COLLEGE OF EDUCATION | UNIVERSITY OF NEBRASKA AT OMAHA
JOURNAL OF CURRICULUM, TEACHING, LEARNING, AND LEADERSHIP IN EDUCATION

Volume 9 | Issue 1 Article 1

September 2024

What Do Pre-Service Teachers Know About Teaching with Technology?

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Abstract *This paper presents the results of a study which examined how 132 pre-service teacher work samples documented implementation of teaching with technology during student teaching experiences. Researchers determined which ISTE Standards for Students and ISTE Standards for Educators the pre-service teachers were using based on their reported technology use from the work samples. Themes of how the technology was used are also reported to gain a deeper understanding of pre-service teachers' use of educational technology. Findings indicate that students are taught to use technology for learning, but often used it for engagement.*

Introduction

The authors conducted this study as part of a cycle of continuous improvement within a college of education at a university in the Midwest. A technology committee began discussions related to understanding more about the technology use (and preparedness) of student teachers while preparing for an accreditation visit. The committee sought to learn more about what instructors were teaching in the college of education related to technology, as well as learning more about what students described related to the use of technology in their student teaching experience. The authors hoped this information would be useful in an evidence-based decision-making process for improving the technology curriculum for pre-service teachers. Using the ISTE Standards for Educators and the ISTE Standards for Students as codes, this paper presents the results of a study conducted by a technology committee in a college of education which examined how pre-service teachers self-reported their use of teaching with technology in their student teaching experiences.

Previous research has found self-reported data from pre-service teachers to be a valuable tool for understanding more about technology integration. For example, work samples are helpful sources for program improvement as they often document unique insight by the student, as well as level of use and rationale for using a technology when teaching (Henning et al., 2006: Henning et al. 2010). This research was done with the goal of establishing a baseline for the current practices of pre-service teachers who are teaching with technology, with the intent of identifying gaps in student teacher preparation. Preparing future educators to teach with technology is critical to teacher development for traditional classrooms, and even more critical as schools shift to remote and hybrid learning (Gomez et al., 2022; Trust, 2018; Whalen, 2021).

Literature Review

Pre-service teachers complete their student teaching in schools which may or may not have the technology they have practiced or learned with during their teacher education program. In addition, researchers have examined the comfort of pre-service teachers when using technology and found varied levels of comfort for teaching with technology (Farjon et al., 2019; Kimm et al., 2020). While the literature indicated that pre-service teachers have varied attitudes towards using technology in their student teaching experience, very few studies have examined the actual behavior and practices of pre-service teachers (Consoli et al., 2023). However, studies have suggested that it is important to give pre-service teachers the opportunity for self-efficacy when using technology (Bullock, 2013). Still the lack of certainty for how pre-service teachers apply technology during their student teaching experiences is limiting for faculty designing teacher education programs (Petko, 2012; Pozas & Letzel, 2023). Although there are many studies which examined the factors which are likely to lead to technology integration by pre-service teachers, they fail to examine the depth of technology use in favor of examining skills, attitudes and intention (Olugbara & Letseka, 2020).

Teacher efficacy, as it pertains to technology use, has been well-studied and found to be of value. However, a teacher can feel secure in technology abilities but not actually possess the skills to implement quality tech strategies (Coffey, 2021). Universities with teacher education programs recognize the importance of providing field experiences that contain a strong background in technology (Farjon et al., 2019). Yet, university faculty are not always trained in up-to-date technology strategies, and many education programs rely on one or two technology classes to train pre-service teachers (Lux, 2013; Nelson et al., 2019; Zakrzewski & Newton, 2022).

Pre-service and novice teachers typically have confidence in their use of technology as they implement it into their daily lives with ease (Ertmer & Ottenbreit-Leftwich, 2010). Yet, when researchers inquired about younger educators and their integration of technology into the classroom, they discovered gaps. Though the younger generation might have a specified skill-set, such as social media and search engines, research suggests their implementation of technology for use in instruction may be limited (Coffey, 2021; Darvin, 2020).

Coffey (2021) suggested that working teachers and teacher candidates generally do not possess the "necessary tools, skills, support, and knowledge to eliminate barriers to technology integration" (p. 19). In 2011, Sutton found three themes when working with preservice teachers and technology. Preservice teachers noticed a disconnect between required technology course(s) and their methods courses, they were not provided with knowledge as to how technology could benefit individual content areas, and most programs lacked technology being implemented into all education coursework so pre-service teachers could build their knowledge and confidence. Today, pre-service teachers' level of comfort with technology still varies widely (Farjon et al., 2019; Kimm et al., 2020).

