Preservice Teachers' Use of the Technology Integration Planning Cycle: Lessons Learned

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── **Abstract** ──

Preservice teachers (PSTs) often feel unprepared to utilize digital tools in meaningful ways that support learning in the elementary classroom. It is imperative that teacher preparation programs provide support in this area so that children can learn to use digital tools to communicate in the 21st century. Previous research suggests that the Technology Integration Planning Cycle (TIPC) can support teachers in making wise decisions related to the use of digital tools to support a literacy goal. In the present study, the authors examined how the TIPC can be used with PSTs as they develop technological, pedagogical, and content knowledge and design literacy lessons that integrate a digital tool. Design-based research was used to frame their inquiry across three iterations and make formative decisions based on the ongoing collection and analysis of data. Results of this study demonstrate that with significant scaffolding the TIPC can support PSTs in designing meaningful literacy lessons. In addition, evidence collected over time suggests that PSTs engage with the TIPC in a recursive rather than linear manner.

Keywords*: literacy, preservice teachers, technology integration, design-based research*

It is imperative that children learn to use digital and nondigital tools to communicate in the 21st century. This has perhaps become even more imperative as many educators have transitioned to distance learning due to the COVID-19 pandemic. That is, distance learning has shifted much of the communication of teaching and learning into a digital space that requires the effective use of digital tools. The increased reliance on technology during the pandemic has made it even more evident that "literacy instruction should prepare students today to produce, communicate, interpret, and socialize with peers, adults, and the broader world" (International Literacy Association, 2018, p. 2). However, preservice teachers (PSTs) often feel unprepared to integrate technology in meaningful ways (Instefjord & Munthe, 2015), and preparing them to do so is a complex process (Tondeur et al., 2011). Thus, it is critical that faculty in teacher education programs support PSTs to integrate technology into their instruction. However, most teacher education institutions find this to be a challenge (Polly et al., 2010).

Previous research suggests there is merit in using the Technology Integration Planning Cycle (TIPC) with PSTs (i.e., Bergeson & Beschorner, 2018; Beschorner & Kruse, 2016; Hutchison & Colwell, 2015). The TIPC is a reflective planning cycle that PSTs can use to support their decision making as they plan literacy instruction that considers the integration of digital technologies. However, the cycle was originally designed for in-service teachers, and existing scholarship has asserted that significant support and scaffolding are necessary when utilizing the cycle with PSTs (Bergeson & Beschorner, 2018; Beschorner & Kruse, 2016; Hutchison & Colwell, 2015). The present study adds to existing literature by describing the type of support that can be provided as PSTs use the TIPC in their coursework. The question guiding the research was: How can the TIPC be used to support PSTs as they use their developing technological, pedagogical, and content knowledge to design meaningful literacy lessons that integrate a digital tool(s)?

TPACK and the TIPC

The present study was informed by two related frameworks. The technological, pedagogical, content knowledge (TPACK) framework was foundational (Koehler & Mishra, 2009). TPACK explains that teachers use overlapping types of knowledge (e.g., pedagogical content knowledge, technological pedagogical knowledge) as they make decisions about their instruction (Mishra et al., 2013). For example, teachers use pedagogical content knowledge when they determine how best to teach specific content based on what they know about teaching and their content. Further, they use technological pedagogical content knowledge when they use what they know about the affordances and constraints of specific digital tools and technology in addition to their knowledge about how to best teach specific content.

TPACK builds on Shulman's (1986) construct of pedagogical content knowledge, which explains that teachers use their knowledge of pedagogy and their content expertise to make instructionally sound decisions in their given context. However, Shulman's pedagogical content knowledge framework did not explicitly address technology and "did not explain how teachers use technology's potential to transform content and pedagogy for learners" (Angeli et al., 2016, p. 13). Therefore, the addition of technological knowledge generated TPACK (Mishra & Koehler, 2006). Taken together, TPACK is "the interdependent, situated knowledge that is needed to integrate the use of digital tools and resources effectively" (Harris et al., 2017, p. 2). The idea of interdependent knowledge that is used when teachers integrate digital tools and resources effectively was particularly important to the present study, because PSTs were learning to make instructional planning decisions that considered the use of digital tools. For example, it was necessary for PSTs to use what they were learning about literacy content and pedagogy while also considering affordances and constraints of different digital tools to meet their literacy goals.

