectively integrate technology?
    a. What are some examples in your past when you helped other
4. In your own words, what does TPACK mean?
    a. How do the 3 different elements work together?
5. What does an effective use of technology in a lesson look like?
    a. What is an example from your own classroom?
    b. What is the pedagogical knowledge needed to teach this lesson?
    c. What is the content knowledge needed to teach this lesson?
    d. What is the technological knowledge needed to teach this lesson?
        i. How did you ensure that either you or the students had this technological knowledge?
6. What "entering characteristics" do you think the preservice teachers will have prior to the first week of class in terms of technology integration skills?
7. What aspects of either the treatment or the control section do you believe will contribute to the most growth (integration efficacy) over the course of the semester? Some examples include blended learning, focus on content-area texts, video case studies, lesson plan outlines, feedback….
8. What do you think the primary differences will be between the treatment and control sections:
    a. In terms of integration efficacy…
    b. In terms of understanding of TPACK…
    c. In terms of learning to use online, out-of-class learning modules…
    d. In terms of attitudes towards using technology in an elementary classroom…
9. The treatment section of the course is based on an Intentional Teaching design. An Intentional Teaching design has four key components: know, see, do, and reflect.
    a. How is each one of these components addressed in the course?
    b. How does an Intentional Teaching design affect elementary teachers' capacity to effectively integrate TPACK?
    c. Which one component, if any, is the most important in terms of helping preservice teachers integrate technology? Why?
    d. Which one component, if any, is the least important in terms of helping preservice teachers integrate technology? Why?
10. What do you feel that the preservice teachers need in order to learn how to effectively integrate TPACK in a blended course?
11. What questions or comments do you have that I have not asked or covered?

Midpoint Interview:

1. I have noticed that students in the control classroom rarely take notes on what you are presenting in class. Conversely, a majority of the students in the treatment class take notes on their laptops.
    a. Why do you think there is a difference?
    b. What role might in-class content play in the observed differences?
    c. Have you noticed any other behavioral differences between the two sections?
2. The types of questions that students ask during class seem to be quite different across the two sections.
    a. What are the types of questions that students seem to most often ask during the treatment and control sections?
    b. If there are differences, what do you think is the cause?
3. Almost all of the students in the treatment section have chosen to use an IWB software for their microteaching. Why do you think that this is so?
4. How have you modeled explicit pedagogical approaches associated with the technologies/content in both sections?
5. You have spent a lot of out-of-class-time working with students in both sections. What are the differences between the two sections in terms of the types of assistance that is being requested? Are there differences?
6. Case Studies
    a. What impact, if any, did the language arts case study have on students' understanding about how to effectively integrate technology?
        i. What did they learn?
        ii. How do you know that they learned?
    b. What impact, if any, did the mathematics case study have on students' understanding about how to effectively integrate technology?
        i. What did they learn?
        ii. How do you know that they learned?
7. In your own words, what does TPACK mean?
    a. How do the 3 different elements work together?
8. What does an effective use of technology in a lesson look like?
    a. What is an example from either section of 3450?
9. To what extent do the preservice teachers in the treatment section have an ability to effectively integrate technology at the midpoint of the semester?
    a. What are these preservice teachers lacking?
    b. In your opinion, what facilitated growth in this area?
    c. In your opinion what hindered growth in this area?
10. To what extent do the preservice teachers in the control section have an ability to effectively integrate technology at the midpoint of the semester?
    a. What are these preservice teachers lacking?
    b. In your opinion, what facilitated growth in this area?
    c. In your opinion what hindered growth in this area?
11. In your opinion, what are the primary differences between the treatment and control sections:
    a. In terms of integration efficacy…

   b. In terms of understanding of TPACK…
   c. In terms of learning to use online, out-of-class learning modules…
   d. In terms of attitudes towards using technology in an elementary classroom…
12. The treatment section of the course is based on an Intentional Teaching design. An Intentional Teaching design has four key components: know, see, do, and reflect.
    a. At the midpoint in the semester, which one component, if any, is the most important in terms of helping preservice teachers integrate technology? Why?
    b. At the midpoint in the semester, which one component, if any, is the least important in terms of helping preservice teachers integrate technology? Why?

