What do pre-service educators know about teaching with technology?

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Introduction

How can we identify that pre-service teachers are using technology in meaningful ways? Because COVID-19 pandemic ushered in an increased use of educational technology, teacher knowledge of resources is more important than ever. Using the ISTE Standards for Educators (ISTE, 2017a) and the ISTE Standards for Students (ISTE, 2017b), higher education faculty in pre-service teacher programs now have the opportunity to step back, reflect, and determine the best way to frame their teaching moving forward. This paper presents the results of a qualitative study which examined how pre-service teachers documented their implementation of teaching with technology in their student teaching experiences.

Within this context, 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. Prior research indicates that pre-service teacher's readiness for technology integration is categorized within areas of self-efficacy theory (how prepared do pre-service teachers feel about using technology) (Belland, 2009; Pan & Franklin, 2011), socio-cultural theory (how well are pre-service teachers supported to use technology (Ward & Overall, 2011; Farjon et al., 2019), and contextual factors (what is the availability and expectations of technology (Bullock, 2004; Yaylak, 2019). In addition, studies examine 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). 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). Further, 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).

The purpose of this research was to learn more about the preparedness of pre-service teachers to teach with technology within the classroom through the lens of the ISTE Standards for Educators (ISTE, 2017a) and the ISTE Standards for Students (ISTE, 2017b). 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). Through the reflections of pre-service teachers during their student teaching experience, this study presents the qualitatively different ways in which pre-service teachers describe their use of technology and how effective it was .

Research Questions

This research seeks to answer the following research questions:

1.) How are the ISTE standards scaffolded throughout the curriculum in undergraduate College of Education programs?

2.) How are pre-service teachers implementing the ISTE educator standards?

3.) How are pre-service teachers implementing the ISTE student standards?

Application of the ISTE Standards in Pre-Service Teacher Education

Teacher preparation programs are tasked with instructing pre-service teachers in how to use technology in the classroom. The Council for the Accreditation of Educator Programs (CAEP) includes technology as a cross-cutting theme. Specifically, the CAEP (2020) handbook states,

> Candidates need experiences during their preparation to become proficient in applications of digital media and technological capabilities. They should have opportunities to develop the skills and dispositions for accessing online research databases, digital media, and tools, and to identify research-based practices that can improve their students' learning, engagement, and outcomes. They should know why and how to help their students access and assess critically the quality and relevance of digital academic content. Preparation experiences should allow candidates to demonstrate their abilities to design and facilitate digital, or connected learning, mentoring, and collaboration. They should encourage use of social networks as resources for these purposes and to help identify digital content and technology tools for P-12 students' learning. Candidates should help their students gain access to what technology has to offer. (pp. 31-32)

However, the level of comfort pre-service teachers have with technology varies widely (Farjon et al., 2019; Kimm et al., 2020). 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). A gap in the literature exists in understanding how the ISTE Standards are used in teacher preparation programs.

Methods

The ISTE Standards for Educators and the ISTE Standards for Students served as the framework for this study. The research questions focused on the standards and results were categorized by the standards.

Thematic analysis

This study used thematic analysis to understand more about how pre-service teachers describe their use of technology during their student teaching experiences and in their coursework. Kiger and Varpio (2020) described thematic analysis as a 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 the 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 require the researcher to use more interpretation in the analysis (Braun & Clarke, 2006).

Participants and Setting

Documentation from 132 pre-service teachers at a regional comprehensive university in the midwest was gathered 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 required to align the teacher education curriculum to the ISTE Standards for Educators (ISTE, 2017). 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 Collection Methodology

This study 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 work sample, a requirement for student teachers in the state in which this study was conducted. This data was de-identified by a third party and shared with researchers. In addition, this study

reviewed 240 courses for evidence of technology use by examining publicly available syllabi for courses which are taken by pre-service teachers during their undergraduate study. A crosswalk was compiled which aligned the ISTE Standards for Educators with the standards indicated in the syllabi. This crosswalk was reviewed by researchers for the study.

