Toward More Meaningful Tech Integration: Supporting Preservice Teachers to Connect and Ideate

Cathleen Kim
Pacific Lutheran University

Mentor teacher technology practices are typically not considerations when identifying practicum placements for preservice candidates. Yet, these shape how new teachers use technology in their own future classrooms. Grappling with patterns in candidate gathered observational data (121 pre-service teachers over seven separate technology-focused courses), this study explored the perceived impact of a designed Thinking Tool and ideation process in lieu of practicum experiences revealing little to no modeling of student use of technology for in-process learning. Data were collected from the Thinking Tool and candidate reflections, and findings suggest a value add toward generating multiple innovative applications. Ideation resulted in moving beyond book-end use in instructional designs to creatively integrating technology to support student talk and sense-making, collaboration, and student organization, engagement, and content creation.

Keywords: teaching, technology integration, teacher preparation, innovation

INTRODUCTION

For over 20 years, effective technology integration has been a focus for schools due to strong evidence that it can support learning (Bransford, 2000; Hickey, Moore, & Pellegrino, 2001), increase academic performance (Hannafin & Forshay, 2008), and achieve valuable 21st century learning outcomes (Bereiter & Scardamalia, 2006; Kozma, 2003). Yet despite this, technology has not generally been taken up in a way that has changed instructional practices to result in student centered instruction deemed most effective (Bull et al., 2016; Herold, 2015; Reiser, 2002). While a result of the COVID-19 pandemic has been an increase in 1:1 devices in classrooms (Hankerson, et.al., 2021) and changes in the mode of instruction (e.g. virtual, hybrid, hyflex), it remains questionable to what degree this has also impacted instructional methodology, both in the instruction being delivered or the ways that the technology is being used.

The number one barrier to technology integration in schools has consistently been teacher beliefs (e.g., Kennedy, 2016), and this continues today (Wilichowski & Cobo, 2021) despite concerted effort on influencing those beliefs through professional development and the recognized need of technology to connect with students during the pandemic. Generally, we find that classroom teachers' use of technology in their everyday instruction is limited pedagogically to teacher-centered dissemination of information (Blikstad-Balas & Klette, 2020). Additionally, Nelson and Hawk (2019) found that while teacher beliefs directly predict intentions to use technology in meaningful, learner-focused ways, this execution only existed when preservice teachers saw technology frequently used by skilled teachers. This modeling traditionally happens in their practicum experiences where preservice teachers view it as essential in developing the skills they need as future teachers (Lokal, Woloshyn, Funk-Unrau, 2013; Maheady, Jabot, Rey, & Michielli-Pendl, 2007; Zeichner & Gore, 1990). These placements match teacher candidates with a more experienced teacher in the field based on grade level and content area interests, and typically do not consider mentor teacher technology practices. This can reinforce the status quo as a barrier to innovation since apprenticeship via practicum paves the way for the kinds of instruction (with and without technology) teacher candidates design and enact upon entering the profession (e.g., Doering, Hughes, Huffman, 2003; Goodnough, Osmond, Dibbon, Glassman, Stevens, 2009; Roberts, Benedict, Thomas, 2014; Tondeur, van Braak, Sang, Voogt, Fisser, and Ottenbreit-Leftwich, 2011).

