An Evolution of Research on Online Teaching and Learning: Preparing Preservice Teachers for the New Digital Classroom

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Abstract

Technology has changed the K-12 classroom over the last 20 years, and as a result, educator preparation programs have had to increase their teaching of the use of technology in the classroom. This article reviews relevant literature and follows the journey of a group of researchers from 2016 to 2024 in the creation and implementation of the Technology Integration Project, which instructs preservice teachers to create an online course and teach in an online setting. This article includes changes made to the Technology Integration Project because of student data. It also includes future directions for technology instruction in schools of education.

Keywords: online teaching, online learning, digital classroom, preservice teachers

Introduction

Teaching in the K-12 classroom has changed over the past 20 years. The use of technology in classrooms has matured from playing computer games as a reward for good behavior to becoming a major part of the learning environment. Now more than ever, preservice teachers must be able to create online lessons with rich, robust, and engaging activities. During the 2020 pandemic, schools went online, and the world had to respond.

As a result of the changes in the K-12 learning environment, educator preparation programs had to react to ensure preservice teachers were able to meet the needs of the students they were preparing to teach. The addition of technology education is imperative as preservice teachers must leave their undergraduate education programs with the capability of using technology tools in their instruction since teachers are now being required to design interactive, online lessons and collect student data in both synchronous and asynchronous settings. The purpose of this article is to provide a summary of the research conducted by professors at one educator preparation program in Georgia, USA, identify key takeaways from that research, and offer ideas for future research in preparing preservice teachers to teach online.

Literature Review

Technology currently plays a vital role in the education process for students and their educators. The ability to navigate the constantly evolving landscape of information technology is essential for all teachers regardless of where they stand on the professional spectrum (Truesdell & Birch, 2013). As online learning becomes more prevalent in the future of education, having a technological skillset that can adapt is critical (Gilles & Britton, 2020). Having a strong foundation in technology will provide the tools necessary for a more robust scholastic experience. A more effective learning environment can be achieved by supplementing the materials being taught with additional digital and media resources (Judge & O'Bannon, 2008; Krumsvik, 2008; Voithofer et al., 2019).

Advancements in technology in our educational school systems have made it necessary for teachers to be prepared with the ability to adapt and change how they approach teaching and learning (Starkey, 2020). Upon graduation, preservice teachers must have confidence in their use of technology in teaching and learning and stay current with their skillsets in the ever-changing digital landscape (Kaufman, 2015). "Professional digital competence" (Starkey, 2020, p. 49) is the ability of the teacher to work in the context of a technology-driven school and education system. Excelling in technical teacher competencies is key to being able to "teach in a digitally infused context, manage digital learning environments, and carry out the broader professional work of being a teacher" (Starkey, 2020, p. 49).

COVID-19 Revealed Critical Skillset Needed for Teachers

With the onset of the COVID-19 pandemic, schools in the United States and around the world had to quickly move into alternative education strategies, shifting from face-to-face instruction to online digital remote delivery. Even with advances in educational technology over the past several decades, educators, students, and parents were thrust into a new learning environment that posed many challenges (Dhawan, 2020). When K-12 schools across the United States closed unexpectedly, many teachers found themselves scrambling to effectively convert lessons to an online format and develop strategies for quality distance education (Francom et al., 2021).

The emergency learning transition forced teachers with little or no online instruction experience to turn their lessons into digital formats within a few days or weeks (Thomas & Kolb, 2020). This was the first experience many teachers had with teaching online. This unprecedented event has caused many administrators to re-evaluate professional development/continuing education offerings, placing more emphasis on digital instruction (Francom et al., 2021).

In unplanned, emergency situations, the opportunity for students to continue with their education online provides more than just academic progress (INEE, 2004). The continuity, stability, and connectivity of the experience gives students hope and optimism (Francom et al., 2021). While many businesses shut their doors and only limited essential activities were allowed, schools did not have such luxury. Schools had to be able to continue offering education to their student bodies. This created apprehension among teachers due to unfamiliarity with remote learning and the technological challenges it presents (Leech et al., 2020). Teachers had varying levels of comfort with the utilization of technology outside the classroom, making it imperative that their school system administrators offer future professional development. Such technology courses offer confidence in remote instruction, higher quality education, and increased learning outcomes (Leech et al., 2020).

While teachers were learning about online instructional platforms, they were also tasked with assisting students with the adjustment to a new instructional delivery method (Cardullo et al. 2021). This experience has shown administrators how important it is to have quality technical support, professional development offerings with an emphasis on digital instruction, and ample opportunities for teachers to practice and gain confidence using online learning management systems (Cardullo et al., 2021). The skills and competencies needed to be successful in this new approach to education had not been fully developed nor available to teachers during their preservice training (Pulham & Graham, 2018). Educators had to handle the stresses and anxieties of these unknowns on top of being able to engage students and teach the course material as tasked. They had to become instructional designers in this new setting, creating new tools while learning new skillsets to tackle these obstacles. Teachers became students themselves, having to research and master video conferencing and complex digital learning platforms for this new classroom framework. Once proficient, teachers then had to instruct students on how to access the new classroom environment. This has added to the workload of the already challenging education profession (Huck & Zhang, 2021).