The Dataset

This study included 2 datasets: 1.) the technology table in the work samples created by pre-service teachers during their student teaching experience, and 2.) syllabi for undergraduate courses in the teacher education program.

Analysis

The thematic analysis included the six steps for thematic analysis for the work samples (see Figure 2). The six steps of thematic analysis allow researchers to analyze qualitative data for codes and themes (Braun & Clarke, 2006). Work samples were analyzed using this six step process, and syllabi were analyzed using descriptive statistics to identify the frequency of use of each ISTE Standard in both the standards for Educators and Students.

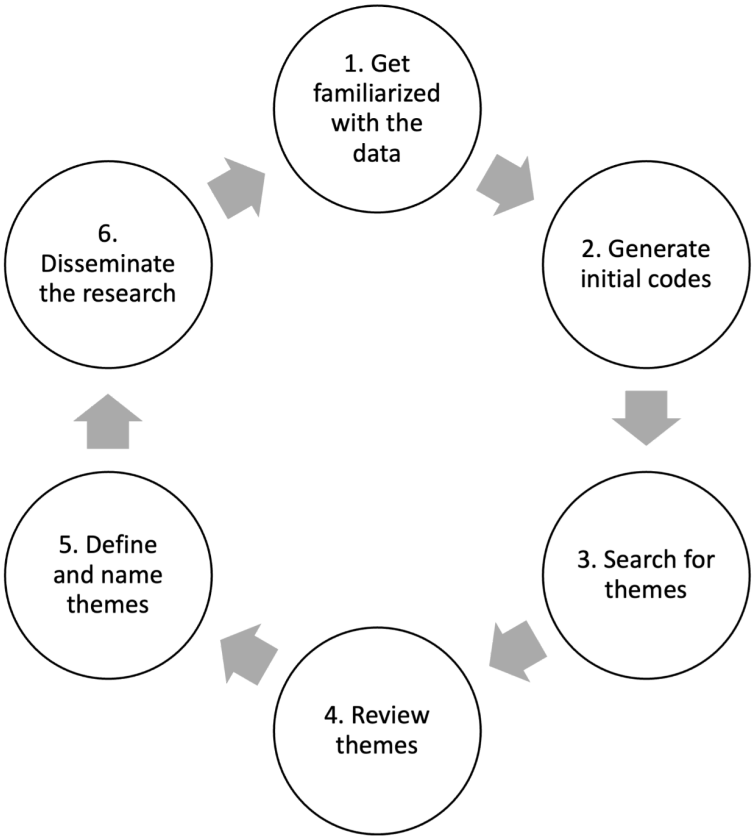


Figure 2. The six steps of thematic analysis (Kiger & Varpio, 2022)

Findings

The findings were analyzed using a thematic analysis and within each dataset. The following is a description of the themes which emerged within the student work samples and the college's educational syllabi. The overall themes are summarized in Table 1.

Table 1. Overall summary of the emerging themes.

Categories of Technology Use	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

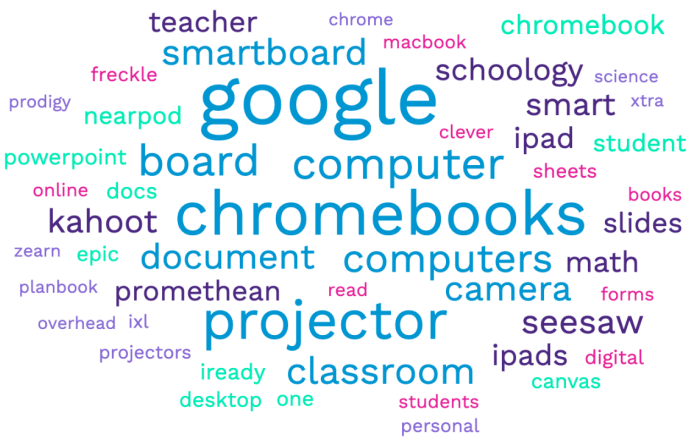
Student Teacher Work Samples

The student teacher work samples were analyzed for themes. Codes were applied to the technology used, alignment with the student and educator ISTE standards, and student descriptions of technology use. Data was extracted as supporting evidence. The codes were arranged into N themes.