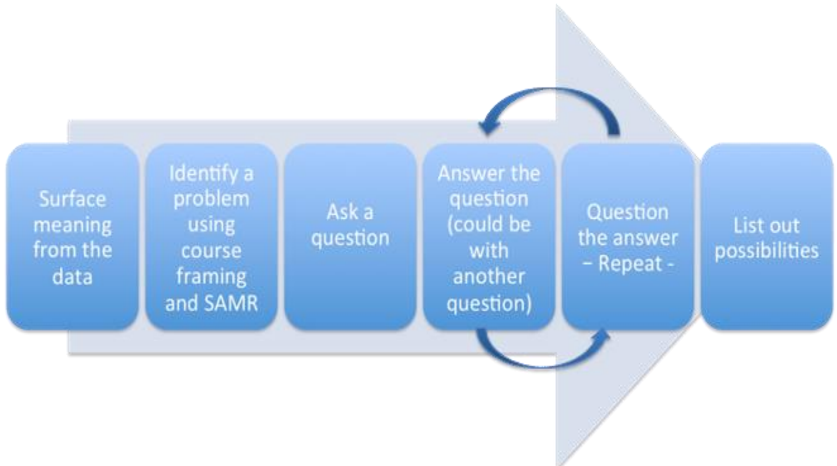
With this context, I asked two questions in order to map out and implement an intervention strategy. First, what are pre-service teacher candidates observing as modeled practice in the field? The Thinking Tool (Figure 1) was designed to support their identification of modeled practices and connect and extend what they were seeing in the field. The second question built on those identified practices in how those same candidates made sense of their observations to think more meaningfully about technology integration in their future classrooms. A structured ideation was designed to stretch thinking beyond those observations (Figure 2). Ultimately, if meaningful technology integration has not been effectively modeled or perhaps more importantly, if the ways to think like an innovative designer in the classroom have not been explored, it may be wishful thinking to expect one to reimagine practice beyond its current state or even look for opportunities to change practice. This would then accentuate [and perhaps has perpetuated] Anderson's 1962 sentiment reiterated by Tyack and Cuban (2003) that "Teachers have regularly used technologies to enhance their regular instruction but rarely to transform their teaching" (p. 122).

Seeking to move out of a reaffirming loop and build current teacher candidate's beliefs and ability to identify potential opportunities where technology can open up spaces to improve teaching and learning, led to the infusion of design thinking and ideation into teacher preparation - structured processes and terminology more typical in other fields. The next section briefly outlines the evolution of ideation.

FIGURE 1
THINKING TOOL TO GUIDE INITIAL CLASSROOM OBSERVATIONS AND BEGIN THE IDEATION PROCESS

What?	How Used?	By Whom?	Other Uses?

FIGURE 2
GENERAL FLOW OF THE IDEATION PROCESS



BACKGROUND

The concept of ideation is, in essence, creativity or creative thought in response to a problem statement and need analysis (Roth, 1973). Any problem has multiple solutions that may or may not meet the underlying actual need, so it is important to thoroughly understand and formulate the problem statement before designing possible solutions. Situated in the field of engineering, Roth saw the compiling of his design and creativity work important as a move toward uplifting an ignored *process* in a time where he felt the typical emphasis was on passive building of a knowledge-base. While he saw both as important for future engineers, he pushed for a more experiential education integrating life and learning "where a student must go out and do things for himself" (Roth, 1973, preface).

While this thinking of process, design, and ideation can be found in the spheres of business, engineering, and more recently, education, it can be implemented in any profession or discipline. In the field of engineering, the ideation (and resulting implementation) can be described as the engineer's efforts to meet the challenges faced by contemporary society and how that demand requires increasingly creative solutions that make better use of existing knowledge for present and future application (Hernandez et al, 2013). Ideation in business is typically associated with the R&D process, specifically when considering both the development and improvement of technology (Link, 2017). Addressing the fundamental processes to imagine and capitalize on the development of ideas can support innovation to fuel entrepreneurship (e.g., Graham & Bachman, 2004). Indeed, the nature of business necessitates the implementation of new products and ideas to meet revenue growth goals when competing against other entities with similar products to be first to market (Cooper & Edgett, 2008).

For educators, engineering design language has been part of K12 student learning for years, and is embedded in Next Generation Science Standards (NGSS) adopted by many states. In the pre-secondary, secondary and post-secondary camps, ideation is utilized to increase student proficiency in working creatively to generate insight and solutions, making and explaining knowledge driven decisions, and effective brainstorming (Adams & Crismond, 2012). Yet, while teachers are increasingly called to be data-driven professionals with continued emphasis on data and accountability in schools (e.g., Jerrim & Sims, 2022), it is less common for teachers to be involved in a structured ideation process based on that data as seen in business or engineering. What follows is the framing and description of the developed intervention for teachers, designed in this same spirit.

THE INTERVENTION

Framing

A blend of constructivist learning and socio-cultural theory guided the design of the Thinking Tool itself and the interactions teacher candidates had with each other around the Tool, supporting them to identify and build on their own experiences and observations in their classroom practicums. However, the foundation through which teacher candidates would contemplate what they observed while engaging in the Ideation Process are instructional technology and design concepts. The framing targeted two things: 1) student-centered instruction (Cuban, Kirkpatrick, & Peck, 2001; Herold, 2015) to aid "in-process learning" rather than being passive recipients, and 2) the Substitution, Augmentation, Modification, Redefinition (SAMR) Model (Puentedura, 2006).