There were some common challenges teachers experienced during this shift to online learning, such as difficulties with technology, communication, and assessment (Kraft et al., 2020; Trust & Whalen, 2020). Teachers also reported difficulty finding/utilizing digital tools, communicating/engaging with their students, and adjusting course materials to the new remote experience (Jalongo, 2021). To minimize these challenges and to help teachers feel confident and prepared, they must feel their instructional technology needs are met, have adequate training in technology delivery, and receive support from their administrators (Kaden, 2020). Those who were most confident in their remote teaching skills reported work environments with supportive school leadership, collaboration with colleagues, and professional development instruction (Kaden, 2020).

Because recent circumstances required the urgent need to move to online education, school leaders and their teachers

had to be able to shift and act quickly. As a result, many schools are now offering a more fluid learning experience via both in-person and eLearning. When it comes to their education, students have more choices and independence than they have had in the past. This new way of teaching and learning will require ongoing investments in technology infrastructure with constantly adjusted curriculum/protocols to produce creative and more effective methods for educating our students (Kaden, 2020).

Although advances in technology over the past few decades laid a foundation for this period of transition to remote learning, much had to be created, developed, and implemented to make this type of educational delivery successful. Therefore, it is essential that teacher professional development and preservice teacher education preparation keep up with ever-changing technological advancements in teaching and learning. Both teachers and students alike are now more than ever dependent on technology for successful education experiences in today's world (Bergeson & Beschorner, 2021).

COVID-19 Forced Educator Preparation Programs to Reimagine Teacher Preparation

During the COVID-19 pandemic, teacher preparation programs faced many hurdles. Field or practicum experiences required for institutional accreditation generally involve a host school and host classroom teacher (Holt, 2021). Opportunities for observation and even teaching experiences give preservice teachers hands-on practice for their future positions in the teaching profession. Few schools remained open for in-person instruction during this time, and even those that did would not allow outside visitors. To gain this important practical experience, it was necessary to shift these field experiences to a virtual/online setting. Preservice teachers who had technology instruction were better equipped. The challenges caused by the pandemic emphasized the importance of preparing all preservice teachers to teach virtually (Holt, 2021).

The pandemic of 2020 not only impacted how students in our K-12 schools were being taught but also how professors in higher education institutions were able to prepare future educators for success. For example, the education faculty at Virginia Tech made it a priority to ensure preservice teachers continued to experience a sense of community during the synchronous meetings and asynchronous assignments. They did this by adapting assignments, so students worked together as a team, ensuring communication lines were established, and encouraging the building of positive relationships (Bradley & Fogelsong, 2021). Likewise, professional development for teachers needed to change to an online format as well (Scott & Huffling, 2022).

Creating a plan that would allow preservice teachers to complete field/practice teaching experiences during this time was a priority for the University of Nevada. Virtual environments were created to give preservice teachers experience and opportunities to demonstrate competency as teachers. To do this, teacher education faculty established a process they called CASE-consistency, access, supervision, and evaluation. A variety of possible teaching and learning scenarios were introduced through CASE, giving preservice teachers insight and preparation for online learning (Quinn & Paretti, 2021).

Teacher educators at the University of West Georgia adjusted field experiences to include assignments focusing on digital instruction. Preservice teachers created an online science learning activity that could be done remotely and interviewed cooperating classroom teachers to get a better

understanding of the challenges faced during the sudden shift to remote learning (Gilles & Britton, 2020). They created videos to share with classmates of reflections/lessons learned from their cooperating teachers/online teaching experiences and explained how they approached the online science learning activity, what went well, and what they would do differently. By redesigning the remaining assignments, teacher educators provided preservice teachers valuable insight into how the pandemic was affecting educators and the necessity to adapt quickly (Gilles & Britton, 2020).

Why is Technology Education so Important in Teacher Preparation Programs?

Technological Pedagogical Content Knowledge (TPACK) is a term that describes the integration of Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK) that was coined by Mishra and Koehler (2006); it requires the integration of Pedagogical Knowledge (PK), Technological Knowledge (TK), and Content Knowledge (CK) to effectively integrate technology into teaching and learning. Teachers must be experts in content knowledge, pedagogy, and teaching with technology. The demand for technology in education continues to increase as communication technology and technology-integrated learning has evolved. To assist teachers and preservice teachers in developing confidence and competence in using new digital media/tools, technical preparation should be included in professional development and preservice teacher preparation programs (Joo et al., 2018). Manokore & Kuntz (2022) found educators who had a higher level of TPACK were able to transition to the digital classroom with fewer complications than many of their peers when schools were forced to close because of COVID-19.