Categories of Technology Use

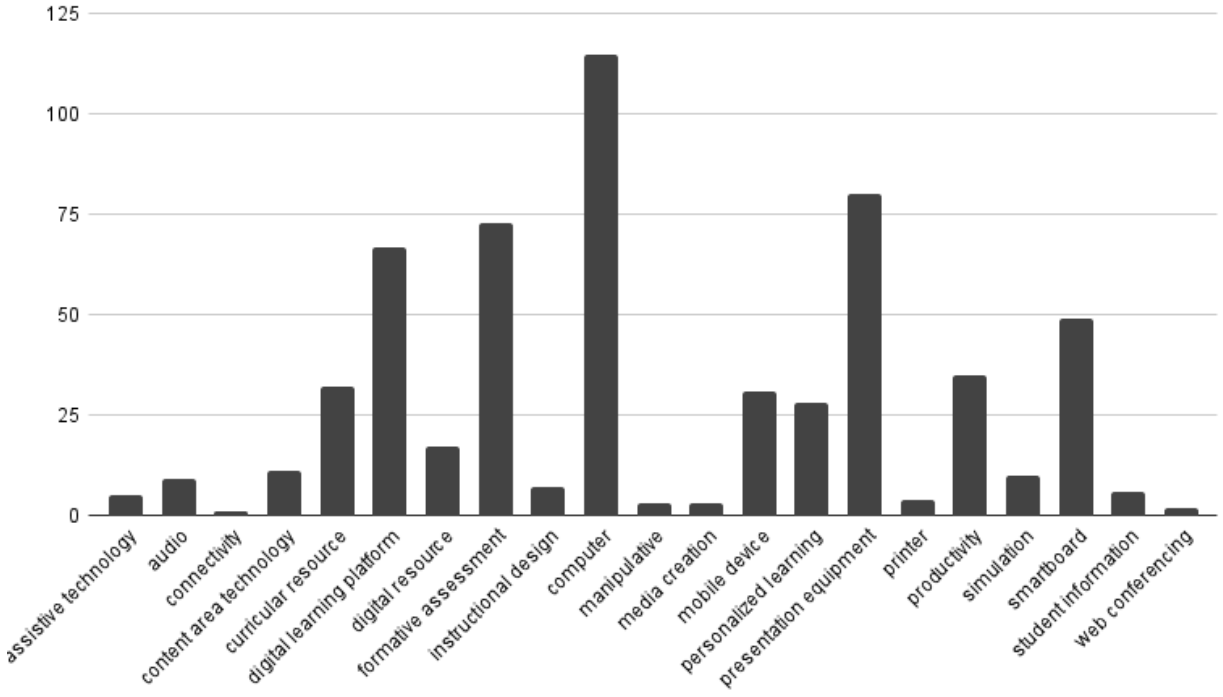
In the student teacher work sample, students document the technology that they used in a column called “Available Technology”. Some students documented one technology tool, and others documented up to ten technologies. These technologies ranged between the laptop used to project their lessons, to specific 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” (see Figure 3).

Figure 3. A word cloud of the natural language used by student teachers to describe the technology they used.



Due to the variation in technologies, researchers applied codes to the technologies listed by student teachers. These codes were inductive as new forms of technology were introduced on the work samples. Researchers ended up with 21 codes which described the type of technology used (see Figure 4). These codes were grouped into 9 themes of technology use: hardware, personalized learning, formative assessment, instructional design, digital resources, digital learning platforms, simulation, assistive technology and productivity. 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 included connectivity (n=1), web conferencing (n=2), media creation (n=3) and manipulatives (n=3).