In Process Learning

The concept I label as "in-process learning" presses candidates to critically think about technology use 1) by students (not just teachers) and 2) as more than presenting gathered information. For example, teacher trainings that still just focus on software use (McKenzie, 2001; Starr, 2012) often yield student tasks that use the internet for research and end with presentation software or word processing to report findings. I call this "book-end use". There is nothing inherently wrong with this sort of task (by students or teachers), but unless more strategically designed, book-end tasks are commonly repackaging or reproducing information rather than constructing knowledge. They also do not typically involve regular and consistent use of technology embedded throughout a lesson or unit of study *to learn* (i.e., "in-process") in ways that encourage students to individually or collectively do things like organize, visualize, discuss, analyze, synthesize, evaluate, document processes, and reflect. Therefore, the learning process is rarely transformed, as called for by the International Society for Technology in Education (ISTE, 2018). Indeed, numerous references to the idea of innovation in technology-based teaching are visible in technology standards and frameworks. Examples:

- Innovative designer, innovative learning environments, innovative educators, innovative solutions (ISTE)
- Innovative tools, innovative and good practices, for innovative thinking (Connected Learning, Ito et al. 2013)
- Innovative and integrated use, innovative tools (TPACK, Mishra & Koehler, 2006).

SAMR

Introducing SAMR, a common model referenced in K12 settings, served to bridge preservice to professional work. It provides a concrete visual in progressive levels to think about more meaningful uses for any technology adoption. The most basic level is **S**ubstitution, where technology used provides minimal added value but serves as a replacement of current practices. An example is having students read a story, text, or article via a digital device rather than on paper, turning pages in a handheld story book. While still a form of substitution, the next level, **A**ugmentation, results in functional improvement. In this case, that same digital storybook or text might also have additional ways to interact with the reading (e.g. various note taking tools, annotation, embedded threaded discussion). These two levels are considered enhancing opportunities. The next two levels are **M**odification and **R**edefinition, both described as transformative. Modification facilitates a significant task redesign as in students using technology to gather analyses about the reading and create visualizations to evaluate effectiveness on multiple criteria. Generally, the first three levels focus more on student consumption, but the aim is for Redefinition. The top level seeks to "redefine," where the use of technology allows for the creation of new tasks and modes of learning previously unimagined.

Process

Two stages: 1) Noticing and 2) Data Analysis with Discussion set the stage for Ideation. Candidates started by completing initial observations of existing practices using the Thinking Tool (Figure 1). This was designed as an open activity geared at identifying what they noticed as classroom-based technology and purposefully did not funnel toward specific devices, apps, software or tools. Candidates noted the technology they saw, who was using it, and the ways it was being used. They were also given an optional column to begin to consider additional uses, although this was rarely used. Once candidates completed their initial observations, data was compiled (Table 1) and presented for whole group analysis and focused discussion. Next, meaning surfaced from the data and discussion became the first step of the Ideation process, a small group process that pushed them to imagine how the technology *could be used* in innovative and more meaningful ways. The general flow of the ideation process is Figure 2 with details elaborated on in Figure 3. As candidates went through the Ideation process, they could choose to try their hand at either or both of two pathways using the green chart or purple chart as a guide (Figure 4). While the end goal is to support more meaningful integration and access agile thinking to "seeing what one hasn't seen" concretely modeled in practicum settings, the starting points are different. The green chart starts with what we have to work with (typically tools, apps, and software approved and purchased by the school or district) and the purple starts with what we want students to know and be able to do.

Overall, the ideation process used set the stage for capitalizing on the intangible assets of ideas to step beyond looking only at what currently exists to reimagine what is possible and arriving at concrete applications (Graham & Bachman, 2004). Taken together, the design of the Tool and the collaborative ideation provided a way to connect and extend the modeling of practice (or lack of modeling) candidates were encountering in their placements.