Guiding Framework

To offset the discrepancy for how technology is implemented by both novice and veteran educators, the International Society for Technology in Education (ISTE) created the ISTE Standards. The intent of the standards is to "provide the competencies for learning, teaching and leading in the digital age, providing a comprehensive roadmap for the effective use of technology in schools worldwide" (ISTE, 2023, para. 1). There are four groupings of standards: Educator, Student, Coach, and Education Leader. For the purposes of this study, the ISTE

Standards for Educators and the ISTE Standards for Students were used as a guiding framework for analysis and informed the research questions.

Researchers have found that teaching practices aligned with the ISTE Standards for Educators support student attainment (Crompton, 2023). The ISTE Standards for Educators encourage teachers to focus on seven roles pertaining to technology: 1) Learner, 2) Leader, 3) Citizen, 4) Collaborator, 5) Designer, 6) Facilitator, and 7) Analyst (ISTE, 2017a). Each of these roles addresses one aspect of technology that leads to a solid understanding for all educators as they become comfortable with using technology for learning. The ISTE Standards for Students include seven roles students can grow in: 1) Empowered Learner, 2) Digital Citizen, 3) Knowledge Constructor, 4) Innovative Designer, 5) Computational Thinker, 6) Creative Communicator, and 7) Global Collaborator (ISTE, 2017b). Additionally, each ISTE Standard for both Educators and Students has indicators that further explain the "how-tos" of technology usage. This framework provides a research-based template to ensure teachers and students use technology to its fullest potential.

The Council for the Accreditation of Educator Programs (2020) (CAEP) includes technology as a cross-cutting theme, and teacher preparation programs are tasked with instructing pre-service teachers in how to use technology in the classroom. Since researchers have found educational technology improves learning outcomes in various settings (Lee et al. 2022; Li & Wang, 2022; Ran et al., 2021; Ran et al., 2022), it is important that all teacher preparation programs find ways to incorporate technology well into courses in order for pre-service teachers to have the ability to use technology in their future classrooms. Using the ISTE Standards for Students and the ISTE Standards for Educators as the framework for technology integration is a natural fit.

Using the ISTE Standards for Educators as their framework, Mucundanyi and Tamang (2022) found that in-service teachers primarily focused on the standards of Designer, Analyst, Facilitator, Citizen, and Learner (p. 11). Additionally, Michaeli et al. (2020) used the ISTE Standards for Educators as their framework to determine if the use of education dashboards led to growth for teachers. Dondlinger et al. (2016) used the ISTE Standards for Students to analyze student interviews in a mathematics classroom to determine what activities lead to learning. Other studies have focused on examining how to help students achieve the ISTE Standards (Ayad & Ajrami, 2017; Hazaymeh, 2021) and how teachers implement the standards (McCoy, 2021).

To help pre-service teachers gain skills in technology, the ISTE Standards for Students and the ISTE Standards for Educators provide clear benchmarks for higher education faculty to incorporate in their curricula. The Standards can be used in assignment design (Machado & Fu, 2020) and for faculty members to model the use of technology in instruction (Foster et al., 2019). Because Crompton (2023) found that the use of teaching practices aligned with the ISTE Standards for Educators led to increased student learning, it is important for these standards to be integrated well into pre-service teacher education programs.

While other technology frameworks exist, such as the PICRAT Matrix (Kimmons et al., 2020); SAMR (Puentedura, 2015); TPACK (Koehler & Mishra, 2009); and the Technology Integration Matrix (Florida Center for Instructional Technology, 2021), the authors chose the ISTE Standards as the guiding framework for this paper due to their adoption by the College of Education at the University where the research occurred. The College of Education uses the ISTE Standards to ensure technology is integrated into pre-service coursework.

Methods

In this study, a Technology Task Force in a College of Education sought to understand how preservice teachers were using technology in their field experiences (student teaching). The committee expected to identify gaps related to teaching with technology and to recommend improvements for preparation. The committee developed two research questions to guide this exploration.

Research Questions The researchers seek to answer the following questions: What alignment is there between the ISTE Standards for Educators and the ISTE Standards for Students and preservice teachers' self-reported use of technology? How do pre-service teachers describe how they use technology to teach? Researchers used the ISTE Standards for Educators and the ISTE Standards for Students as a coding framework for a thematic analysis (Kiger & Varpio, 2020) to examine how pre-service teachers self-reported their use of teaching with technology in their student teaching experiences. Kiger and Varpio (2020) described thematic analysis as a simple method of analyzing qualitative data which involves searching across a dataset to identify patterns and interpret themes. Thematic analysis is a useful method for engaging in new research, as it allows researchers to begin to understand more about a set of experiences across the data set (Braun & Clarke, 2012). Thematic analysis is typically an inductive approach, though deductive analysis can be applied to constructivist paradigms, which requires researchers to use more interpretation in the analysis (Braun & Clarke, 2006).