Figure 4. Technology used during student teaching experience

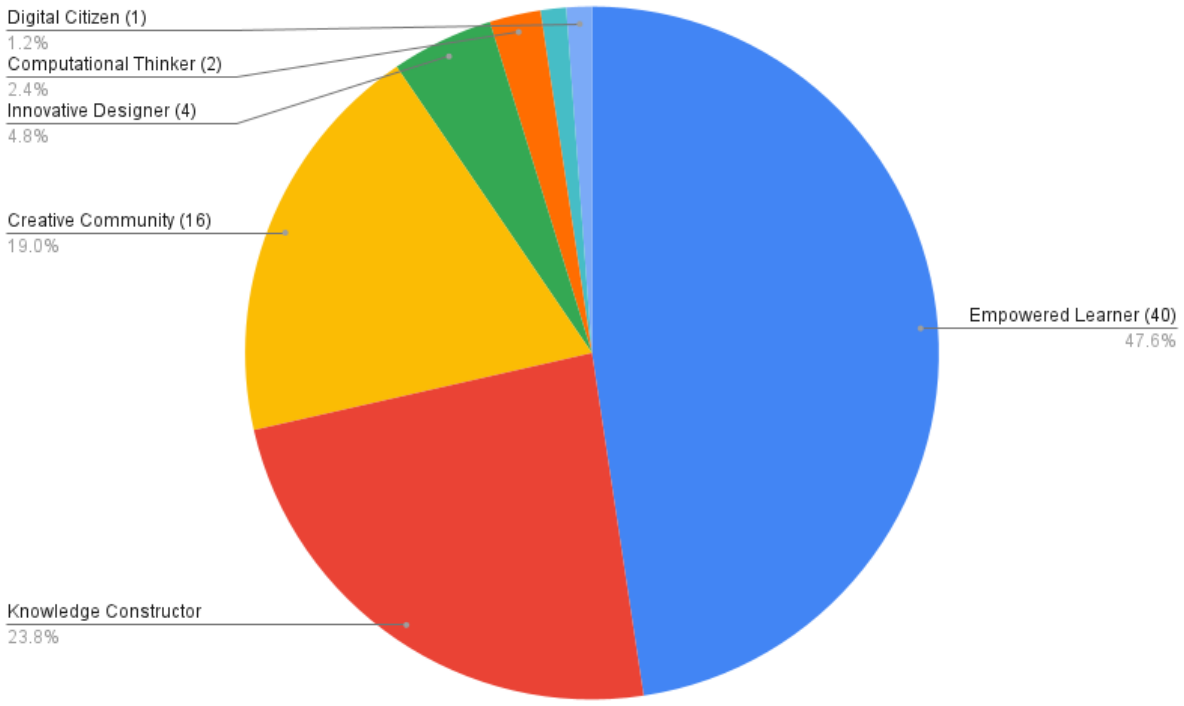


Use of Technology for Student Learning

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. Researchers coded the work samples (n=131) for alignment to the ISTE Standards for Students to identify areas in which the student teachers identified that they used the technology to support student learning.

Of the 588 instances of technology documented, researchers identified application of the ISTE Standards for Learning 82 times (14%) as evident within student teacher reflections. The distribution of the codes which included the ISTE Standards for Students included (see Figure 5).

Figure 5. Codes assigned to reflections on technology use for each of the ISTE Standards for Students.



Within the reflections written by pre-service teachers to explain their use of technology, three themes were found within the reflections which described using technology for learning: student empowerment, student engagement, and choice.

Theme 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. For example, one pre-service teacher who used Zearn (a math resource) 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 then 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 more clear 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 reflection aligned with the Knowledge Constructor standard, almost all referenced hardware they used with students, like iPads or Chromebooks.