TABLE 1
DESCRIPTIVE ANALYTICS FROM CANDIDATE CLASSROOM OBSERVATIONS OF TECHNOLOGY USE

Technology	Use	References
Doc Cam	Model procedures; present information	Teachers = 79 Students = 2
Smartboards, whiteboards, TV, Apple TV	Present information	Teachers = 73 Students = 3
Projector and computer	Model procedures; present information	Teachers = 70 Students = 1 (show class the pictures of a story he was reading)
Other devices (teachers)	Professional tasks (grading, attendance, student data)	Teachers = 54 Students = 1 (inputting grades)
Dedicated student devices [laptops, COW carts (computers on wheels), computer lab, iPads]	Testing, skill review, reading, games, free-time	Students = 101
Other applications (students)	Google docs for collaboration, taking pictures of physical classroom anchor charts, video editing/stop motion video, touchpad letter formation, and coding	Students = 12

FIGURE 3
IDEATION PROCESS DETAILS

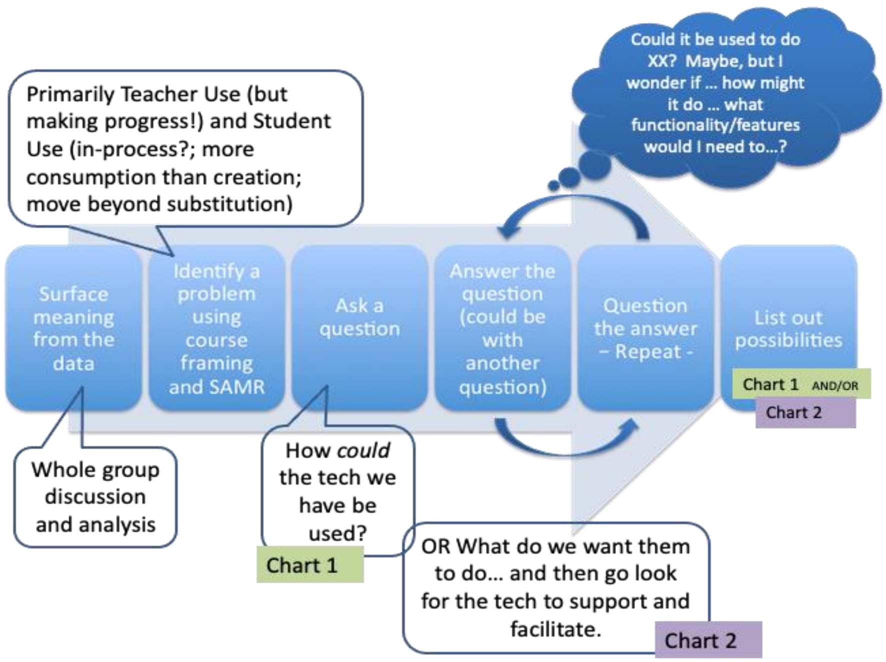
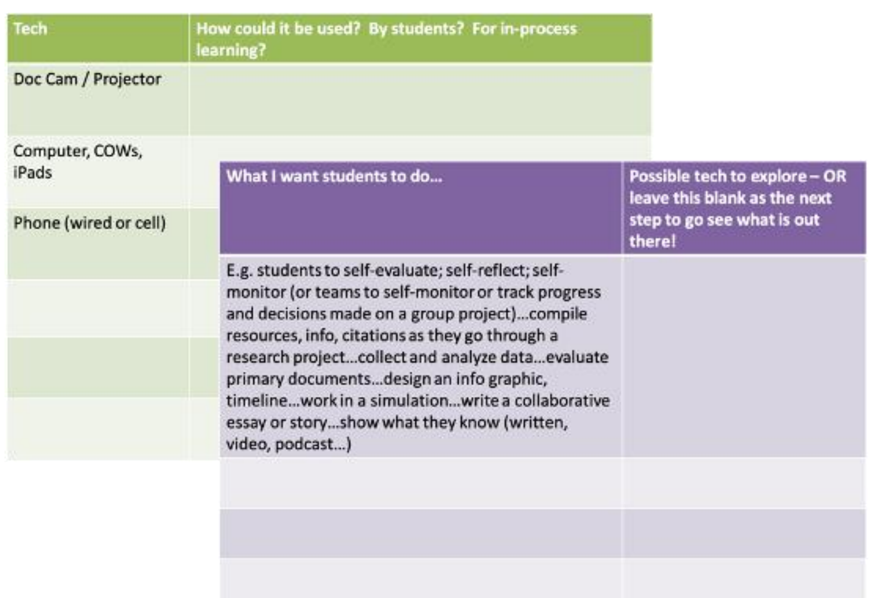