The TIPC, which was informed by TPACK, was also a foundation for the study (see Figure 1).
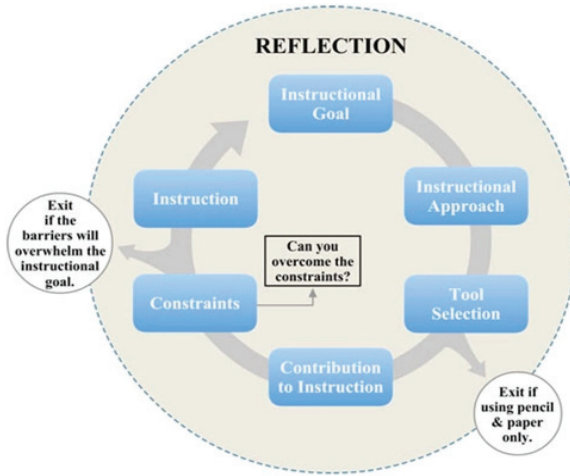
Figure 1. *The Technology Integration Planning Cycle (Hutchinson & Woodward, 2014).*

The TIPC is "aimed at helping literacy teachers consider whether their planned instruction contributes to both digital and nondigital literacy development" (Hutchison & Woodward, 2014, p. 458) and includes seven elements: (1) determining an instructional goal, (2) determining an instructional approach, (3) selecting a digital tool (or exiting the cycle), (4) determining the contribution of the digital tool to the instruction, (5) determining the potential of constraints, (6) identifying instructional considerations, and (7) reflection. The cycle was initially created for practicing teachers, but previous research suggested that it can be used effectively with PSTs as long as modeling, guided practice, and support for independent practice are provided (Bergeson & Beschorner, 2018; Beschorner & Kruse, 2016; Hutchison & Colwell, 2015).

Methods

Design-based research seeks solutions to practical problems in education through iterative cycles of design and analysis in authentic contexts for learning (McKenney & Reeves, 2012; Reinking & Bradley, 2008). We used design-based research to frame our inquiry with the goal of advancing both theory and practice related to the use of the TPIC in preservice teacher education. Design-based research was well suited for our project because our aim was to study learning in the naturalistic setting of PST literacy coursework. On a local level, we aimed to support PSTs' ability to plan instruction that utilized digital technology in meaningful ways while maintaining focus on the literacy goal. In addition, we aimed to support practitioners at universities in considering approaches for teaching about technology integration in literacy education. Further, our study aimed to advance theory by putting the TIPC to practice in preservice courses.

This study encompassed three iterations of educational design across three years of literacy coursework with three separate groups of PSTs. For each iteration, one of the researchers was the professor for the course, and the other researcher collaborated on the educational design and data collection and analysis. In this way, both of us worked collaboratively across this project, alternating between the professor and researcher roles, to make formative instructional decisions about the use of the TIPC in preservice teacher coursework. The iterative nature of this project allowed us to revise our educational design across time, and when similar findings were present across all three iterations, we were

able to consider whether these data pointed to more than a local interaction with our design (Cobb et al., 2003; Hoadley, 2004). In the first iteration, PSTs read and discussed Hutchinson and Woodward's (2014) article "A Planning Cycle for Integrating Digital Technology Into Literacy Instruction," learned about digital tools, and designed lessons that integrated digital tools to support a literacy goal. In the second iteration, the instructor increased modeling and scaffolding for each step in the TIPC. And in the third iteration, the instructor refined instruction to support deeper understandings and help PSTs stay focused on the literacy goal.

Data Sources

In the first iteration, we collected 10 PSTs' lesson plans, video recordings of PSTs' lessons, audio recordings of a midterm conference with the instructor, and a final reflection paper and written reflections to analyze how PSTs used technology in their literacy instruction. In the second iteration, we collected 27 PSTs' pre- and post-assessments of knowledge related to technology integration before and after instruction (Appendix A). In addition, the lesson plans that these 27 PSTs developed as part of their coursework, and their written reflections across the study, were sources of data (224 pages total). In the third iteration, we collected the lesson plans and written reflections that 13 PSTs developed as part of their coursework. In addition, verbal protocol reports (Ericcson & Simon, 1994) from two PSTs allowed us to hear PSTs' thinking while planning their lesson. For the verbal protocol reports, PSTs used the digital tool Kaltura Capture to capture audio and video while planning their lesson. In these verbal protocol reports, the PSTs paused to share and record their thinking throughout their planning and specifically for each step of the TIPC. We asked PSTs to record their thinking based on an open-ended prompt: "What are you thinking?" This prompt makes visible the current thoughts and processes of PSTs by activating short-term memory (Ericsson & Simon, 1993; Millis et al., 2006). These verbal reports resulted in 66 minutes of think-aloud statements, which were then transcribed and included as data.

Participants

All PSTs in three literacy courses were invited to participate in this study. A majority of them accepted the invitation and were then included in this study. The PSTs in the first iteration of our study (*n* = 10) were undergraduate and graduate students taking the course "Literacy Assessment and Instruction II" at a private university in the midwestern United States. The PSTs in the second iteration (*n* = 27) and the third iteration (*n* = 13) were undergraduate students at a different public university in the Midwest. They were all in their junior year of college and were taking the course "Literacy Methods for the Intermediate Classroom." Approximately 20% of PSTs identified as students of color, 80% identified as White, and 10% were multilingual. In all three iterations, the literacy coursework in this study was required for licensure. All of the participants had taken at least one literacy course prior to this study, and all participants had at least some experience in practicum. During each iteration, one of us was the instructor for the course and the other collaborated on the research and educational design and analysis.