As digital access continues to increase throughout society, preparing preservice teachers to teach effectively with digital technologies and media should be central to initial teacher preparation (Mourlam et al., 2021). Preservice teachers should be well-versed in digital technologies and media. They should be able to integrate these resources into their curriculum upon entering the profession (Mourlam et al., 2021). Preservice teachers' attitudes and competence in using educational technology are greatly influenced by the teacher education program's approach and design of technology integration preparation (Kaufman, 2015; Koch et al., 2012; Nelson et al., 2019).

The number of students participating in online education options in K-12 school systems continues to rise, and preservice teacher education programs must prepare future educators to teach in virtual environments. Online teaching skills are not only necessary for teachers who teach fully online but also for in-person teachers in traditional schools to be prepared to infuse online offerings into their curriculum (Davis & Roblyer, 2005; DeNisco, 2013). Blended learning environments that utilize both in-person teaching practices and online learning tools are a natural result of constant technological advancement. The practice of integrating both approaches is likely to only increase and become an even more necessary skill set for educators as technology advances (Luo et al, 2017). Teachers who have technology skills are discovering that there are benefits and pedagogical potential for student learning by integrating technology into subject content (Judge & O'Bannon, 2008; Krumsvik, 2008).

Before the pandemic, many online college courses were based on text material

without much interaction/engagement between teachers and students. This type of online course made it difficult to build a sense of community that encourages involvement and participation (Bradley & Fogelsong, 2021). If professors and students connect with one another in various ways, socially, cognitively, and through the instructional learning environment, there is a much stronger likelihood that the students will feel engaged and connected, which can lead to more favorable performance outcomes (Ornelles et al., 2019).

Preservice teachers must have an awareness of possible technological limitations that may come into play as part of their course delivery and design. Having firsthand knowledge of the potential technological obstacles in the actual school districts where they will work, will give preservice teachers the confidence they need to be successful (Tondeur et al., 2016; Voithofer & Nelson, 2021).

Need For Integration of Technology into Educator Preparation Program (EPP) Courses

Traditional EPP instruction in technology has been provided through stand-alone courses and workshops (Mishra & Kohler, 2006; Shofner, 2009), resulting in isolated knowledge of technology tools rather than an in-depth understanding of best practices for technology integration. The constant changes in technology, coupled with an emphasis placed on what technology resources are available rather than how various forms of technology can be integrated into content instruction often results in preservice teachers' inclusion of technology into teaching as a means of meeting a lesson component requirement rather than true integration (Mishra & Kohler, 2006).

In the past, on rare occasions, schools were forced into eLearning to fill gaps in educational instruction. This eLearning may have come about due to events like prolonged inclement weather or outbreaks of illness. With this practice, some students have shown confidence with Learning Management Systems (LMS), thus making the transition to remote instruction easier to tackle (Lieberman, 2020). Also, many schools in the United States had protocols in place to offer eLearning avenues intermixed with normal in-person schedules.

Even such limited exposure to remote instruction proved helpful as online learning was thrust upon K-12 teachers with little time to adjust. Being able to switch between in-person and online learning effortlessly as circumstances arise is crucial. Whether the instruction is remote or in person, teachers remain at the center of the educational process, and they “contribute with their professional, moral, and pedagogical-psychological qualities to the outcome of this process” (Velichová et al., 2020, p. 1639).

Although today's EPP students may be made up of more digital natives than previous generations, they frequently experienced traditional models of instruction in their own learning experiences, and thus, they possess a traditional view of instruction (Cheon et al., 2012). "The use of technologies still seems to remain bound to a set of basic teaching and learning activities, whereas the more advanced and complex pedagogical activities are significantly less frequent" (Brun & Hinostroze, 2014, p. 235). A study by Instefjord and Munthe (2017) measured the digital competency of preservice teachers and addressed challenges teacher educators face in preparing them for a digital future. The teacher educator’s ability to instruct students on how to use digital tools while explaining the ethical responsibilities involved with social media, to promote learning with digital technology, to use

interactive whiteboards and other digital media, and to act as a role model to encourage technology in the classroom increases digital competency in preservice teachers (Starkey, 2020). More than 650 preservice teachers in Norway responded to survey questions relating to their perceptions of digital emphasis in their teacher education programs and rated questions on a six-point scale ranging from (1) strongly disagree to (6) strongly agree. A mean score between one and 2.9 was considered low, a mean score between three and 4.9 was considered average, and a mean score over 4.9 was considered high (Instefjord & Munthe, 2017). Of the nine questions on the survey, three were low-scoring, and six were in the average range. There were no questions on the survey in which preservice teachers answered in the high range. The findings of the study reinforce that it is vital for teachers to develop the ability to integrate digital/technological resources into their practice to create a successful learning experience. This lack of personal experience in technology-rich classrooms results in a greater need for EPPs to model and scaffold the technology integration that they wish to see their graduates employ in their own classrooms.

