A Comparison of Preservice and Inservice Teachers' Most-Valued Technology-Supported Activities for Teaching and Learning

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Abstract

We examined teachers' pedagogical reasoning for and the technological knowledge underlying their most-valued technology-supported activities for teaching and learning. Data from 140 preservice and 100 inservice teachers included open-ended, narrative responses to survey questions. Qualitative research methods guided analysis of the data that identified (a) the technology-supported activities and (b) the technical tools, target users, types of uses, rationales for use, and the technological pedagogical content knowledge (TPACK) underlying each activity. Preservice teachers described mostly teacher-focused and fewer student-focused techno-activities, and their reasoning for use focused on the technology's presentational and engagement effects. A majority of inservice teachers' techno-activities were student-focused, and their reasoning highlighted the technology's support for knowledge acquisition of higher-order cognitive skills and collaborative learning. The knowledge underlying all teachers' techno-activities was predominantly technological pedagogical knowledge (TPK), but inservice teachers also evidenced technological content knowledge (TCK). These results may reveal differences in the teachers' respective learning experiences or reflect a professional maturation process.

Introduction

Teachers are the decision-makers and the designers of whether and how they use technology in their classrooms (Ertmer, 2005; Tsai & Chai, 2012). Such decision-making and designing occurs within complex educational contexts. Teachers face a range of barriers and supports for technology use in classrooms (e.g., Authors, 2016; Ertmer, 1999, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Hew & Brush, 2007; Tsai & Chai, 2012). Increased clarity on barriers has guided shifts in teacher education and professional learning that have led to increased technology use by teachers over the last decade. Yet, research continues to show preservice and inservice teachers may not have a wide breadth of technology usage in subject areas, and technology integration has yet to be prevalent and equitable in PK-12 schools (e.g., Tondeur, Pareja Roblin, van Braak, Voogt, & Prestridge, 2017; Zyad, 2016).

Decades of research has focused on describing teachers' technology knowledge, often using the technological pedagogical content knowledge (TPACK) conceptual model (Angeli & Valanides, 2005; Mishra & Koehler, 2006). Recent studies find that teachers' perceived TPACK may not aptly reflect their behavioral intentions or smoothly translate into enacted actions in the classroom (e.g., Jen, Yeh, Hsu, Wu, & Chen, 2016). Thus, research must begin to unpack teachers' technology-mediated practices to better understand teachers' TPACK development and use in the PK-12 environment, such as by considering the role of pedagogical reasoning in the context of technology (e.g., Harris & Phillips, 2018; Hofer & Harris, 2019). There is a range of teachers' rationalizations underlying their choices of technology (Li, 2014; Voet & Wever, 2017). A teacher's reasoning for technology use may reveal how they value technology applied in their practice. Yet, the research that links teachers' technology use or planned use with their underlying reasoning for their technology choice(s) is sparse. Hence, our study examined teachers' reasoning for using technologies that they deemed valuable for teaching and learning.

Literature Review

Technology Use by Inservice and Preservice Teachers

Inservice teachers in PK-12 contexts use technology mainly for lesson preparation and professional development needs (Ottenbreit-Leftwich, Glazewski, Newby, & Ertmer, 2010; Zyad, 2016). For instance, Zyad's (2016) study showed that technology was most frequently used by teachers for preparing lesson plans and keeping a database of various instructional materials. In recent years, more research has documented the increasing use of technology by inservice teachers during their classroom instructional time. The majority of these classroom-based technology uses were teacher-focused and transmissive in nature (Tondeur et al., 2016; Voet & De Wever, 2017). For example, Tondeur et al. found technology was integrated by most of the teacher participants to support structured learning approaches–most commonly the use of the data projector or interactive whiteboard to deliver instruction. Few opportunities were provided for student-centered applications. Similar findings were observed by Voet and De Wever. Their results showed that student use of technology remained scarce as teachers perceived technology as a resource for the learning task, rather than as a tool for supporting student inquiry learning.

In comparison to inservice teachers, there are fewer studies of preservice teachers' technology use. Among the studies of technology use, similar patterns, such as the domination of productivity software like Word and PowerPoint, were revealed in the cases of preservice teachers. Hu and Yelland (2017) found when integrating technology in instruction, preservice teachers, rather than their students, initiated and directed most of the activities. Understanding why teachers choose to use various technologies will advance more breadth in technology use.

TPACK in Relation to Teachers' Technology Use

Earlier literature has extensively examined teachers' perceived TPACK and its relationships with salient cognitive and affective aspects such as teachers' pedagogical beliefs, self-efficacy, and attitudes towards technology (e.g., Crompton, 2015; Tondeur, van Braak, Ertmer, & Ottenbreit-Leftwich, 2017). After recognizing that teachers' perceived TPACK may not aptly reflect their behavioral intention or smoothly translate into their enacted actions in the classroom (e.g., Jen et al., 2016), more researchers have begun to unpack teachers' technology-mediated practices to better understand teachers' TPACK development in the PK-12 environment (e.g., Gómez, 2015; Gonzalez & González-Ruiz, 2017). Gonzalez and González-Ruiz (2017) conducted multiple case studies to explore if the behavioral intention of six preservice teachers' technology-supported mathematical tasks for teaching was associated with the TPACK model. Findings showed that behavioral intentions revealed in the participants' explanations of technology-supported tasks was unrelated to the TPACK components. Research that involves more participants can expand exploration of teachers' knowledge when making educational technology planning decisions.