Participants and Setting This research was conducted with 131 pre-service teachers at a regional comprehensive university in the Midwest during Fall 2021 and Spring 2022. This university is a CAEP accredited institution in which the standards require that technology is taught throughout the curriculum and engaged with by teacher candidates (CAEP, 2022). In this university, the faculty are encouraged to align the teacher education curriculum to the ISTE Standards for Educators (ISTE, 2017a). Pre-service teachers at this school complete their student teaching in urban, suburban, and rural schools at various levels of education. Pre-service teachers represented a variety of content areas including physical education, math, art, science and music within early childhood, elementary, middle and high school levels. Pre-service teachers are encouraged to provide differentiated instruction using assistive technology and accommodations while implementing technology on a whole classroom basis.

Data Sources and Collection This study included one dataset, the technology table in the student teacher work samples created by pre-service teachers during their student teaching experience. Researchers examined existing data created by pre-service teachers and submitted to the university upon completion of their student teacher experience as part of their student teacher work sample, a requirement for student teachers in the state in which this study was conducted. The student teacher work sample is a required component of the student teaching experience. It consists of four sections and an appendix. The four sections are 1) contextual factors, 2) assessment plan, 3) design for instruction, and 4) analysis of student learning and reflection. In each section, student teachers respond to questions including about their integration and use of technology. In the student teacher work samples, students were asked to list what technology they used and then write what they did with the technology and why they selected the technology. This data was de-identified by a third party and shared with researchers (see Table 1).

Table 1. Example technology table in the student teacher work sample.

Table 6 Technology to Enhance Student Learning			
Available Technology (listed in Section 1 Table 3) List one technological tool or resource per cell below in this column	Use of Technology: Indicate with the appropriate letter code if the technology was used for: P= Planning L= Lesson Implementation A= Assessment	Why was this technology selected?	• What the use of technology effective? • Did the technology increase student engagement and student learning? • Share specific information and examples of how the use of technology enhanced student growth.

Analysis The thematic analysis (Braun & Clarke, 2006; Kiger & Varpio, 2020) included the six steps for thematic analysis for the student teacher work samples. In step 1, researchers familiarized themselves with the data. In step 2, researchers generated initial codes using a larger coding framework. This framework was the ISTE standards, and researchers assigned both the ISTE Standards for Educators and ISTE Standards for Students to each student teacher work sample. Based on the pre-service teachers' descriptions of what technology they used and why they used it, three researchers reviewed each ISTE Standard for Educator and ISTE Standard for Student to determine which standard(s) aligned with the technology use (see Table 2). The student teacher work samples included columns for students to document why they chose the technology they used, and reflect on the effectiveness of using that technology.

Table 2. ISTE Standards for Educators and Students Roles

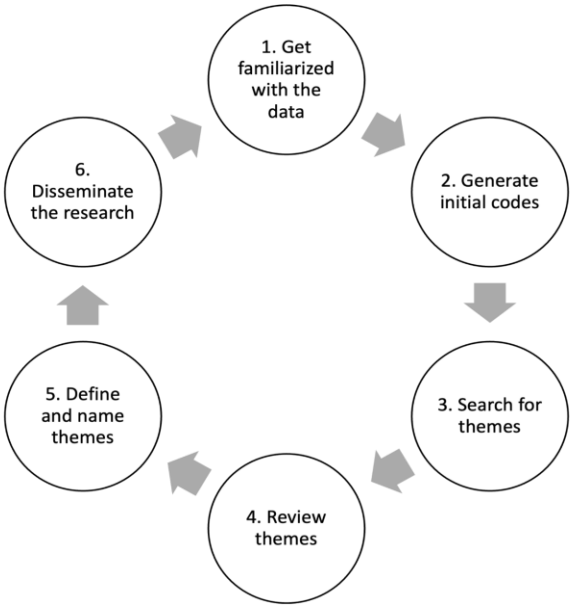
ISTE Standards for Educators Roles (2017a)	**Paraphrased Description**
Learner	Educators who engage in continual learning.
Leader	Educators who seek out leadership in education to support students.
Citizen	Educators who help students engage well in a digital world.
Collaborator	Educators who work with other teachers and their students to enhance learning.
Designer	Educators who create effective learning environments and activities.
Facilitator	Educators who support learning with technology.

Analyst	Educators who use data to make informed decisions.
ISTE Standards for Students Roles (2017b)	
Empowered Learner	A student who is active in their learning.
Digital Citizen	A student who engages in ethical and responsible behavior in a digital world.
Knowledge Constructor	A student who builds knowledge for themselves and others.
Innovative Designer	Students who use technology in a design process.
Computational Thinker	Students who use technology to solve problems.
Creative Communicator	Students who communicate well with technology.
Global Collaborator	Students who use technology to collaborate with others in any location.