Data Analysis

We analyzed data after each iteration using inductive analysis (Miles, Huberman & Saldana, 2014). We took notes on artifacts, wrote memos of initial thoughts, established tentative themes, and reread data to verify evidence of themes (Saldaña, 2015). Tentative themes included concepts, ideas, and actions such as uncertainty about decisions related

to the connection between the literacy goal and digital tools that were being considered, lack of pedagogical technological knowledge, and evidence of meaningful reflection about planning and enacting instruction. Throughout our study, we met regularly to discuss our analysis, identify similarities in our memos and themes, and discuss differences until consensus was achieved. Based on the analysis of data after each iteration, we made formative decisions to guide instruction and improve the design of future iterations.

Using the TIPC With PSTs

The findings from each of the three iterations of the study are described in the following section.

Iteration 1: Increasing Preservice Teachers' Understanding of Digital Tools That Could Be Used for Literacy Goals

During the first iteration, in the course "Literacy Assessment and Instruction II," 10 PSTs planned, implemented, and evaluated weekly lessons that they taught to a child in first through fifth grade. While reviewing lesson plans each week, the instructor noticed that lessons planned by PSTs rarely included digital tools. In an effort to support PSTs in using digital tools during their lessons, the instructor provided the PSTs with Hutchinson and Woodward's (2014) article describing the TIPC. PSTs read this article as part of their homework, and during the next two classes they discussed this article in class and began planning lessons that followed the TIPC framework. Also, in response to PST requests, the instructor for the course provided weekly examples of digital tools, such as Drawing Pad, Storybird, and Storykit, that could be used in elementary classrooms for literacy learning. Results of the first iteration (see Beschorner & Kruse, 2016), indicated the following themes related to planning instruction that integrates technology.

Conscious planning. PSTs were able to write lesson plans that suggested thoughtful planning. Kathryn, a PST, explained, "I think that the cycle helped us to think through each piece [of instruction] and helped us to carefully select what we wanted to do with our students." Further, several PSTs indicated that they were making conscious decisions at multiple points in the lesson planning process. For example, Jenna stated, "As I planned lessons for Jasmine, I thought a lot about tool selection.... After thinking hard about this step of the planning cycle, I realized Jasmine could do the same things and achieve the same goals without the technologies."

However, PSTs often reported feeling uncertain about the decisions that they made as they reflected on their instruction. Alexandra explained this feeling: "I don't know that they [the digital tools that she used] necessarily enhanced my instruction or helped Casey [the student] meet the instructional goals any more effectively." Similarly, Lauren reported,

> I don't know if the laptop was all that useful.... Although Korey [the student] was fired up about using it, he is a very slow typer. I think he needs to work on this, but I do not think that tutoring is necessarily the best time.

This suggests that although PSTs were thoughtful about their planning and used the TIPC to think about their instruction in ways that considered digital technology, they were not always confident in their decisions as they reflected on the instruction that they provided. Yet the TIPC did allow PSTs to consider their emerging understandings of the affordances and constraints of specific digital tools that may not have been examined without the use of the TIPC as a scaffold.

Making decisions about digital technology. These 10 PSTs indicated that they were interested in integrating digital technology into their instruction. Yet they reported rarely having knowledge about digital tools that might help them meet their literacy goals. PSTs had taken a course related to educational technology and had been introduced to digital tools in the course, but it did not seem to be enough knowledge to plan for literacy instruction. Heather indicated that she was

> currently unaware of ways to integrate technology for students on both an individual and group level. I search a lot and get frustrated trying to find apps or ideas to use technology, so instead I use traditional resources and methods.

Similarly, Alexandra stated that she only incorporated technologies that she was aware of. Therefore, the PSTs requested lists of digital tools, and the instructor presented digital tools each week.

The results of the first iteration suggested that the TIPC supported PSTs to make conscious decisions while lesson planning, but PSTs reported limited knowledge of digital tools and often felt uncertain about their instructional decisions, especially related to selecting digital tools (Beschorner & Kruse, 2016).

Iteration 2: Increasing Scaffolding for the TIPC and Use of Digital Tools

Based on the call for more explicit instruction and scaffolding related to the TIPC as a framework to support PSTs in planning lessons, scaffolding was increased during three weekly class sessions of the course "Literacy Methods for the Intermediate Learner." Specifically, PSTs were provided with more opportunities to learn about the TIPC and reflect on pedagogy, digital tools used in elementary classrooms, and instructional planning related to technology integration were provided.