Pedagogical Reasoning and Action

Scholars have begun to also consider teachers' pedagogical reasoning and actions as a conceptual frame underlying the technology integration process (Harris & Phillips, 2018; Hofer & Harris, 2019). Developing and supporting teachers' pedagogical reasoning and critical decision-making regarding technology integration in classroom teaching is crucial because educational technology options are ever-expanding. Past investigations of how technological knowledge (i.e., TPACK) underlies teacher actions enacted in classrooms has begun to expand beyond the 'what' and 'how' of teachers' technology use to also consider the 'why.' Loughran (2019) asserts "making sense of the 'why' comes with its own challenges because much of that thinking – the pedagogical reasoning – underpinning practice has long been recognized as tacit in nature" (Loughran, p. 4).

Some studies (Hofer & Harris, 2019; Niess & Gillow-Wiles, 2017) are specifically framed around Shulman's (1987) theory of pedagogical reasoning and action, while others have explored reasoning processes from a TPACK conceptualization (Guzey & Roehrig, 2009; Janssen, Knoef, & Lazonder, 2019) or domain-specific (Sherman, 2014; Voet & De Wever, 2017) or both (Wilkerson, Andrews, Shaban, Laina, & Gravel, 2016). Of the handful of existing studies, most are situated in inservice contexts with a small number of participating teachers mostly at the secondary level (e.g., Guzey & Roehrig, 2009; Hofer & Harris, 2019; Niess & Gillow-Wiles, 2017; Sherman, 2014; Voet & De Wever, 2017). Two studies involve preservice teachers (Janssen et al., 2019; Wilkerson et al., 2016). These researchers contend that studies of pedagogical reasoning will enable better understandings of teachers' knowledge, TPACK or otherwise, within instructional planning and decision-making.

Studies have identified that teachers' pedagogical reasoning for technology integration mirrors their established pedagogy and knowledge (Guzey & Roehrig, 2009; Sherman, 2014). Sherman's study of four mathematics teachers found that even when teachers had intentions to use technology for high-cognitive activities, most often lessons were implemented in low-cognitive ways, which revealed a mismatch between intentions and use.

The literature also suggests there is a wide range of teachers' rationalizations underlying their choices of instructional technology (Heitink, Voogt, Verplanken, van Braak, & Fisser, 2016; Li, 2014; Voet & De Wever, 2017). Voet and De Wever found 22 secondary social studies teachers voiced four types of rationales for their adoption of technology tools: (a) increasing effectiveness of instruction, (b) connecting to students' daily lives, (c) increasing work efficiency, and (d) complying with peer pressure to use technology. The teachers' technological practices tended to be teacher-centric with little active technology use by students. In Li's study, teachers articulated their use of technology for either attending to personal teaching needs (e.g., professional development or lesson preparation) or addressing student learning needs (e.g., enhancing engagement or facilitating understanding). Heitink et al. reported that most of teachers' technology use was to strengthen teaching pedagogy and/or subject matter learning. Wilkerson et al. (2016), in a study with preservice teachers, found the teachers valued and used technology (a) as a modelling tool, (b) as a way to share student ideas, and (c) as a way to show student ideas.

These rationales have been identified in studies involving pedagogical reasoning and situated with teachers who were planning lessons within specific contexts, such as involving fewer than five pre-introduced technologies (Sherman, 2014; Wilkerson et al., 2016); for specific activities, such as inquiry (Guzey & Roehrig, 2009; Wilkerson et al., 2016), communication and collaboration (Niess & Gillow-Wiles, 2017), or high-level mathematics thinking (Sherman, 2014); or using specific supports or aids for lesson development (Hofer & Harris, 2019; Janssen et al., 2019, Wilkerson et al., 2016). Through very detailed case studies, past research has begun to identify a range of teachers' reasoning underlying their choices of technology. We had the opportunity to use a larger teacher participant pool than past studies to examine teachers' reasoning for using technologies that they deemed valuable.

Thus, our study examined a large participant pool of both preservice and inservice teachers, examined proposed/enacted techno-lessons, explored the reasoning for technology use in the lessons, and determined the requisite TPACK for designing the lessons. Our research questions included:

1. What technology-supported teaching and learning do preservice and inservice teachers value most?
    a. Who are the targeted users (students or teachers) in these valued technology-supported activities?
    b. What are the common technology tools involved in the technology supported activities?
    c. How are students or teachers using technology in these technology-supported activities?
    d. How do teachers reason about the value of technology-supported activities?
2. What TPACK knowledge is reflected in preservice and inservice teachers' technology-supported activities?