When reviewing the standards for alignment, the researchers reviewed both the standard itself as well as the indicators for each standard. The researchers also identified quotes from the student teacher work samples that they determined supported assigning the standard(s). To ensure reliability of the standards alignment, two researchers worked separately to analyze the student teacher work samples and assign standards. Then, the researchers compared their work and for any discrepancies in standard alignment and brought in a third researcher to help determine which standard(s) were addressed in the student teacher work samples if there was discrepancy. When they found discrepancies, the research team discussed the data and decided together on the final theme. This occurred in only 3 instances for each standard set.

In addition, researchers extracted data that might include items of interest and evidence of technology use. In step 3, researchers examined the initial codes and extracted data and developed themes using an interpretive process. In step 4, they reviewed the themes using a two-level analytic process. In the first level, researchers looked at the data within each theme to ensure it was a fit and had sufficient supporting data, and in the second level, researchers determined if the themes fit meaningfully within the full body of data. In this stage, researchers also calculated inter-reliability of data analysis and determined that there was a 95% agreement rate in the analysis. In step 5, the researchers created a narrative description of each theme, including providing the supporting evidence needed to create a coherent narrative, while also addressing any overlap. In step 6, the final analysis was written to disseminate the findings in a meaningful way (see Figure 1).

Figure 1. *The six steps of thematic analysis (Braun & Clarke, 2006; Kiger & Varpio, 2022)*



Note. The authors created the figure based on the steps listed in Braun and Clarke (2006) and Kiger and Varpio (2022).

After determining the ISTE Standards for Educators and the ISTE Standards for Students the pre-service teachers were using, the researchers identified themes for how students were using the technology during their student teaching experiences. The student teacher work samples were analyzed for themes using thematic analysis. Researchers applied codes to the technology used and student descriptions of technology use, then researchers extracted data as supporting evidence. They arranged codes into themes, then further reduced to subthemes, which included Use of Technology, Use of Technology for Student Learning, and Use of Technology for Teaching (see table 3).

Table 3. Codebook aligned with themes.

Theme 1: Use of Technology	**Theme 2: Use of technology for student learning**	**Theme 3: Use of technology for teaching**
Assistive technology Audio Connectivity Content area technology Curricular resource Digital learning platform Digital resource Formative assessment Instructional design Computer	Subtheme 1: Student empowerment Simulations Collaboration Practice Catch errors Clarity Personalization	Subtheme 1: Become more engaging Entertaining for students Capturing student attention Interactivity Lack of engagement Low effort Subtheme 2: Confidence-

Manipulative Media creation Mobile device Personalized learning Presentation equipment Printer Productivity Simulation Smartboard Student information Web Conferencing	Subtheme 2: Student engagement Fun Engaging Interesting Games Subtheme 3: Student choice Student participation Personal devices Mobility Active learning Choices when learning	building Checking accuracy Review knowledge Standards alignment Subtheme 3: Teacher agency Ease of use Ability to share Ability to collaborate Easy to modify Shared editing access Create interactive assignments Executing tasks

Findings

In this study, researchers examined student teacher work samples to understand more about how preservice teachers were teaching with technology during their student teaching experiences. The following presents the findings in order of the research questions.

RQ1: Alignment to ISTE Standards Of the 588 instances of technology documented in the student teacher work samples, researchers identified application of the ISTE Standards for Students 82 times (14%) as evident within student teacher reflections. The distribution of the codes with the ISTE Standards for Students included is presented in Table 4. Table 4 also showcases example quotes aligned with each ISTE Standard for Students.

Table 4. Codes assigned to reflections on technology use for each of the ISTE Standards for Students with example student quotes

ISTE Standards	Percentage	Example Student Quotes
1.1 Empowered Learner	47.6%	Students engage in asking their own questions and create classroom discussion from their personal experiences and connection
1.2 Digital Citizen	1.2%	Students can look back and see how they can be safe, be responsible, and be respectful for the class period. Along with items that need to be turned in or if there is something specific I need them to remember such as an upcoming test.

1.3 Knowledge Constructor	23.8%	Students are able to use their Chromebooks to research information about their writing without having to go search for a library book.
1.4 Innovative Designer	4.8%	Students were engaged while designing a poster on Canva. They created an informational chart on vegetables for a Foods course.
1.5 Computational Thinker	2.4%	Students learned how to drag unifix cubes, connect them, and move them around the page. We walked through a problem together and found the solution.
1.6 Creative Communicator	19.0%	Students can interact with other students via discussion boards which leads to better writing communication skills.
1.7 Global Collaborator	No Evidence	It allowed students to experience virtual field trips.