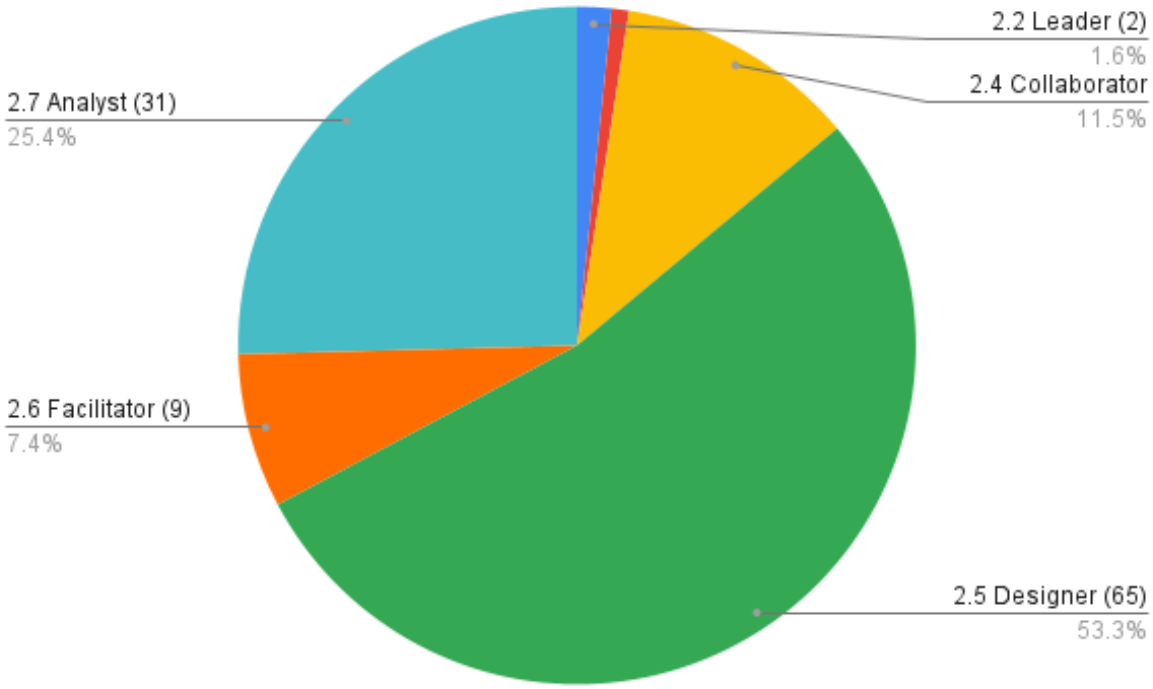
Theme 2: Student engagement. Regardless of the technology used, the pre-service teachers who referenced how technology was used for learning often described it within a frame of being engaging for students, even motivating them. For example, one pre-service teacher described their reason for using SeeSaw 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."

Theme 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."

Use of Technology for Teaching

Researchers also coded the work samples (n=131) for alignment to the ISTE Standards for Educators to identify 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 learning 126 times (21%) as evident within student teacher reflections (see Figure 6). The distribution of the codes applied found 2.5 Designer to be the most used (n=65) and 2.3 Citizen to be the least used (n=1). Other standards which were used minimally included 2.2 Leader (n=2) and 2.1 Learner (n=4).

Figure 6. Codes assigned to reflections on technology use for each of the ISTE Standards for Educators.



Within the reflections written by pre-service teachers to explain their use of technology, three themes were found within the reflections which described using technology for teaching: .

Theme 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 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."