After the move to online learning, public K-12 teachers in Minnesota were sent surveys to give the administration a better understanding of the level of preparation teachers felt they had before the rapid shift to online teaching. Of teachers who responded, 78% indicated that they had no experience with distance learning prior to COVID-19. When asked if their preservice teacher education programs offered preparation for online teaching, 78% responded that they had no preparation for online teaching. For teachers to be effective in distance learning, preservice teacher preparation programs must provide instruction in online technology and pedagogy skills and create opportunities for distance learning clinical experiences (Champa et al., 2020). "With the increasing demands for online teachers and the reality of the possible necessity given the most recent pandemic experience, preservice teacher programs have a responsibility to provide teacher candidates with 21st century experiences in both brick and mortar and online environments" (Champa et al., 2020, p. 61).

The COVID-19 pandemic was very disruptive to educators and their students. Even so, it did show that our educational leadership was able to be creative and adapt to this new landscape of remote learning quickly. It will be of utmost importance to continue to incorporate this method of education in the teaching profession moving forward (Eady et al., 2021). Preservice teacher training programs have had to develop strategies to train new educators in remote learning instruction. "New teachers must be prepared in their teacher education programs to serve the rapidly growing number of online students and have the pedagogy skills for the blended learning models of the future" (Kaden, 2020, p. 11).

Solutions: One College's Answer to the Need for Technology Integration in Teacher Education

Due to the increasing popularity of online courses and programs, a researcher at a small university in Georgia, USA began to research the preference of in-service teachers for online versus face-to-face classes. Cooper et al. (2014) polled in-service teachers in online classes and found that although end of course grades revealed that face-to-face students had much higher grades than online students ($p = .005$), the online students rated their course much higher than did face-to-face students ($p = .013$). The results of this study yielded information regarding specific variables

students rated higher for their online classes than their face-to-face classes and visa-versa. Variables such as intellectually challenging and stimulating, thinking critically about the subject, connecting what they learned to other experiences, and learning to use multiple resources to enhance learning were among the ones cited by students as better in the online class. For the face-to-face class, students more highly rated the instructor's preparedness for class, ability to explain concepts well, timely feedback, and enthusiasm. These results prompted more research into online teaching and learning.

Cooper et al. (2017) explored the use and modeling of various technology tools for teaching with their undergraduate preservice teachers to prepare these candidates to teach in the 21st century. The exploration included 14 technology tools that were integrated into various methods courses at the undergraduate level with preservice teachers. Several of the teacher candidates discussed how they were able to utilize the tools modeled for them in their own field placements. One tool, Padlet, was cited by many students as a particularly useful tool in their own teaching practice. Students also found VideoScribe, Kahoot, and Quizlet to be beneficial in their teaching practice (Cooper et al., 2017).

Additionally, Cooper et al. (2017) presented the theoretical framework that is the basis for the researchers' continued work. This TPACK framework continued to ground the work in subsequent studies presented here. Through the use and modeling of the 14 tools that the study explored; the researchers aimed to develop preservice teachers' Technological Pedagogical Knowledge (TPK). The results of this study indicated that preservice teachers "increased their technological pedagogical knowledge (TPK) as they learned to use a variety of technology tools (see Table 1; Note: Technology tools have been updated since the first publications.) for K-12 teaching and learning" (Cooper et al., 2017, p. 55).

Table 1

Summary of Technology Tools

Technology Tool	Technology Tool Description	Use of Technology Tool in Courses
ClassHook	ClassHook is a website that allows teachers to type in a concept that he/she wants to teach or choose a subject area to search for video clips to use in instruction. The videos are tagged by topic, subject, and grade level.	ClassHook was used in a jigsaw activity. A group of preservice teachers investigated ClassHook and how it could be used with a variety of subjects and grade levels and then shared their ideas with the rest of the class.

Technology Tool	Technology Tool Description	Use of Technology Tool in Courses
Easel.ly	Easel.ly is an infographic generator. It has several preloaded infographics to choose from or you can create your own.	Easel.ly was used by students to create infographics for various ages and stages of child development. Each group of teacher candidates was given a different age range, and they created an infographic of the stages of cognitive, physical, and emotional development that occurs for their groups' age range.
Edpuzzle	Edpuzzle can be used to create interactive videos. Audio and questions can be added to either a video from a variety of sources such as YouTube, or you can upload your own video. Students are not able to continue with the video until they have responded to the embedded questions.	Edpuzzle was used to introduce differentiation. Questions were added at various points in the video to allow for class discussion.
FlipQuiz	FlipQuiz is a way for teachers to create fun and engaging review games for their students by creating their own game boards.	Flipquiz was used in a jigsaw activity. A group of preservice teachers investigated Flipquiz and how it could be used with a variety of subjects and grade levels and then shared their ideas with the rest of the class.
Emaze	Emaze is an online presentation tool.	Emaze was used for groups of teacher candidates to create presentations on the history of special education.
Kahoot	Kahoot is an assessment tool in which students respond to polls or quizzes in a competitive fashion. Students gain points by how fast they choose the correct answer to a question. Students play the game using a technological device.	Kahoot was used as a formative assessment for several topics in the course: educational theorists, classroom management, cultural diversity, etc. Teacher candidates also created their own Kahoot to use with students in their field lessons.
Funbrain	Funbrain is an online site that allows teachers to search for games, videos, and books by grade level.	Funbrain was used in a jigsaw activity. Preservice teachers investigated how it could be used with subjects and grade levels and then shared their ideas with the rest of the class.