The ISTE Standards for Educators speak specifically to using technology for teaching to support student learning. Therefore, the researchers used the ISTE Standards for Educators to determine areas in which the student teachers identified that they used the technology to support their teaching. Of the 588 instances of technology documented, researchers identified application of the ISTE Standards for Educators 126 times (21%) as evident within student teacher reflections (see Table 5). The distribution of the codes applied found the ISTE Standard for Educator Designer to be the most used (n=65) and the ISTE Standard for Educator Citizen to be the least used (n=1). Other standards which were used minimally included the ISTE Standard for Educator Leader (n=2) and the ISTE Standard for Educator Learner (n=4). Table 5 also includes examples of student quotes aligned with the ISTE Standards for Educators.

Table 5. Codes assigned to reflections on technology use for each of the ISTE Standards for Educators with example student quotes

ISTE Standards	Percentage	Example Student Quotes
2.1 Learner	No Evidence	[Chemlibre] is a resource that I utilize to ensure that every piece of information that I teach is correct.

2.2 Leader	1.6%	Computer labs have been configured to support teaching and learning by providing rows/groups of computers in a lecture-style classroom set-up. Lab computers and software allowed students to complete course assignments or learn new programs.
2.3 Citizen	No Evidence	Google Slides is effective when it is used for introductory presentations, especially, but can be used for many things in the classroom like directions, expectations, procedure, etc.
2.4 Collaborator	11.5%	This technology was effective because it's easy to use and modify as I need. It is also easy to share with my cooperating teacher and advisors.
2.5 Designer	53.3%	We used SeeSaw to plan activities for students to complete during class as a supplement to their learning. The activities we gave the students helped them practice the skills taught in class.
2.6 Facilitator	7.4%	The projector was effective in implementing the lesson because it allowed me to show the whole class my slideshows.
2.7 Analyst	25.4%	I really like using Quizziz because once the quiz is over, you can look back on students' answers and if

	there was a question that a lot of students missed.

RQ2: Students' Descriptions of Technology Use The following is a description of the themes which emerged within the student teacher work samples from the words used by the students to describe their use of technology. The overall themes are summarized in Table 6.

Table 6. Overall summary of the emerging themes

Use of Technology	**Use of technology for student learning**	**Use of technology for teaching**
Hardware Personalized learning Formative assessment Instructional design Digital resources Digital learning platforms Simulation Assistive technology Productivity	Student empowerment Student engagement Student choice	Become more engaging Confidence-building Teacher agency

Use of technology. The theme "Use of Technology" included codes related to how the preservice teachers documented the type of technology used in their student teaching experience. In the student teacher work sample, students documented the technology they used in a column called "Available Technology". Some students documented one technology tool, and others documented up to ten technologies. These technologies ranged between the laptop used to project their lessons, to specific software used to interact with students. Students were able to choose the terms they used to describe the technology use and chose 588 technologies. Due to the nature of students' natural language, some technologies were listed more than once by others, like "Google" or "Chromebooks", and many listed the individual technology names that they used like "Nearpod" or "Kahoot".

Due to the variation in technologies, researchers applied codes to the technologies listed by student teachers. These codes were inductive as students described their technology use in varied and unique ways. Researchers ended up with 21 codes which described the type of technology used (see Table 7). These codes were grouped into the following nine themes of technology use: hardware (functional use), personalized learning, formative assessment, instructional design, digital resources, digital learning platforms, simulation, assistive technology and productivity (see Appendix A). Of the codes identified by researchers, the most common technology use reported by students was 1) computers (n=115), 2) presentation equipment (n=80), and 3) formative assessment tools (n=73). The least used technology codes reported by students included 1) connectivity (n=1), 2) web conferencing (n=2), 3) media creation (n=3), and 4) manipulatives (n=3).

Table 7. Technology used during student teaching experience.

Name of Technology	Number of Times Mentioned
Assistive Technology	5
Audio	9
Connectivity	1
Content Area Technology	11
Curricular Resource	32
Digital Learning Platform	67
Digital Resource	16
Formative Assessment	73
Instructional Design	8
Computer	115
Manipulative	3
Media Creation	3
Mobile Device	31
Personalized Learning	28
Presentation Equipment	80
Printer	4
Productivity	35
Simulation	10
Smartboard	49
Student Information	6
Web Conferencing	2

Use of Technology for Student Learning. Pre-service teachers also wrote reflections about why they used the technology they listed. Researchers coded these reflections, and a theme emerged that preservice teachers described how they used technology for student learning.