Scaffolding pedagogy. To scaffold learning about pedagogy, all PSTs read the article "A Planning Cycle for Integrating Digital Technology Into Literacy Instruction" (Hutchinson & Woodward, 2014) and selected an additional article of their choice related to the use of digital tools in literacy education. At the beginning of the second session, PSTs discussed these articles in a jigsaw structure and then wrote individually about their guiding principles for integrating digital tools in education. In addition, the instructor provided opportunities for student reflection about technology integration by explaining and displaying the TIPC (Hutchinson & Woodward, 2014), TPACK (Koehler & Mishra, 2009), and the Substitution, Augmentation, Modification, or Redefinition (SAMR) model (Puentedura, 2014). The intention of these readings, jigsaw discussions, and written reflection was to build background knowledge about pedagogical considerations for the use of digital tools in literacy instruction.

Conscious alignment of pedagogy and digital tools. In written reflections, all PSTs reported high standards for their pedagogy related to the use of digital tools to support literacy learning. Lauren noted,

> I believe that technology should only be used if the pros and cons have been reviewed and intensively thought out prior to the lesson. If technology is used merely as a cute activity or fun thing to keep students occupied, I don't think the instructional goals are being addressed or expanded upon.

Similarly, Olivia reflected, "Like all literacies, reflection on the strategies used with digital literacy and technology use is necessary. You don't need to use it if it doesn't enhance the lesson. Definitely use it if it will enhance the lesson."

This alignment of pedagogy was evident in session three as PSTs began planning instruction using the TIPC in class. As an example, Avya believed it was important for students to connect prior knowledge to new information while reading. Based on this belief, she planned to use an interactive digital poster in her instruction so that students could add content to the digital poster before, during, and after reading. In another example, Danika wrote about the importance of personal choice and making authentic and real-world connections with texts. In line with these beliefs, she selected PowToons for her digital tool because it provided opportunities for choice and she believed comic strips would be relevant to her fifth-grade students' lives.

In addition to Avya and Danika's beliefs, some other commonly held pedagogical beliefs that guided PST's selection of a digital tool included the importance of social collaboration, choice, hands-on learning, visual displays of thinking, creativity, student-centered learning, and relevance to students' personal lives. The lesson plans that PSTs designed suggested that they were able to select digital tools that were aligned with their pedagogy.

Scaffolding digital tools. After PSTs wrote about and discussed their guiding principles for technology integration, they gathered in small groups to explore digital tools and discuss the affordances and constraints of these tools (e.g., Adobe Spark, Seesaw, Popplet, Glogster, ThingLink, Tumblebooks, Starfall, Storyboard That, Storybird) related to an instructional goal. As PSTs worked together, they recorded their findings on a shared Google Doc. This exploration of tools served as guided practice for the PSTs to build their technological knowledge and consider the affordances and constraints of a digital tool related to a literacy goal.

Knowledge of digital tools used in elementary classrooms. As a result of this exploration, PSTs reported gaining valuable technological knowledge about digital tools. Pre-instruction written reflections revealed PSTs had little to no knowledge of digital tools being used in elementary classrooms. Consequently, they highly valued having the opportunity to explore digital tools in small groups during class. Cynthia wrote, "The exploration of these technological tools influenced my thinking exponentially. I was able to see which aspects of the tools would or would not work for my future classroom." As they analyzed digital tools, PSTs also considered the affordances of such tools. Andrea wrote,

> I feel that technology allows students to participate in authentic and engaging ways previously not allowed, ... technology expands students' reach both in terms of their audience and their experiences through virtual field trips, ... and technology allows students to show what they know in a variety of manners all of which provide a more individualized platform.

On post-instruction written reflections, all PSTs listed several digital tools that they could use in their future elementary classrooms.

In addition, PSTs thought critically about digital tools. As an example, on the shared Google Doc, they wrote accurately about constraints of tools they explored. For example, they noted digital tools that were "difficult to navigate, had a time-consuming log in, had many options that might overwhelm students, asked only lower-level questions, and were expensive." PSTs were also able to recognize affordances of tools, such as "writing tools that could help students organize their thoughts, increase creativity and motivation, provide opportunities to collaborate and give each other feedback, create multimodal texts, share learning with the world, and support visual and auditory learners." The opportunity to explore digital tools in a small group was highly valued by PSTs and cited most often in

written reflections as an important support for their learning.

More scaffolding and practice with digital tools is needed. Though this scaffolded exploration of digital tools was an important support for PSTs, it didn't appear to be enough. In 75% of PSTs' written reflections, the process of selecting a digital tool while planning their lesson was listed as their biggest challenge. Victoria reflected, "I think the integration of technology and literacy is hard! It seems that I need a lot more practice and time with using various digital tools to feel comfortable enough integrating them with my future students." Similarly, Abdullah wrote, "This lesson was hard for me.… I had a hard time coming to a conclusion of what technology I was going to do. There were so many options." Keitha noted, "When I was creating my lesson, it was hard to think of a way to use tech beyond substitution. Many of my ideas, I could do in paper and pencil." In addition, PSTs evaluated digital tools in narrow ways based on limited experience, exposure, and expertise with these tools. As an example, PSTs who listed social collaboration as an important pedagogical consideration rejected digital tools because they didn't see a way for students to collaborate while using them, not yet recognizing that students could talk while using digital tools as they can while using traditional tools.