Concluding Interview:

1. In your own words, what does TPACK mean?
   a. How do the 3 different elements work together?
2. What does an effective use of technology in a lesson look like?
3. To what extent do the preservice teachers in the treatment section have an ability to effectively integrate technology at the end of the semester? Why?
4. To what extent do the preservice teachers in the control section have an ability to effectively integrate technology at the end of the semester?
5. Regardless of the section, some of the students have told me that they are more open to the use of technology to support teaching and learning in an elementary classroom than when they started the course. Why do you think that this is so?
6. Regardless of the section, some of the students have used technologies mentioned in class in other assignments for other classes. Why do you think that this is so?
7. How would you like students to view you as an instructor?
8. You often mentioned students' grades during the in-class meetings. Why?
9. In your opinion, to what extent did I play a part in the design of the two sections?
10. To what extent did I play a part in your decision-making throughout the semester in terms of what I observed?
11. (Know) To what extent did you rely on students' capacity to engage in self-directed learning about…
    a. Content knowledge.
    b. Pedagogical knowledge.
    c. Technological knowledge.
12. (Know) Describe how you helped students in the control group learn about the technological knowledge needed to make a (1) blog or a (2) screencast?
13. (Know) Describe the resources page and what was provided on it.
    a. To what extent did you add information to this page over the course of the semester?
14. (Know) Readings
    a. How were you able to assess what students understood from the readings?
       i. Did you grade the quizzes for the readings?

ii. To what extent did the students' grades on the readings inform your instruction?

b. In the control section, how did you connect the readings that students did outside of class with what they were learning at a particular point in the semester?
c. In the treatment section, how did you connect the readings that students did outside of class with what they were learning at a particular point in the semester?
d. Based on my interviews, some of the students felt like the readings were neither applicable to what they were learning in class nor helpful for their immediate assignments. Why do you think that this was the case?
    iii. How would you respond if I said that the students were from the control section?
    iv. How would you respond if I said that the students were from the treatment section?
    v. What changes would you make to the either the readings to address this?
    vi. What changes would you make to what is "done" with the readings to address this finding?

15. (See) To what extent did the case studies help students "see" how TPACK works in an actual class? Why?
    a. How do you know this?
    b. Were any of the case studies particularly helpful or unhelpful? Why?
    c. What role did students' answers to questions embedded in the case study play in your assessment of what they learned from the case study? Why?
    d. How did you connect what students learned in the case study to the larger course? Why?
16. (See) When you were introducing a new technology like blogs or Interactive Whiteboard Software, I noticed that you provided a lot of examples of how other teachers have used these technologies. Why?
    e. In some cases (like the blogs), the examples were the only form of instruction about the technology. Why?
17. (See) How might you introduce greater student learning through the "seeing" of other students' microteaching lessons?
18. (Do) There were two main forms of "doing" in the treatment section: microteaching and lesson plan outlines. Was one of those more important in your own mind in terms of TPACK development? Why?
19. (Do) Microteaching:
    a. What type of feedback did you give to students on their microteaching? Please describe what you said.
    b. To what extent did you connect your feedback with TPACK?
    c. If you were going to have the students participate in microteaching in future semesters, what would you change (if anything)?
20. (Do) What was your rationale for just providing numeric feedback on students' lesson plan outlines?

   a. In your opinion, how would you rate the quality of the revisions when you switched from detailed written feedback to just using numbers?
   b. If someone received a 3 on a particular dimension in the rubric, how did that person know what to change to make it better when you did not provide written feedback?
   c. To what extent did students speak to you about revisions to their lesson plans?

21. (Reflect) A nearly universal statement in all of the interviews was that students did not choose to revise their lesson plans based on what they learned during the three-week module. Why do you think this was the case?
22. (Reflect) To what extent did students' reflections on the microteaching reveal an understanding of TPACK?
   a. How did you assess students' reflections?
   b. How would you incorporate more reflection into the course?

Supplemental Material C10

Descriptors and Fields for Categorizing Data Sources for the Qualitative Analysis

Descriptor 1: Participants

- Section
  - Treatment
  - Control
- Participant Name
  - *All of the participants from both sections were included in this field.*
- Artifact
  - Interview (Pre)
  - Interview (Mid)
  - Interview (Post)
  - Course Evaluation
  - Microteaching
  - Microteaching Reflection
  - Case Study (Math)

Descriptor 2: Field Notes

5. Meeting (Week)
   a. Week 1
   b. Week 2
   c. Week 3
   d. Week 4
   e. Week 5
   f. Week 6
   g. Week 7
   h. Week 8
   i. Week 10
   j. Week 11
   k. Week 13
   l. Week 14
6. Section
   a. Treatment
   b. Control
7. Topic
   a. Math
   b. Digital Images
   c. Digital Video
   d. Google
   e. Interactive Whiteboards
   f. Introduction & TPACK
   g. Language Arts
   h. Digital Audio
   i. Math tools
   j. Mobile Devices
   k. Presentations
   l. Science
   m. Social Studies
   n. Wikis and Blogs

Supplemental Material C11
Preliminary Code List for Qualitative Analysis

All of the participant names are pseudonyms.