Within this theme, three subthemes emerged, including student empowerment, student engagement and student choice.

SubTheme 1. Student empowerment. When pre-service teachers explained their use of technology for learning, it was almost always described within the context of the empowered learner, meaning that students took an active role in their learning. For example, one pre-service teacher who used Zearn said, "The technology increased student learning by allowing students to use the site as a pre-assessment for them to practice math questions that follow along with the lessons and units being taught." Another used Snap and Read and said that it empowered their students: Students were able to use Snap and Read to have their stories read to them. This allowed for students to catch errors in their writing that were made clearer through listening to their story being read. Sometimes when you are writing, you tend to have just one lens on. Using Snap and Read in this way allowed for another lens to be added through listening to their story being read aloud. Of the pre-service teachers whose reflections aligned with the Knowledge Constructor standard, almost all referenced hardware they used with students, like iPads or Chromebooks. They said, "One example of [how] this resource enhances student growth is by providing them with a tool in the classroom for their individual use. Many times, we have students who will have such a good question, and instead of telling them I will look it up and get back to them, they can do it themselves. This technology is important for them to learn now because it is what they will be using their whole life." Another student described the use of Chromebooks as being able to allow students to work on their own, "Students were also able to research on their own and get visuals for artwork ideas."

SubTheme 2. Student engagement. Regardless of the technology used, the pre-service teachers who referenced how technology was used for learning often described it within a frame of being engaging for students, even motivating them or making their learning more interesting. For example, one pre-service teacher described their reason for using SeeSaw as, "This technology enforces student engagement and learning by creating fun activities on Seesaw, like a photo scavenger hunt where they have to find an object that goes with what they are learning." Another student who used Mystery Science said they thought it was valuable because, "Students engage in asking their own questions and create classroom discussion from their personal experiences and connections." A music education student said that using a digital metronome made it so that "Students could listen to the metronome to keep the beat better," essentially allowing them to be more engaged and present in their activities. Several students described the use of technology for brain breaks as a strategy to keep them more engaged in the lessons before and after the break. For example, one student said, "The use of technology is effective because it helps us project our lessons and gives the students the ability to have brain breaks when the students need them." Another said, "I was able to show brain breaks, slideshows, books, poems, videos, model my writing, use a timer, and much much more with the help of my Chromebook."

SubTheme 3. Student choice. Pre-service teachers described technology use as effective when students were actively participating when using it. For example, one reflection indicated that personal devices (most likely iPads or mobile devices) allowed students to physically move around to complete the lesson: "Personal devices were used the best in class when students had to move throughout the room scanning QR Codes to research specific sites needed for their assessments on careers." The ability to move around the room allows students to choose where they are most comfortable. Another student described how Clever, a digital learning platform, enabled students to have choices when learning. They wrote, "Often during free time, we would

allow students to make a choice from a broad category, and students would be engaged to have that choice option available."

Use of technology for teaching. Pre-service teachers also wrote reflections about why they used the technology they listed. These reflections were coded by researchers, and a theme emerged that preservice teachers described how they used technology for teaching. Within this theme, researchers found three subthemes that described using technology for teaching: to become more engaging, to build confidence, and to develop teacher agency.

SubTheme 1. Become more engaging. Pre-service teachers frequently described how they were using technology to create what they felt was a more engaging learning experience for their students. For example, one pre-service teacher said that use of the projector "definitely increased engagement by providing students a central visual within the classroom." Similarly, another student described the Smartboard as "promoting engagement through interactivity and could also be moved up and down to certain levels." However, not all documented that their use of technology was as engaging as they would like. One pre-service teacher who used Zearn (a math resource) said, "I saw student engagement decrease with this tool. The tool is great for learners that need the content a second time, yet those students who do not need it often click through without trying."

SubTheme 2. Confidence-building. In many cases, pre-service teachers reflected on how their use of technology helped them to feel more confident in their knowledge or teaching. Statements related to confidence were always aligned with what researchers classified as content-area technology. A pre-service teacher in science said that using ChemLibre was helpful for ensuring accuracy in their instructor. They wrote, "This is a resource that I utilize to ensure that every piece of information that I teach is correct." Another pre-service teacher said that "[Blookit] was used to allow me to review basic knowledge of exponents before growing deeper with harder topics and standards within the unit." Pre-service teachers need to align their teaching with state standards. One said that SeeSaw made it easier for them to do that, stating, "Students were given activities to do on Seesaw that were directly tied to [state] learning standards."