Technology Tool	Technology Tool Description	Use of Technology Tool in Courses
iRubric	iRubric is a website where teachers can search, create, and share rubrics	iRubric was used in a jigsaw activity. A group of preservice teachers investigated iRubric and how it could be used with a variety of subjects and grade levels and then shared their ideas with the rest of the class.
Padlet	Padlet is a way to add online sticky notes to an electronic bulletin board. It can be used by an individual or collaboratively as a class.	Padlet was used to ask teacher candidates to respond to the prompt: What do you think of when you hear the words Flipped Classroom? Padlet was also used to gather and organize collections of children's literature by genre and potential teaching use. Individual teacher candidates developed personal Padlets of fifty pieces of children's literature.
Moovly	Moovly can be used to create animated videos. Teachers can choose from prepopulated ideas, upload photos of their own, and also add audio files.	Moovly was used to create an animated video to introduce preservice teachers to Zoom, an online conferencing tool.
Nearpod	Nearpod creates a way for teachers to engage students in their presentations. Teachers can add different types of files, websites, photos, videos, and various types of questions. Students do not need an email account to attend the presentation.	Nearpod was used to present information on Google tools and Chrome extensions and how they can be used in the classroom. Pre-service teachers answered questions periodically throughout the presentation.
QR Code Generator	QR Code Generator is an online website that creates a QR code for any web address, document, video, etc.	A QR Code Generator was used for teacher candidates to create QR codes for a variety of resources related to each of the following exceptionalities: Intellectual Disabilities, Learning Disabilities, Attention Deficit Hyperactivity Disorder, Emotional Behavioral Disorder, Autism, Speech and Language Impairments, Hearing Impairments, Visual Impairments, and Physical Disabilities.

Technology Tool	Technology Tool Description	Use of Technology Tool in Courses
Pear Deck	Pear Deck allows students to join an online interactive presentation. Teachers can embed various types of questions, videos, and text within the presentation, and students can join in through their Gmail accounts.	Pear Deck was used to present information on data analysis tools. The students answered questions related to how they can use Excel as a data analysis tool.
Plicker	Plickers allows teachers to create formative assessments and collect student data without the use of expensive clickers. The teacher simply prints Plicker cards that students use to answer questions and then scans the cards with an app to quickly see how many of the students chose the correct answer.	Plickers was used to have teacher candidates answer questions related to videos they watched. Teacher candidates were also shown explicitly how to set up Plickers for potential use in their own field placements.
Quizlet	Quizlet can be used to create online flashcards. The information on the cards can be read to students, and they can play several games to interact with and learn the content.	Quizlet was used as a way for teacher candidates to collaborate with the use of technology tools. Each group of teacher candidates was given a list of technology tools that can be used to investigate differentiation. They had to add their technology tools and explain how each could be used for differentiation to a flashcard in Quizlet. All teacher candidates could access the flashcards and therefore had access to all the technology tools and uses without having to create all the flashcards themselves. This activity was like an online jigsaw strategy.
Remind	Remind is an online messaging tool. Teachers can ask his or her students to join a class and send text announcements, voice messages, pictures, and documents to students. Students can also have individual conversations with teachers and peers.	Remind was used to "remind" preservice teachers of upcoming assignments, what they needed for class, and any schedule changes. Preservice teachers were able to ask questions and get a quick response from his or her teachers.

Technology Tool	Technology Tool Description	Use of Technology Tool in Courses
ThingLink	ThingLink can be used to create interactive pictures. Students can pin pictures, text, videos, and websites to a picture to create a repository of information.	Thinglink was used for groups of teacher candidates to create interactive pictures for each of the following exceptionalities: Intellectual Disabilities, Learning Disabilities, Attention Deficit Hyperactivity Disorder, Emotional Behavioral Disorder, Autism, Speech and Language Impairments, Hearing Impairments, Visual Impairments, and Physical Disabilities. Each group provided information on the definition of the exceptionality, how it is diagnosed, its characteristics, a video, and an additional piece of information of their choice.
Formative	Formative can be used to create an online chat room. Students can share ideas and answer questions. Reponses can be seen in real time.	Formative was used to allow teacher candidates to respond to the question: What are some characteristics of students who are gifted and talented?
weetDeck	TweetDeck makes it possible to customize your viewing space with the Twitter content you want to see using columns. These columns can change as little or as often as you want and are the core of getting TweetDeck to work for you.	TweetDeck was used to help teacher candidates organize the information gleaned on Twitter into meaningful units to follow streams in a more organized manner. Teacher candidates were required to build columns to follow the course hashtag, two hashtags related to children's literature, and a minimum of two regularly scheduled Twitter chats in which they participated.
Storyjumper	Storyjumper is an online tool that allows students to write their own stories. Students can use a variety of props as well as upload their own pictures.	Storyjumper was used as a presentation tool. Preservice teachers wrote a story to explain the following exceptionalities: Intellectual and Learning Disabilities, Attention Deficit Hyperactivity Disorder, Emotional Behavioral Disorder, Autism, Speech/Language Impairments, Hearing and Visual Impairments, and Physical Disabilities.