Scaffolding for instructional planning. After PSTs explored digital tools in class, the instructor modeled the use of the TIPC to plan two literacy lessons that integrated digital tools to support a literacy goal. For both of these lessons, the instructor shared thinking related to each step of the TIPC framework. In the first lesson, the instructor modeled the use of Padlet to support students' thinking related to identifying the main idea and supporting details of a text. In the second lesson, the instructor modeled thinking about creating Adobe Spark videos to communicate findings of online research about endangered animals. After observing the TIPC being modeled, PSTs began planning their lesson during class and completed their planning as homework. They used a planning template (Appendix B) that prompted each step of the TIPC framework.

More support for planning is needed. Though this scaffolded support with the TIPC was helpful, and PSTs were grateful for the support of the TIPC in developing their lesson plans, most PSTs found it difficult to use digital tools in a way that enhanced the literacy goal. Alex wrote, "The biggest challenge for me was finding a tool and way to use it that enhanced the learning rather than simply replacing a pen and paper." Phillip wrote, "Once I identified my instructional goal and approach, it was time consuming to find a digital tool that authentically enhanced that, and not just provided a substitute."

PSTs who were comfortable aligning their technology to pedagogy still had difficulty considering how it supported the literacy goal. As an example, Carl selected Google Slides to support the literacy goal of determining the theme of a story. When writing about how the tool contributed to the literacy goal, he described his beliefs about social collaboration and didn't refer to the instructional goal of identifying theme in a story. Also, about half of the PSTs' lessons showed no evidence of how the digital tool supported the literacy goal. Even though PSTs could explain the importance of maintaining focus on the literacy goal, many were not able to do so. Tracy explained,

> Remembering to also model the comprehension strategy. I have no idea why I just blanked on that aspect of the lesson. I feel like I was more focused on trying to perfect the technological integration part of the lesson than I was the comprehension strategy which is really what should have been the main focus of the lesson.

Peer rehearsal of the lesson led to increased understanding for PSTs. When

the PSTs returned for the third class session, they rehearsed their planned lessons in small groups and provided feedback. This opportunity to teach and discuss their lesson plan with peers in class was important for PSTs and the second most commonly listed helpful support in written reflections. Kayla wrote, "I think that the peer 'teaching' workshop was really, really helpful. I liked seeing what type of lessons my peers came up with from the same standards and the same book." Similarly, Shawn wrote, "I thought my lesson went well. Physically modeling it and explaining it to peers got me thinking about details I might want to add in; things like providing context for that day's lesson." Other PSTs reflected on what they learned based on difficulties they encountered. For example, Aaron wrote that he would change his lesson by adding more "modeling how to use the site. I did not do this for my first lesson, and I definitely thought it deserved and needed some modeling."

All of these course activities, including the readings and written reflections on pedagogy, the small-group exploration of affordances and constraints of digital tools related to a literacy goal, faculty modeling of the TIPC, and the rehearsal and feedback of designed lessons, were intended to scaffold the use of the TIPC to design lessons that integrate a digital tool for a literacy goal. The difficulty of this task for PSTs led us to conclude that more support was still needed.

Iteration 3: Enhancing the Literacy Goal

We made adjustments to the instructional plan based on the previous iteration. For this third iteration, the PSTs studied the TIPC in a similar instructional sequence than in the second iteration, but we refined our instructional approach to support depth of understanding while using the TIPC to design a lesson. Specifically, we embodied this study with fewer digital tools for PSTs to explore in class, asked students to perform a search to locate additional tools that have similar capabilities, and emphasized the importance of using digital tools to enhance the literacy goal.

Fewer digital tools. Students initially explored fewer digital tools in class in an effort to alleviate the level of difficulty for PSTs in considering digital tools for literacy lessons by developing deeper knowledge of fewer digital tools. We believed this might help PSTs keep the focus on the instructional goal. Results indicate that PSTs felt more confident with their selection of the digital tool in this third iteration than in the previous iteration. Based on analysis of PSTs' written reflections of learning, only 30% indicated that they found it challenging to select a digital tool for their lesson, compared to 75% who wrote about this in Iteration 2. Sarah reflected during the final class,

> I think the most helpful support for this lesson was last week in class when we were in groups and did our own research on the different digital tools that were out there. I love technology and was excited to learn more about this topic. Learning about the affordances and constraints of the digital tools helped me be more confident in my choice and follow through.