SubTheme 3. Teacher agency. Several codes were merged to develop the theme of teacher agency. For example, pre-service teachers wrote about the ease of use that technology provided for them as teachers and described features like sharing (for example, Google Drive), which allowed them more agency to collaborate with other teachers. About their use of Google Drive, one wrote, "This technology was effective because it's easy to use and modify as I need. It is also easy to share with my cooperating teacher and advisors." Another described their use of Google Slides as helpful for working with their supervising teacher stating, "This technology was selected because it allowed [my supervising teacher] and I to collaborate on lesson plans in real-time. We both had editing access to the slide presentation and could make edits as we planned for upcoming lessons." Some pre-service teachers described how technology made it possible for them to do more than they could do without it. One said, "SeeSaw is effective because it allows teachers to make interactive assignments for students. Instead of just writing on a worksheet, students can write, drag, highlight, type, insert video or sound, use manipulatives, and more." The pre-service teachers also documented many uses of hardware, such as laptops, iPads or projectors. The reflection on these tools indicated that they valued the potential for the hardware to allow them to execute needed tasks. For example, one described their use of a laptop

as an "effective tool that allowed for me, as a teacher, to effectively plan lessons, locate resources, as well as communicate with families and colleagues."

Discussion

This study broadly examined how preservice teachers at one institution described the implementation of technology during their student teaching placement. It is of great value for teacher educators to identify how preservice teachers describe their use of technology when they are engaging in their student teaching experiences (Henning et al., 2006; Henning et al., 2010). Reflection by preservice teachers in all facets of instruction is necessary in predicting the likelihood of success when working with content and pedagogy. In addition, it can also assist higher education instructors in identifying gaps in curriculum related technology. Reflecting on our practice as educators by using data-driven methods, is useful to 1) improving practice and curriculum, 2) aligning with accreditation standards, and 3) preparing students for technology readiness before beginning an immersive instructional experience.

Our findings indicate that pre-service teachers use the ISTE Standard for Students Empowered Learner (n=40), more than any other standard, and ISTE Standard for Students Digital Citizen the least of all the standards (n=1). In addition, the pre-service teachers described their technology use from a teacher-centric perspective, frequently setting students up to be passive users of technology instead of designing opportunities for students to be interactive or creative. This also included use of technology for "brain breaks" or for implementing technology solely to keep students engaged.

For teacher educators, this is an important finding. There is an opportunity in higher education to ensure that pre-services teachers have the skills and strategies to design lessons that use technology as a tool for learning as well as for access and equity. To move beyond this misconception, higher education should reevaluate how technology is presented in required coursework. Key technologies need to be identified, researched, and distributed within the education department so pre-service teachers can focus on learning technology concepts with a transfer understanding versus surface level understanding. Hattie et al. (2017) suggested that instructors explicitly assist students in transferring new knowledge collectively, as opposed to assuming the students will make connections independently. This idea could not be more powerful as it is within the field of educational technology. Vocabulary, teaching methods, instruction, and programs designed to instruct and engage students are ever changing. Preservice teachers need to be able to discern the appropriate technology for their lessons from the extensive lists of resources already available to concepts that have not yet been created. Higher education instructors need to facilitate this understanding.

One concern moving forward is that many of the pre-service teacher reflections indicated misconceptions about the types of technology available and the best use of these technologies to support instruction. For example, a student may say that the tool, Clever, provides their students with choice, when it is simply integrated modules or games curated by the teacher that have been added and are accessible in Clever. Similarly, another student indicated that Google Classroom allowed their students to go on virtual field trips, when this was also likely made possible by media extensions for Google Classroom rather than the digital learning platform itself. As the students who participated in the study have not concentrated on educational technology, their understanding is limited. However, all pre-service teachers, regardless of their content, should be able to speak accurately to the technology they are using and its impact on students' learning.

Therefore, the researchers suggest when instructors see misconceptions, they should address them and provide clear guidance on the appropriate use and limitations of various educational technologies. Instructors can also provide overarching understandings with technology vocabulary. Identifying trends such as "learning platforms" versus products such as "Google Classroom" will benefit preservice teachers as inevitable changes concerning these concepts will develop in the future. The findings indicated that students are being instructed on the use of technology pedagogy in their coursework but may not possess the language for discussing it. Consequently, most of the data from the work samples were not coded at all due to lack of depth in their response and inability to assign a code. A student may have said they used the computer in their classroom to teach a lesson, but that statement alone does not align with the ISTE standards. Instructors may want to consider devoting more time in class to discussing positive implementation of technology for teaching and learning. Additionally, group sessions where students can share the instructional choices they are making with guidance from a qualified instructor will help them articulate the value in their use of technology. This is important because the findings indicate that preservice teachers lack the vocabulary to express how they use technology in lesson design. To address this need, faculty can create opportunities, such as group discussions or guided reflections for pre-service teachers, to practice communicating their use of technology and its pedagogical implications. Developing a strong technology vocabulary will assist students in identifying which technology is a valuable tool. In addition, the vocabulary will assist students in their explanations of how they have implemented research-based technology in their instruction.