Technology Tool	Technology Tool Description	Use of Technology Tool in Courses
VideoScribe	VideoScribe can be used to create animated videos. Users can add text and audio files.	Videoscribe was used by an instructor to create a video presentation of an interview with an elementary and a middle school gifted teacher.
Web Whiteboard	Web Whiteboard is an online interactive whiteboard. Teachers can invite students to join, share a link, and save what they create.	Web Whiteboard was used in a jigsaw activity. A group of preservice teachers investigated Web Whiteboard and how it could be used with a variety of subjects and grade levels and then shared their ideas with the rest of the class.

The Technology Integration Project

Cooper et al. (2019) built upon the 2017 study with another study that had the aim of determining if preservice teachers' TPACK was developed through participation in and completion of an online project. This project, *The Technology Integration Project,* instructed the preservice teachers to create an online module using a Learning Management System with the following components:

- Design instruction specific to a content area and related to a specific grade level.
- Include at least three technology tools to teach the content; one must be a video of the preservice teacher teaching content.
- Relate the technology tools to the 2016 International Society for Technology in Education (ISTE) standards for students and the 2016 Technology Integration Matrix Table of Student Descriptors.
- Develop and build at least one quiz, one assignment with a rubric, and one discussion board.

As an additional piece of the project, "the preservice teachers were also required to facilitate the online module they created to two peers and be a student in two peers' online modules and reflect on the pros and cons of teaching and being a student in an online class" (Cooper et al., 2019, p. 55). Qualitative data collected in the form of class discussions and written feedback from students led the researchers to conclude that the preservice teachers in the study "not only built technological pedagogical knowledge (TPK) by learning how to use appropriate technology tools for different types of instruction but also developed TPACK" (Cooper et al., 2017, p. 55) because they were required to use their technical pedagogical knowledge (TKP) with their content knowledge (CK) to facilitate an online lesson to their peers. Based on the data, the online project was considered successful in developing preservice teachers' knowledge and skills on how to select and use appropriate technology tools for their content, grade level, and teaching approaches.

In addition to these first three studies, Cooper et al. (2020) examined preservice teachers' technology integration self-efficacy (TISE) before and after the completion of the *Technology Integration Project*. In this study, the researchers, with permission from its authors, Horvitz et al. (2015), used a modified version of the *Examining Faculty Attitudes Toward Online Teaching* survey and administered it to

preservice teachers in one undergraduate institution's elementary, special, and secondary education programs both before and after completing the *Technology Integration Project*. The results of this study indicated that the *Technology Integration Project* served to strengthen preservice teachers' TISE as most preservice teachers who took the pre-survey responded more positively to the post-survey. Among the areas where preservice teachers felt stronger on the post-survey were their knowledge of how to teach online, "getting through to the most difficult students, controlling disruptive behavior, motivating students, having clear expectations for student behavior, getting students to believe that they can do well, and responding to difficult questions from students" (Cooper et al., 2020, p. 4). Furthermore, these preservice teachers, after two semesters of their education courses, felt they "would be able to establish routines, gauge comprehension, promote critical thinking, foster creativity, get students to follow the rules and meet deadlines, improve student understanding, and convey expectations, standards, and rules" (Cooper et al., 2020, p. 4).

Cooper et al., (2020) published the article, *Preparing Teacher Candidates to Teach Online: A Case Study of One College's Design and Implementation Plan*. This article describes the detailed three-phase plan for developing preservice teachers' technology knowledge and skills, which is the *Technology Integration Project* that was originally presented and described in the 2019 study above. The article sought to present an overview of one educator preparation program's comprehensive design and plan for preparing preservice teachers to integrate technology into their daily instruction, as well as how to teach K-12 students online. It was found that "Based on grades, presentations, and student discussion, over the course of three semesters, the preservice teachers enhanced their knowledge of technology tools and online learning" (Cooper et al., 2020, p. 134). Additionally, preservice teachers "further enhanced their TPK" and "developed their TPACK" (Cooper et al., 2020, p. 135) because they were required to use their technical pedagogical knowledge (TPK) with their content knowledge (CK) to teach an online lesson to their peers.