FIGURE 4
STARTING WITH WHAT ONE HAS (GREEN)
STARTING WITH WHAT ONE WANTS (PURPLE)



METHODS AND DATA SOURCES

Descriptive analytics (from the part of the Thinking Tool where candidates identified the technology they were seeing and how it was used), enhanced an understanding of the kinds of modeling seen in their practicum experiences. Each class was analyzed and coded separately, and all classes were also examined holistically. Qualitative methods added insight into the meaning candidates gave to the data, their new applications of existing technology, and their thoughts on the ideation process. This included the applications they articulated, the rationales for the design of their integration ideas, and the issues that arose as they worked through the ideation process. An inductive examination of topics and themes was grounded in the data to illustrate a range of implications. Patton (2002) describes this as a “sense-making effort that takes a volume of qualitative material and attempts to identify core consistencies and meanings” (p. 453).

While data collection is ongoing, what is analyzed here includes the designed Thinking Tool collected from candidates in seven masters and undergraduate level teacher preparation technology classes over the course of two years (2018-2020) with the ideation intervention and associated process reflections added in 2020. Each course lasted 15 weeks. Total number of candidates involved was 121, with classes ranging from 8 to 25. Participants included combined classes of elementary and secondary preservice teacher candidates who were not separated out into separate courses by grade level or content area as dictated by the existing structure of their preparation program.

RESULTS AND DISCUSSION

Drawing meaning from the Thinking Tool and the ideation process reflections revealed the following tentative insights into preservice teacher candidates’ practicum tech-integration experiences and their thoughts regarding the ideation process to push their thinking. Through using the Tool individually and collaboratively, many were surprised to find such an extreme difference between the amount of teacher use compared to student use. When they started to purposefully look for student use, they realized that teachers were the primary creators (mostly just for presentation), and students, even with dedicated devices, were recipients of information, using technology mostly for testing and skill review. Some of the findings are highlighted below:

Use of Technology: (Table 1)

- Teachers, as the primary users, presented material.
- Students used devices for testing, skill review, reading, and games.
- Student assignments were almost entirely word processing and presentations (Word, PowerPoint, Google Docs just for writing, Google Slides). A few references were made to using these tools collaboratively. This theme existed even for 1:1 device schools.
- Little student use was mentioned – a few references to calculators, personal devices to listen to music or use for polling in class, and even a mention of an electric pencil sharpener.

While candidates seemed surprised at varying levels of the disconnect between the ways teachers and students were using technology, a common insight encompassed the idea that “I thought it was meaningful to think about how much I create versus how much students create when it comes to tech use.” As they reflected, they shared how the activities in their practicum settings were often repackaging information as described below:

> At the moment in my classroom, students are working on PowerPoints to showcase research topics about the early 1900s, an assignment designed by my mentor teacher to help contextualized the time period of this week’s short story.

Candidates explained that the data spoke clearly as it “…highlighted the need to have students be doing the sense-making and creation with the tech. It really highlighted in-process use over bookends.” Realizing this (from collective data and reflection on practicum experiences) is the first step toward seeing a need to think about possibilities “…that tech can involve your students more than just involving you.” Another candidate stated that technology “…is not an extra; it is an integrated element of learning. I keep coming back to how we can have students BUILD in technology rather than just mindlessly consume it.”

As candidates came together to discuss their findings along with other classes' data, they explained that they were able to use the framing and the ideation process to help each other get "unstuck". This typically meant a common initial reaction summarized by one candidate as "I don't know how else I might use it than what my teacher does" was supported by collaborative efforts to challenge those initial statements. Using the framing of student use and in-process learning (and underlying social theories of learning), candidates came up with a number of targeted applications they would later flush out more in lesson planning. These were more powerful because candidates generated the ideas rather than passively receiving a list of good practices.