Yet not all students felt confident with their digital tool. Ted reported, "The more I play with this technology tool, the more I realize I have no idea how to use it."

Though more PSTs appeared less overwhelmed by the selection of their digital tool, all of them indicated in their written reflections that they spent time outside of class exploring digital tools for their lesson. Arya shared,

> The most helpful support was getting to explore Padlet during my own free time. This helped me know what to expect from the digital tool…. Also, exploring Padlet allowed me to be better prepared to answer questions and help fix errors.

Mai Chong wrote,

I spent a lot of time exploring ThingLink, so during that time, I had created an example ThingLink. The example ThingLink played a role in me learning how to navigate the site, and it was used as a tool for teaching.

PSTs' investment for exploring digital tools suggests that they believed their growing knowledge of digital tools was important for their future work as a teacher. Interestingly, the majority of PSTs selected for their lesson plan a digital tool that they had not explored in class rather than using the technological knowledge they had developed in class.

After PSTs were familiar with a few tools, they were encouraged to identify and analyze tools with similar affordances and constraints by performing a Google search. The intention of this activity was to encourage PSTs to engage in an authentic activity that teachers often undertake to increase pedagogical technological knowledge (Beschorner & Woodward, 2019). We found that PSTs were able to (a) identify tools with similar capabilities (e.g., several platforms for creating presentations), (b) describe the differences in the tools that they identified, and (c) explain how those capabilities and differences might influence instruction. For example, one PST compared Adobe Spark with Media Space and FlipGrid:

The tools are similar because all three of them allow students to video record and use their voice to narrate.… Adobe Spark and MediaSpace are very similar in the aspect that they both use PowerPoint.... FlipGrid would be slightly different in that it doesn't have a PowerPoint built into the software. FlipGrid would be a great tool to utilize for student responses."

Focusing on the literacy goal. Finally, the importance of using technology to enhance the literacy goal was emphasized. We did this by (1) explicitly talking with PSTs about the importance of staying focused on the instructional goal, (2) bolding the words *instructional goal* in the planning template, and (3) asking students to reflect on whether their technology overwhelmed their literacy goal. Results suggest that more PSTs (77%) stayed focused on their literacy goal than past iterations and fewer PSTs (23%) believed the technology overwhelmed their literacy goal. After teaching his lesson, Ben wrote, "I thought it did go really well. The tool I chose worked really well to enhance my lesson but still keep the instructional goal at the forefront." Jamar noted,

The digital tool allowed for students to expand deeper with the topics of Inside Out and Back Again. To support the text, students could use videos, images, maps, descriptions, and webpages. The interactive scale of all of these resources could not be done with paper and pencil. ThingLink allowed for students to deeply interact and engage with multiple topics, topics that were of interest to the students.

It is worth noting that although PSTs felt more comfortable selecting a digital tool, they primarily used the digital tool after reading the text. This suggests that the use of digital tools may be more accessible to PSTs as a separate activity or product of reading rather than as a support to the reading process. However, it is also possible that more students would have used digital tools to support comprehension processes before or during reading if their coursework with TIPC had come after more coursework related to comprehension processes.

Though most PSTs stayed focused on their literacy goal during this iteration, it was still challenging for some of them to use a digital tool in a way that enhanced the

literacy goal. A few PSTs concluded at the end of their lesson that paper and pencil would have worked just as well for the instructional goal. Malaki wrote,

> I modeled how to use the technology for the students, but it was not a tool that was high on the SAMR model. Popplet substituted a Venn Diagram, so it didn't necessarily add to the lesson, but it didn't take away from it either.

In addition, some PSTs had difficulty recognizing how a digital tool could move beyond substitution to enhance a literacy goal. For example, when small groups considered the digital tool Voki, they wrote, "It is funny but nothing more than a substitution of recording yourself talk." They went on to state that for PSTs who were shy, Voki could replace speaking for them in class. Yet they didn't identify the ways Voki could be used to create multimodal texts that could be shared beyond the classroom.

Changes made by PSTs. Verbal protocol reports allowed us to examine the processes of two PSTs as they planned their lesson. These PSTs made continual changes throughout their lesson planning. As an example, Olivia started planning her lesson by selecting her literacy goal with a caveat: "but who's to say I'm going to keep with that because I feel like I have no idea where to go from here." Within a couple of minutes, Olivia made a change:

> OK, so, I've decided to change my instructional goal, which I kind of expected…. I've been looking at the different technologies and it looks like you can make a map.... That's where I'm at right now. We'll see if that sticks.