Course & General:
- Treatment
- Control

Intentional Teaching:
- Know
- See
- Do
- Reflect

Participants:
- Treatment Student
- Control Student
- Brad Jenks
- Ansley (T)
- Bianca (T)
- Jane (T)
- Melissa (T)
- Liza (T)
- Katie (T)
- Samantha (T)
- Eleanor (C)
- Sophie (C)
- Gabbie (C)
- Kinsley (C)
- Stella (C)
- Aubree (C)
- Irene (C)

TPACK:
- Pedagogy (PK)
- Content (CK)
- Technology (TK)
- TPACK

Activity:
- Lecture
- Class Activity
- Discussion
- Case Study
- Quiz
- Microteaching
- Project
- Lesson Plan Outline
- Flipped Classroom
- Final Exam

Subject Area:
- Language Arts
- Math
- Social Studies
- Science

Course Evaluation:
- S1: Diversity
- S2: Time
- S3: Learning
- S4: Worthwhile
- S5: Goals
- S6: Approachable
- S7: Teaching

Emerging:
- Sarcasm
- Grades
- Personal Stories
- Teaching Stories

Supplemental Material C12
Sample Analytic Memos

This is a partial list of analytic memos created during the qualitative analysis. It is included as a reference for understanding how memos were used in the study.

- Motivation and the desire to learn is one of Brad's philosophies. Does this relate to his repeated discussion about the importance of student engagement?
- I think that Brad wants preservice teachers to be motivated by knowledge to become better teachers. It will become apparent that grades are a driving motivator for these college students.
- Examine the difference between this phrase- it is really important to "do"- with what actually happened in class. Both did a lot of doing in terms of assignments but was it the right kind of doing?
- Brad is not very confident in teaching science and social studies. Will this be reflected in what he does in class?
- An emerging theme for Brad and his instructional practice is that content is this thing, like facts, that exist. He does not articulate an understanding that there are certain ways of knowing and teaching content knowledge. This is something that I saw in his explanations of content during class. He would often not explain content- not even give direction. See the IATH portion of my lit review.
- I need to go back and re-code Brad's interviews. I should have realized this: If you have TPACK, then you can integrate technology effectively so that it enhances student learning.
- Decision-making needs to be a theme that I add as an emerging code. Research content- find an activity- incorporate technology.
- An emerging theme is that none of the students consider revising the lesson plan outlines as a form of reflection. Does this mean that it is more of a mechanical process of integrating the instructor's feedback?
- Liza does not have a good handle of TPACK at the midpoint. Check to see her definition in the final interview.

Supplemental Material C13
Revised Code List for Qualitative Analysis

Curricular Structure:
- Broad Survey
- Deep Dive
- Guided Hand-Holding
- Technology-Pedagogy Connection

Curriculum:
- ITCP Beliefs
- Methods Class Beliefs
- Control Approach Brad
- Treatment Approach Brad
- Subject Area Confidence
- TPACK: CK as Easy or Starting Point
- TPACK: PK as Most Important
- TPACK: TK as How to Use Tech

Student Rx Do:
- Do Positive
- Do Negative
- Do Lesson Plans
- Do Class Activities
- Do Projects
- Do Teaching

Beliefs:
- Beliefs: Preservice Teachers
- Beliefs: Relevant Topics or Examples
- Self-Directed Learning

Grades:
- Beliefs: Grades
- Feedback Practices
- Feedback Rx from Students
- Grade Rx from Students

Frequency:
- Frequency Student Presentation
- Feedback Instance
- Assignment Expectations
- Grade Instance
- Story Instance
- Frequency Tech Show
- Frequency Discussion Small Group
- Frequency Discussion Whole Class
- Frequency Tech In-Depth

Case Study:
- Case Study Negative
- Case Study Positive

Reading:
- Rdg Negative
- Rdg Positive

Sarcasm:
- Incompetence Sarcasm
- Behavior Sarcasm
- Grade Sarcasm
- Assignment Sarcasm
- Other People Sarcasm
- Self-Sarcasm