More recently, Cooper et al., (2024) sought to evaluate the implementation of the *Technology Integration Project* and its impact on increasing preservice teachers' TPACK. For this study, the authors' permission was granted to use the survey (see Appendix) that was developed in the article, TPACK*: The Development and Validation of an Assessment Instrument for Preservice Teachers* (Schmidt et al., 2009). According to Cooper et al., (2024) "the online survey results indicated that over the course of four semesters, preservice teachers developed strong TPACK" (p. 4) and "were becoming emerging technology teacher leaders" (Cooper et al., 2024, p. 16). Additionally, most of the survey questions that received the highest responses, "agree" or "strongly agree," were in relation to the preservice teachers' ability to select technologies to use in their classrooms that enhance their teaching practice, serve as a teacher leader in assisting others in their school or district in how to use technology, and choose the technologies that best support the content of their lessons.

The Evolution of the *Technology Integration Project*

When the *Technology Integration Project* was first designed (see Table 2), it was designed by a single professor who had over 13 years of online teaching experience. This professor created all the needed pieces and worked collaboratively to prepare the other faculty members who would teach each part of the project. Faculty members

who were charged with teaching aspects of the project were provided with training sessions from the lead professor. Instructional technology resources, assignment materials, and examples were included in that training. Table 2 depicts the objectives of the project and indicates in which semester a particular aspect of the project occurred.

Table 2

First Iteration of the Technology Integration Project

Objectives	Semester 1	Semester 2	Semester 3	Semester 4
Develop a working knowledge of foundational educational technology terms	X			
Explore curriculum and standards	X			
Create online instruction in an LMS, including the use of technology tools, an assignment with a rubric, a quiz, and a discussion board	X			
Record video teaching content	X			
Completion of a peer's online module (in the second iteration was changed to Critique peer's course)		X		
Provide and receive constructive feedback		X		
Analyze peer data in an LMS setting (in the second iteration was changed to Compare and contrast LMS data analysis to Excel data analysis features)			X	
Plan and deliver instruction using technology			X	X
Assess student learning using technology			X	X
Collect data on impact of instruction				X
Collect and analyze data to create online lessons				X

After the first year of implementation, the second semester assignment changed from having students complete a peer's online module, as the material was too easy for the peers and did not provide valid data to be analyzed in semester three, to a peer review of the online module. In the third semester, instead of analyzing the data from their peer "students", the preservice teachers examined the data analysis tools provided in an LMS versus those available in Excel (see second iteration notes in Table 2).

As time progressed and faculty teaching assignments changed, more and varied faculty were teaching courses that involved embedded assignments that were part of the *Technology Integration Project,* and with more student feedback, it was decided to split the first part of the project between two courses instead of just one first semester course (see Table 3). This allowed the preservice teachers more time to develop quality online instruction in an LMS.

Table 3

Third Iteration of the Technology Integration Project

Project Objectives	Semester 1
Develop a working knowledge of foundational educational technology terms	Course 1
Explore curriculum and standards	Course 2
Create online instruction in an LMS, including the use of technology tools, an assignment with a rubric, a quiz, and a discussion board	Course 2

After another year, faculty evaluation survey results were reviewed, and it was discovered that not all professors felt comfortable teaching the technology instruction that was embedded in their courses. Therefore, an educational technology seminar was developed that would house the first year (two semesters) of *the Technology Integration Project,* and it would be taught by professors with expertise and experience in teaching with and about technology.

Digital Age Teaching Seminar

The *Digital Age Teaching Seminar* was the name of the newly designed course that was born out of several rounds of student and faculty feedback from the *Technology Integration Project*. The *Digital Age Teaching Seminar* was designed to give preservice teachers experience with the infusion of educational technology into the K-12 curriculum. Preservice teachers engage in activities and projects designed to impart a practical understanding of the knowledge and skills required to teach in the digital age classroom. Preservice teachers also gain firsthand experience in developing their own online course and integrating technology into classroom activities to create learning environments that address the needs of diverse learners. Additionally, preservice teachers explore productivity tools, educational software, and web-based information and reflect on what constitutes effective teaching in an online learning platform. This course is designed as an online course, with both asynchronous and synchronous components. This course seeks preservice teachers to meet six learning outcomes, which are as follows:

- Identify and describe guidelines to address ethical and security

issues related to the use of computers and the Internet in the context of teaching and learning.
- Develop a working knowledge of and apply the 2016 International Society for Technology in Education (ISTE) standards for educators and students.
- Define and apply key educational technology terms as they are used in teaching and learning.
- Develop an online learning module for K-12 classroom use that incorporates quality content.
- Explore current software available for teachers, including software that is discipline-specific, and use software to enhance teaching and learning.
- Use computer-based technology to enhance teaching and learning by exploring and evaluating their usefulness for elementary, middle, and high school age students' learning.