With Olivia's new literacy goal of comparing settings in the story, she explored different digital tools related to maps and made a pedagogical decision to switch the digital tool based on its the affordances and constraints. Then as she began writing her instructional plan, she sought alignment between her literacy goal, digital tool, and pedagogical approach, considering whether she wanted the digital tool to be all encompassing for the lesson, whether the digital tool was a substitution for paper and pencil, and whether it was too far removed from her literacy goal. She continued to make more changes and stated, "I'm editing and I'm jumping all over the place, but the longer I do this the more exciting this lesson plan is, and the more I actually want to try it." As Olivia finished her lesson plan, she reported being excited to teach it during the small-group rehearsal. Then after the rehearsal, she reflected that the technology tool did overwhelm the literacy goal, so she decided to make some final tweaks to her lesson plan in order to focus more on the book before turning in her lesson plan for feedback and a grade.

Olivia's process seemed to be similar to other PSTs'. Throughout written reflections, PSTs reported changing their selection of a digital tool, changing their literacy goal, and changing their pedagogical approach. For example, Ben switched the digital tool while planning his lesson to allow for technology to be used at a modification level. Cailey decided to switch the placement in her lesson to introduce the digital tool so that she wouldn't overwhelm the literacy goal with the digital tool. Aaden explained that he spent a lot of time exploring his digital tool but switched the tool to provide more support for the literacy goal. The changes the PSTs made to their lesson plan often resulted in stronger lesson plans and suggested that PSTs were invested in learning how to design a literacy lesson that integrates a digital tool.

Educational Importance

The three iterations of this study allowed us to refine and improve our design and also consider generalization based on replication. We suggest the following design

principles for teacher educators, which are all related to supporting PSTs' ability to use their TPACK to develop lessons that integrate digital tools into literacy instruction.

Design Principles to Advance Practice

- Faculty can provide intentional support in literacy methods courses for PSTs to consider digital tools in relation to a literacy goal. This promotes technology integration, rather than stand-alone technologies.

- Faculty can give PSTs opportunities to learn about digital tools used in elementary classrooms by exploring these tools and collaborating with classmates on the affordances and constraints of the tools related to a literacy goal. In addition, faculty can consider integrating digital tools into their own university coursework to build technological knowledge.

- Faculty can provide PSTs with significant modeling, scaffolding, and guided practice using the Technology Integration Planning Cycle in multiple courses and for a range of instructional goals. This is consistent with previous assertions related to the importance of extensive support (Tondeur et al., 2011).

- Faculty can be explicit throughout the modeling, scaffolding, and guided practice about the importance of staying focused on the literacy goal. Specifically, they can provide examples of instruction where the technology does and does not overwhelm the instructional goal.

Advancing Theory

The TIPC was originally designed for practicing teachers. Designing technology integration lessons can be difficult for PSTs who are still learning pedagogical knowledge, content knowledge, and technological knowledge. The evidence collected over time suggests that PSTs can use the TIPC to plan literacy instruction that integrates digital technology (e.g., Beschorner & Kruse, 2016; Hutchison & Colwell, 2015). However, the results of all three iterations of our study also suggest that PSTs might engage with the TIPC in a different way than more experienced teachers because they move between the stages in the cycle in a more recursive manner. For example, whereas a veteran teacher might make decisions about content and pedagogy before determining what tool will support the learning outcome, PSTs seem to regularly revisit their choices at every point of their decision making. That is, they determine an instructional goal, then decide on their pedagogical approach, but then go back and revisit their goal to ensure that the pedagogy and goal are aligned. Figure 1 illustrates the original TIPC, and Figure 2 illustrates the recursive decision making of PSTs while using the TIPC. There are many reasons PSTs might have approached their lesson plan with a recursive process, which are described below.
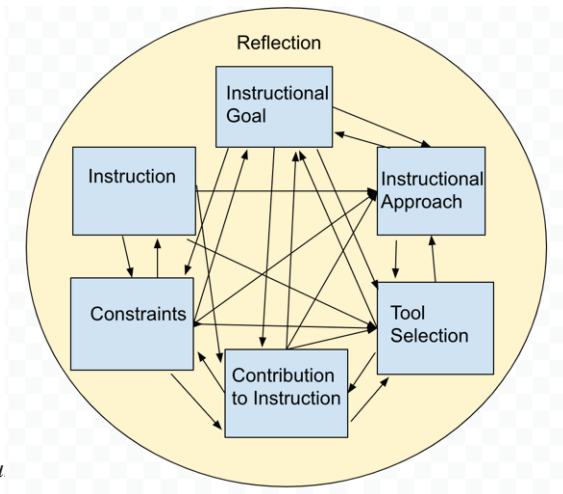
Figure 2. *The recu   ison & Woodward,*
2014).

New knowledge. One reason PSTs moved back and forth in the cycle was because their knowledge about digital tools, content, and pedagogy for the elementary classroom were all developing. The PSTs reported that the process for selecting a digital tool was time-consuming and challenging. Max wrote, "The more I play with this technology tool, the more I realize I have no idea how to use it. So I might change it up a bit, but I like the idea of working with setting." Though PSTs invested time in the selection of the digital tool, most seemed to have limited understanding of purposes and affordances of these tools contextualized to the elementary classroom and literacy goals.