The preservice teachers in this study also described technology as a tool for engaging students more than other practices (as in assessment, practice, retrieval or other instructional use). The work samples collected for this study were completed post-Covid, not long after schools had been closed for remote learning. The focus on technology for engagement during remote learning was common as teachers sought to keep online students interested in the material with games, media, and online social interaction (Hollister et al., 2022). Perhaps the preservice teachers in this study had more comfort with technology for engagement due to their own experiences in online learning and observing other teachers who had used technology for classroom involvement during Covid-19 school closures. As a result, higher education instructors should illustrate ways in which educational technology has previously been used for fun with unintentional learning as opposed to the commitment of the ISTE Standards and its purposeful intent for technology in the classroom. More research in the area of intentional use vs. fun is needed.

Limitations

Researchers originally conducted this study to learn more about how technology is taught, and how students understand it, within one college. There are several limitations to this study. One limitation is that the study uses existing data only and does not gather student perceptions of use. In addition, students were not observed teaching, nor were faculty observed for their application of the ISTE standards in their courses. Lastly, the results of this study are heavily influenced by the design of the student teacher work sample, which included guiding questions.

Recommendations for Future Directions

The authors pursued this study to provide information to a task force related to the current practices of teaching with technology by preservice teachers. Therefore, the results were useful to inform future directions within the College of Education for preparing preservice teachers to teach with technology. Early recommendations include modifying the student teacher work sample so that 1) pre-service teachers identify which ISTE Standards they use, 2) the instructions are less focused on engagement and more on meaningful use of technology, and 3) hardware is separated from software so that students are able to identify the tools they use for teaching (many students described the laptop as their teaching tool rather than the software they used for building engaging experiences). Pre-service teachers often failed to differentiate between hardware and software use which indicated they had a challenging time determining when their use of technology was replacing a traditional teaching practice vs. amplifying or transforming learning. Additionally, instructors are providing more opportunities for reflections on teaching with technology and how it might empower students and educators.

Additional recommendations include the use of educational technology frameworks, such as the PICRAT Matrix (Kimmons et al., 2020), SAMR (Puentedura, 2015), TPACK (Koehler & Mishra, 2009), or the Technology Integration Matrix (Florida Center for Instructional Technology, 2021), in higher education courses to help students reflect on their use of technology. To scaffold, a framework could first be used when students are in the field observing veteran teachers to reflect on their use of technology. Then, students would apply the framework to their own work during student teaching.

Conclusion

This study examined pre-service teachers' descriptions of their use of technology during their student teaching experience. The findings suggest that these pre-service teachers primarily rely on technology for engagement, or to feel more confident about their teaching. Student teachers also need to have flexible skills for teaching with technology, as what they learn to use in their teacher preparation programs may or may not be available in the schools in which they teach. The researchers believe this study is designed in a way that other schools may be able to replicate it to identify their own strengths and weaknesses related to preparing pre-service teachers for their teaching experiences. The qualitative nature of this study also helped the researchers identify which strategy is effective in improving the practice of pre-service teachers.

The authors report there are no competing interests to declare.

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Appendix A

Student Teacher Technology Use

broaHardware	**Personalized Learning**	**Formative Assessment**
• Speakers • Remote wifi • Elmo • Echo • Chromebook • Printer • 3d Printer • Chromebook • iPad • iPhone • Wacom Tablet • Surface Go • Overhead Projectors • Document camera • Smartboards • Promethean board • Stylus	• iReady • Reading A-Z • STAR • Head Sprout • Freckle • Zearn • Xtra Math • IXL • Reading A-Z • ABC Mouse	• Kahoot • Nearpod • Blooket • EdPuzzle • GeoGebra • Gimkit • Quizizz • FlipGrid • Google Forms • PearDeck • Boddle • Flocabulary
Instructional Design Resources	**Digital Resources**	**Digital Learning Platform/SIS**
• Planbook • Lumino • Bitmoji Classroom • TeacherMade • OER	• BrainPop Jr. • Epic! • PebbleGo • Raz-Kids • Headsprout	• Google Classroom • Seesaw • Clever • Intellispark • Jupiter • Canvas • Schoology • PowerSchool • Infinite Campus
Simulation	**Assistive Technology**	**Productivity**
• PHET • Teach Chemistry • Gizmos • America’s Army Simulation • Google Earth	• Electric Keyboard • Read and Write • Snap and Read • Voice to text	• Google suite • Interactive notebooks • EdCite • Good Notes • OneNote