Preservice teachers are assessed on the above stated learning outcomes through a variety of activities and assignments, including: (1) weekly class participation in collaborative, small, and whole group discussions and in-class activities (polls/surveys, game-based vocabulary reviews, etc.); (2) reading responses and quizzes— read and answer questions based on the assigned course text, Doug Lemov's, *Teaching in the Online Classroom: Surviving and Thriving in the New Normal* (2020) as well as other assigned course readings surrounding relevant topics such as the privacy and safety concerns of online learning, copyright law, learning differences and inclusion in the online learning environment, and assessing online learning with rubrics; (3) a technology tool analysis and peer review assignment where preservice teachers explore an assigned or chosen technology tool, practice using it, and present its usefulness and relevance to K-12 learning and then peers review each other's presentations to add to their overall repertoire of tools; (4) a technology demonstration project and peer review in which students create an online lesson in an LMS including: the use of technology tools, an assignment with a rubric, a quiz, and a discussion board, and critique a peer's course (parts of the pre-existing *Technology Integration Project*); and (5) a distance learning lesson plan where preservice teachers are charged with designing a lesson that is meant to be delivered entirely online utilizing both asynchronous and synchronous components.

Pilot data from the first group of special, elementary, and secondary education preservice teachers who completed the new *Digital Age Teaching Seminar* in fall 2021 and spring 2022, indicated a preference for either an asynchronous course format or a mixture of asynchronous and synchronous learning. There was a slightly higher preference for asynchronous learning. Flexibility as to when they can complete their coursework and being able to move at one's own pace were the most common reasons stated for the preference for the asynchronous format. Opportunities to ask questions, speak to classmates, and face time with the professor were reasons stated for preferring a mixture of both asynchronous and synchronous formats. The majority also reported that they did in fact download and regularly use BrightSpace Pulse (a mobile application that helps students manage their courses with a calendar, announcements, and information about assignments and grades) to view course announcements, notifications, content, assignments, and check on their grades. The overall feedback from preservice teachers on the course was

positive, and they enjoyed taking the course and learning more about teaching digitally.

In spring 2023, the *Digital Age Teaching Seminar* was included in the middle grades' education program, and they were surveyed as well. Their responses were in line with the previous student responses. Now that several instructors with expertise in technology have taught the class and now that this course is taken in all programs (special, elementary, middle, and secondary education preservice programs), course instructors plan to meet and discuss possible revisions, deletions, and/or additions to course content and course format based on data collected.

Conclusion

Gone are the days of chalkboards and erasers being clapped after school; even whiteboards are being traded for Smartboards. Students carry tablets rather than books, and in each student's hand, you will find a cell phone instead of a pencil. As technology changes, teachers must change their methods of instruction. To that end, the faculty of educator preparation programs must be able to understand and teach preservice teachers how and when to implement technology into instruction. Preservice teachers must know how to design an online class, teach in a synchronous and asynchronous format, and collect and use data from the online courses they teach. Researchers have tested different methods for teaching technology instruction to preservice teachers and will continue to do so, as there is only one thing certain about technology instruction: change. This research has provided insight into what is working regarding how to prepare preservice teachers to teach online. It has also guided continuous quality improvement and curriculum revisions for the EPP. The *Technology Integration Project* described throughout the research can provide other teacher educators with a model for their own programs so they can prepare their preservice teachers for the digital-age classrooms they will soon be stepping into. Future research directions will provide meaningful data and additional insight into how EPPs can continue to develop their teacher candidates' knowledge and skills for 21st century teaching.

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Appendix

Novice Teacher TPACK Survey

1. Please indicate if you completed the D2L Project at GGC.
- Yes
- No

2. Please choose from the options below.
- I am a student teacher.
- I am a classroom teacher.

3. Please indicate the semester and year that you graduated from GGC.

4. Please indicate your gender.
- Male
- Female

5. Please indicate your race/ethnicity.
- White
- Asian
- Hispanic
- African American
- Mixed Race
- Native American
- Other

6. Please indicate your age.

7. Please indicate your areas of teacher certification.

8. Please indicate your highest educational degree.

9. Please indicate your number of years of teaching.

10. Please indicate the grade levels you have taught.

11. I can teach lessons that appropriately combine mathematics, technologies, and teaching approaches.
- Strong Agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree

12. I can teach lessons that appropriately combine literacy, technologies, and teaching approaches.
- Strongly Agree
- Agree
- Neither Agree or Disagree
- Disagree
- Strongly Disagree

13. I can teach lessons that appropriately combine science, technologies, and teaching approaches.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly disagree

14. I can teach lessons that appropriately combine social studies, technologies, and teaching approaches.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly disagree

15. I can select technologies to use in my classroom that enhance what I teach, how I teach, and what students learn.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly disagree

16. I can use strategies that combine content, technologies, and teaching approaches that I learned about in my coursework in my classroom.
- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly disagree

17. I can provide leadership in helping others to coordinate the use of content, technologies, and teaching approaches at my school and/or district.
- Strongly Agree
- Agree

- Neither Agree nor Disagree
- Disagree
- Strongly disagree

18. I can choose technologies that enhance the content for a lesson.

- Strongly Agree
- Agree
- Neither Agree nor Disagree
- Disagree
- Strongly disagree

19. Please indicate how what you have learned from the D2L project at GGC has helped you in your teaching.

20. Please indicate the technology tools that you have used with students.

(Schmidt et al., n.d.)