Technology in relation to literacy goals. Another reason PSTs moved back and forth in the cycle was because they were centered on maintaining the integrity of the literacy goal. That is, they made changes to their lesson plans so that the technology would not overwhelm the instruction. For example, Daryl explained how he considered his digital tool in relation to his literacy goal: "Initially I chose StoryJumper, but I was trying to change my goal to fit the technology. That is why I chose to change to Seesaw. Seesaw worked really well because it did not overwhelm the 'literacy' goal." In order to maintain integrity of the literacy goal, PSTs moved through the TIPC in a recursive rather than linear fashion, which is illustrated in Figure 2.

Emerging confidence. Some of these recursive moves back and forth between pedagogical decisions appeared to be essential behaviors toward an emerging development of confidence. An example of this can be seen when viewing verbal protocol recordings. For example, Lena explained, "So I've chosen the standard 5.1.6.6, but who's to say I'm going to keep with that because I feel like I have no idea where to go from here." In addition, in written reflections, many PSTs explained that they chose to tell about their lessons rather than teach their lessons to their small group because they did not feel confident yet in their lesson plans. By telling about their lesson, Derek wrote that he could get "critical feedback on the spot". Anne explained in her written reflections that she could "bounce ideas off of one another to make changes." Shayla wrote, "I love instant feedback because it allows me to make changes as I go."

Complex thinking. Yet data indicated that PSTs were engaged in complex thinking as they used the TIPC to plan instruction. For example, Lena considered using a digital tool to create a Venn diagram but then decided against this because the digital

Venn diagram in her lesson would have been a substitution for paper and pencil. As PSTs moved between steps in the cycle, they often made changes that resulted in stronger lesson plans. For example, Fiona began exploring a digital maps tool and then discovered it was difficult to use and switched to another digital map tool that she decided also improved the realism of the story and opportunity for students to get a more authentic understanding of the historical settings in the story. The investment of PSTs to reconsider tools, goals, and pedagogies enabled them to refine the final product and seemed to strengthen their understanding about digital tools, content, and pedagogy. In the verbal protocol recordings, Lena explained, "I'm editing and I'm jumping all over the place, but the longer I do this the more exciting this lesson plan is and the more I actually want to try it."

Conclusion

This study considered how faculty in university classrooms can support PSTs for a technological future that is continuously changing and built on previous research related to using the TIPC with PSTs (e.g., Hutchison & Colwell, 2015). We believe there is potential in future use of the TIPC to support the development of PSTs' ability to plan literacy lessons that are not overwhelmed by technology. The TIPC encourages PSTs to thoughtfully consider several aspects of the instructional plan and evaluate potential digital tools to see if the tools contribute to the literacy goals. These considerations are important for children's learning as technology integration increases in elementary classrooms.

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Appendix A

Pre- and post-assessment of knowledge of technology integration

What do you believe about using technology for literacy instruction?

Name technology tools that could be valuable for literacy development in elementary educational. For each tool listed, provide a reason you believe this tool could be valuable.

What are some considerations for instructional planning related to technology use and literacy goals?

What, if any, experiences have you had using technology for literacy education?

Do you have access to an iPad or Chromebook? If not, do you have a laptop or iPhone?

What questions do you have about the integration of technology and literacy education?

Appendix B

Lesson plan template adapted from the Technology Integration Planning Cycle (Hutchinson & Woodward, 2014)

Text: *Inside Out and Back Again* by Thanhha Lai

1. Instructional Goal:

Choose one of the following literacy standards and highlight your choice:

5.1.2.2 Determine a theme of a story, drama, or poem from details in the text, including how characters in a story or drama respond to challenges or how the speaker in a poem reflects upon a topic; summarize the text.

5.1.3.3 Compare and contrast two or more characters, settings, or events in a story or drama, drawing on specific details in the text.

5.1.6.6 Describe how a narrator's or speaker's point of view influences how events are described.

2. Objective:

Assessment:

3. Instructional Approach
What do you know about how students learn **related to your instructional goal**?

4. My digital or nondigital tool is:
How does this tool contribute to the **instructional goal**?
What are potential constraints of using this tool?
How will you overcome these constraints?

5. Instructional Plan:
Launch:
Instruction:
Closure:

Reflection after teaching my lesson:

How did your lesson go?

What could students do?

Would you make any changes to your instructional plan?

What was the most difficult part of planning and teaching this lesson?

What was the most helpful support?

Reflect on your guiding principles related to technology integration. Were you able to plan with these guiding principles in mind?

What challenges did you face? Did the technology ever overwhelm the literacy instruction? If so, how do you know?

Perform your own Google search to answer the following questions:

What additional digital tools have similar capabilities?

How are these tools the same?

How are these tools different?