Ideation Results

- **Supporting student talk**: doc cams to show work in process for peer feedback and to facilitate whole group discussion, blog posts, comparing work and problem-solving strategies to make thinking more visible and public. Increasing this seemed to support multiple other ideas expanding collaboration.
- **Collaboration**: students sharing files and interactive writing, sharing work with classrooms and students in other geographical locations, use of digital collaboration spaces to work together, synthesizing resources and group note taking, peer tutoring, documenting the decision-making processes within group projects.
- **Individual student organization**: planning calendars and task management, monitoring and graphing progress, supporting students to self-monitor.
- **Supporting student engagement**: Increased use of teacher tools as well as teaching students to use and set these up for themselves to review and learn material: e.g., Quizlet, Kahoot.
- **Variation in content creation**: students creating more evidence of learning through audio/visual, music, videos, use of webcam or phone.

While there were numerous references to ideas that were new to them (demonstrating they were pushing on ideas) many were still firmly rooted in substitution. While the iterative questioning cycle in Figure 3 produced significant conversation that candidates found valuable (extending their ideas around application), the green chart focused on what to do with the tech as a tool-forward and tool-directed thinking. For example, having students present information via technology was the highest affordance mentioned (35 references; the second highest was collaboration at 29 with knowledge construction as the lowest at 8). A new-to-many-of-them idea was:

> …my group brainstormed that doc cams can be used by students to share their work or even teach something to their peers. This could potentially be engaging for students not only because of the material, but also because of the sheer excitement of sitting in the teachers chair at the front of the classroom and being able to "be the teacher" for an allotted amount of time.

This type of comment demonstrates substituting technology in ways that may have been innovative when presentation tools first found their way into classrooms in the 1990s. Yet perhaps even this is still not common as another candidate stated, "I haven't seen students present any of their own work via technology and we're still doing almost all of our activities and assignments on paper." Yet, the move was in the right direction in brainstorming ways technology could facilitate students talking more about ideas (27 comments on collaboration) rather than just presenting gathered information. Representative of those are the following two quotes:

> …having students use the doc cam to share their work or come up to do sample problems, to show their classmates how they may have found an answer or explain their thinking.

> Shared document programs like Jamboard enforce the need for discussion and compromise among peers, as well as facilitating the opportunity for students to develop their own teaching/instruction abilities.

Still, candidates recognized that there was room to grow. One candidate rationalized:

> …it is a lot easier to brainstorm things on the "lower level" of SAMR. Take my groups doc cam sharing example, this is a great idea and could be helpful in classrooms to improve student engagement, but no new ideas are being invented. It is definitely not a revolution to have student-led discussions or have classmates share their work with each other, but that does not mean that this experience is invaluable. It is incredibly challenging to think outside the box and come up with new innovative ways to integrate technology into the classroom…

For the process itself, the struggle to reach beyond modeled practice and how to start imagining what we don't know was initially frustrating. Candidate comments resulted in a variety of themes.

Ideation Process

- Forced going back to the framing, SAMR, and paying attention to technology standards (state standards and ISTE).
- Encouraged the asking of questions and thinking "outside of the box for ways students can use tech on a regular basis to help them learn."
- Learned much from the interaction with peers. Many candidates commented that they relied on building off of each other's thoughts, "I couldn't have done this alone; we were better as a group."
- Forced deeper thinking. A number of candidates mentioned that while they really wanted me to give them answers, they recognized that part of the ideation process was to get them to use the Tool and framing to ask, question, and ponder to think more deeply together.

The process was generally deemed a positive use of time, summarized by the sentiments from the following two candidates:

> The Ideation activity was really wonderful. Both graphic organizers pushed my thinking about how to integrate tech that helps student understanding and agency. I also found SAMR to be a useful thing to discuss because prior to taking this course I didn't understand the ways in which tech can be utterly passive versus a means to engage in ways that without the tech may be impossible.
>
> IN-PROCESS tech use. Jumping up the SAMR ladder. These things give me a good lens to filter my tech ideas through before investing too much time in design.

But the work doesn't stop here. While perhaps the more practical place to start ideating, groups that began with the green chart, pondering other ways to use existing classroom hardware, software, apps, data, etc. expressed ideas closely aligned to what they were already seeing in classrooms. Starting with the purple chart, what we want kids to do, led to more direct problem-solving approaches to push on existing options as well as questioning the existence of other tools that would support their new pedagogically driven designs (student use; in-process learning). It opened up more space on how technology could shift those goals but left candidates recognizing they needed time to explore more. One candidate stated, "It has allowed me to see tech as a way of exploring new things rather than just using it in daily teaching and life."