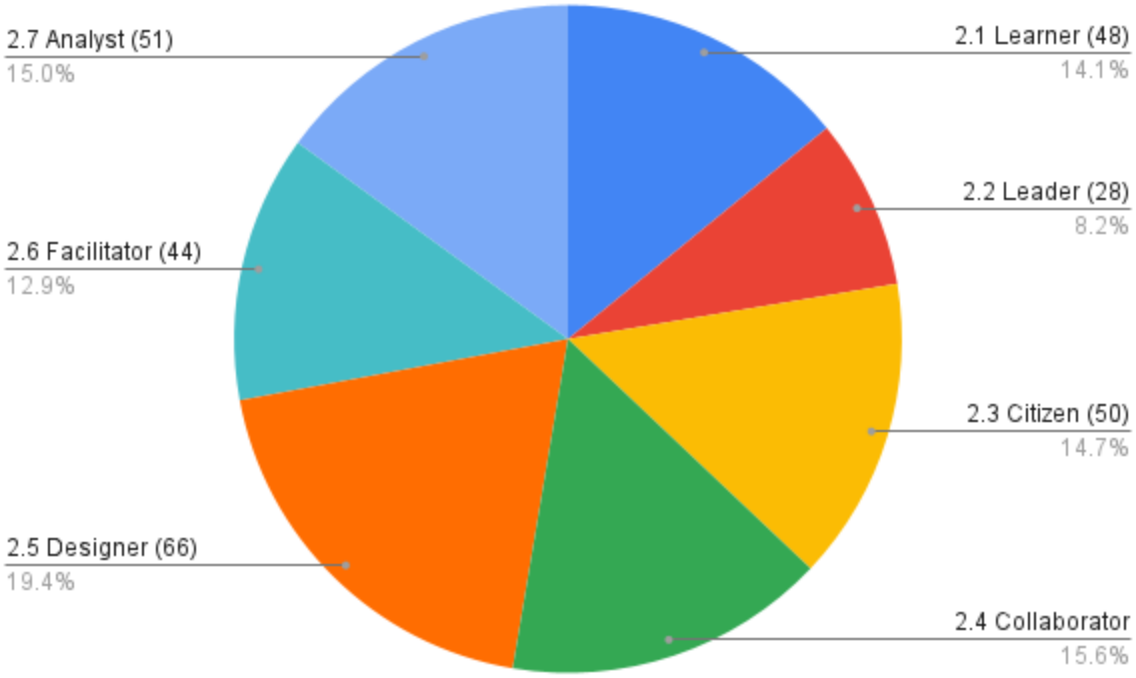
Theme 2: Confidence-building. In many cases, pre-service teachers reflected on how their use of technology helped them to feel more confident in their knowledge of teaching. Statements related to confidence were always aligned with what researchers classified as content-area technology. A pre-service 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."

Theme 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 also 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.

College of Education Syllabi

The final data set examined how technology was taught to the pre-service teachers using the ISTE Standards for alignment. This dataset examined the ISTE Standards for Educators taught across the full College of Education undergraduate curriculum as reported by faculty on their syllabi (n=113). There were a total of n=340 uses of the ISTE Standards for Educators, distributed across the seven standards, across all syllabi (see Figure 7). Some courses aligned with more than one standard.

Figure 7. The use of the ISTE Standards for Educators in College of Education syllabi



While Standard 2.5 Designer was used the most (n=66), the sub-standard 2.5a was specifically used 29 times: "Educators use technology to create, adapt and personalize learning experiences that foster independent learning and accommodate learner differences and needs." Standard 2.2 Leader was used the least as an overall standard, however substandard 2.6c in the Facilitator standard was used the very least of all standards, with only 8 courses using it: Students will create learning opportunities that challenge students to use a design process and computational thinking to innovate and solve problems."

Discussion

It is of great value for teacher educators to identify ways in which we can improve instruction of technology for pre-service teachers so that they are prepared to enter the classroom. 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 ISTE Standard 1.1: Empowered Learner (n=40), more than any other standard, and Standard 1.2 Digital Citizen the least of all the standards (n=1). The pre-service teachers described how they used technology for engagement but rarely described how technology was used for learning or to create equity in their classrooms. In addition, the pre-service teachers described 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 (Kimmons et al., 2020). 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 (Kimmons et al., 2020). For teacher

educators, this is an important finding: there is an opportunity in higher education to ensure that pre-services teachers learn how to use technology for transforming teaching practices so that students use technology in creative ways (Kimmons et al., 2020) as well as for access and equity.

While pre-service teachers described their technology use mostly from the perspective of the empowered learner, this finding contradicts with what was found in the syllabi from the courses in which the pre-service teachers completed prior to student teaching. Syllabi indicate that pre-service teachers are taught a variety of content from the ISTE Standards for Educators. This gap indicates that pre-service teachers had experienced technology instruction in their program, yet were unable to articulate how they implemented it. ISTE Standard 2.5a was taught the most (n=29) and ISTE Standard 2.6c was taught the least (n=8). With this information, the college can identify courses where Standard 2.6c may be taught more and in various courses.

Recommendations for Future Directions

Early recommendations include modifying the student 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). In addition, reflections on teaching with technology, and how it might empower students and educators, is being implemented.

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

We 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 us to identify which strategy is effective in improving the practice of pre-service teachers.

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