Overall, the initial observation and ideation process with the thinking tool laid a foundation that expanded and directed the purposes for their new-tool exploration. This impacted the way many thought about intentionally designing lessons - what to focus on in terms of technology and teaching practices to meet student needs. In the words of another candidate:

> I think that as teachers we consistently adopt what we have seen work for others, or we are told what the most effective strategies and practices are. We are not nearly as innovative as we should be, and think that this task highlighted that for me. This challenges me to consider innovative strategies and practices that are specifically tailored to my environment and my students, rather than only implementing strategies and practices that I have picked up from others. This is not to say that evidence-based practices shouldn't widely adopted, but I think that they need to be tailored to specific environments and students, and teachers should not become content with these practices alone, but should be in a constant process of innovation, because the world around us is.

IMPLICATIONS AND RECOMMENDATIONS

This study contributes to our understanding of the experiences preservice teacher candidates may be exposed to in the field with regard to technology integration. Driven by current research that implies that we are still not hitting the mark (Blikstad-Balas & Klette, 2020), it helps connect our thinking to the potential role of technology specific modeling in their practicum settings. Wideen, Mayer-Smith, and Moon (1998), in a review of 97 studies of general teacher education programs found that preservice teachers need high-quality modeling because their beliefs are shaped by what they see and are told. They consider their practicum as "…an opportunity for practicing and gaining experience" (156), verifying in many cases the practices they should be using. If candidates are mainly seeing technology used by teachers for direct instruction or rarely seeing it used by students for in-process learning, then perhaps the designed Thinking Tool and ideation process provides a possible path toward more meaningful technology integration – increasing awareness and supporting preservice teachers to stretch to redefinition and innovative thinking, reimagining what is possible. Encouraging circling back and continual questioning so that candidates start doing this for themselves is part of an ideation process. As one student said about ideation, "[You] Always answered our questions with a question. By doing this, it allowed us to expand our thinking and not be stuck in a fixed mindset." As students are primarily consumers, changing this also means impacting how teachers themselves come to see their own relationship with technology.

The COVID pandemic certainly required many educators to immediately pivot and rethink technology and teaching and learning. Ongoing observational data from candidates suggests that while there was an uptick in apps used by teachers in 2020, this has since dwindled back to pre-COVID levels with technology still used fairly exclusively by teachers with students interfacing with technology only superficially. If the rise of identified apps during COVID is an indicator, we may be getting better with teacher creation although it is yet to be determined how much of that continues with many school districts having returned to fully in-person learning. Not a single current candidate describes what they are now seeing in schools as "tech forward". Has it become so common place that we don't notice it anymore? Or, if not, what does persist and how is it being conceptualized and used? Tentative reporting by candidates indicates that technology use continues in classrooms as many schools adopted 1:1 models, but primarily in limited ways to "maintain things" such as students submitting assignments and fun "distractions" and teachers using email, grading, and sending out information.

Recent studies have looked at impacts of COVID in education and technology from a teacher perception perspective and self-reported data (e.g., An, Kaplan-Rakowski, Yang, Conan, Kinard, & Daughrity, 2021; Ikpeze & Schultz, 2021). Rare during this time are the actual methods teachers used *with* technology analyzed in combination with those perspectives. Since teacher beliefs so strongly impact use, and COVID forced this unexpectedly on many, it is still unclear if this was a welcomed thing or not. Specifically looking at the COVID impact to actual instructional practices beyond just visible technology apps and devices would be beneficial in the wholistic claims made around the affordances and constraints of technology in our schools. For example, if a teacher did not see value in integrating technology prior, how did COVID and the unprecedented switch to remote instruction facilitated by technology impact not only teacher perception but the *actual* practices implemented and therefore the learning that occurred or did not occur during this time? Were those practices meaningful use, forwarding 21st century skills and flexible thinking so students can adapt to current and future environments or did they lead to increased direct instruction through a screen?

Ultimately, a path toward more meaningful technology integration could include critical reflection and strategic ideation to shift practice beyond substitution. For new teachers entering the profession, the process suggests that imagining how technology can transform instruction without it being consistently modeled involves recognizing when practices are replication overlayed with technology and being willing to explore opportunities for design so students use tools to actively construct their own learning.

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