Method

This qualitative research study is part of two larger research projects examining technology-related learning and integration in one teacher education program and in several middle schools.

Participants and Data Sources

Preservice teachers (n=140) enrolled in a university-based certification program for elementary certification at a large southwestern U.S. university answered the following questions in a survey administered within two weeks of their graduation and teacher certification:

- Describe the most valuable learning technology (a learning technology you could not imagine teaching without) that you or your students will use in the future, if available?
- Please explain why your chosen technology (listed above) is so valuable, such as its value to you and your students, how you or your students will use it, and what objectives it helps you reach?

Inservice teachers (n=100) were situated in four different middle schools in a southwestern U.S. state. Saguaro MS was located in a rural setting, served a Latinx-majority student population, and 72% of its population was economically disadvantaged. Porter MS was an urban school with 50% White student population and 40% economically disadvantaged. Walnut MS was suburban with 12% of students economically disadvantaged and 75% White. Verona MS was in a rural location and served a student population with 53% economically disadvantaged and 57% White. In the teacher survey, these teachers answered:

- Please list all the technologies (whether you have access to them or not) you feel are required for you to have available to assist your students in learning in the subject areas you teach.
- List the technology and the specific subject matter/content concept(s) it supports. You may be as broad or as specific as you like. You can discuss: its value to you and your students, how you or your students will use it, and what objectives it helps you reach.

We examined the inservice teachers as a whole group whose reported practices from the four schools contributed to a rich dataset. The open-ended, narrative data allowed deep examination of teachers' reasoning. A limitation exists: we did not observe teachers' practice and actions in a classroom setting.

Data Analysis

The open-ended data was analyzed in a spreadsheet. First, we listed, counted, and grouped each learning technology(ies) teachers mentioned into categories used in a common educational technology text. We then identified techno-idea chunks that expressed both a learning technology and a use and/or reasoning/value statement. For these chunks, we coded for (a) the type of activity (student vs. teacher uses) and (b) the reasoning/value(s). We used open-coding using emic and etic coding categories, subcategories, and definitions, while constantly comparing our generated codes and coded data to ensure consistency (DeCuir-Gunby, Marshall, & McCulloch, 2011; Miles, Huberman, & Saldana, 2014). We also employed multiple coders with code checking between researchers until 100% agreement on codes was achieved, which enhances trustworthiness (Miles et al., 2014). We then used a TPACK knowledge framework culled from the literature (Authors, 2018) to code the requisite knowledge we inferred as underlying each teacher's expressed techno-idea(s) (see Appendix). Finally, we created data displays (Miles et al., 2014) to explore and compare patterns in the findings from preservice and inservice teachers.

Results

Target Users and Types of Activities within Teachers' Valued Technology-Supported Lesson Activities

Preservice teachers' techno-activities involved more teacher focus (64.6%) versus inservice teachers' activities (44.6%). Conversely, inservice teachers' techno-activities involved more student focus (55.4%) (Table 1).

Depictions of teacher use and reasoning within teachers' valued technology-supported lesson activities. Considering the nature of tasks and different aspects of teaching responsibilities, we identified four categories of teacher-focused techno-activities (see Table 1):

- Designing and preparing for lessons–Teachers used technology to prepare for the class ahead of time, which included writing lesson plans, researching for course content, creating various instructional materials, transferring digital content from home to work.
- Teaching lessons–Teachers used technology to enhance their teaching when they executed a lesson, such as delivering information in multimedia formats, facilitating student-centered activities, showing students how to research online, and managing classrooms.
- Grading and assessment–Teachers used technology for formative and summative assessments and grading.
- Communicating with students and parents–Teachers used technology to communicate with students and parents.

Results showed that the majority of teacher-focused techno-activities that preservice and inservice teachers described involved teaching lessons (see Table 1). While preservice and inservice teachers used similar tools across all these teacher use categories, inservice teachers valued these activities for their potential to facilitate students' knowledge development and skills practice; preservice teachers valued the presentational effects that technology offered. In the following sections, we compare the common tech tools that preservice and inservice teachers used across these different categories of their teaching and the values they anticipated in adopting these techno-activities.

Table 1. Frequency of Teacher and Student Uses Mentioned in Techno-Activities

Target User and Activities	Frequency[a]: Preservice Teachers		Frequency: Inservice Teachers	
	n	%	*n*	%
TEACHER USES (total)	**135**	**64.6**	**137**	**44.6**
Designing and Preparing for Lessons	29	13.9	23	7.5
Teaching Lessons	93	44.5	95	30.9
Grading and Assessment	5	2.4	14	4.6
Communicating with Students and Parents	8	3.8	5	1.6
STUDENT USES (total)	**74**	**35.4**	**170**	**55.4**
Passive Hands-Off Learning (PHOFF)	26	12.4	21	6.8
Passive Hands-On Learning (PHON)	4	1.9	33	6.3
Active Hands-On Learning Participation (AHON-P)	30	19.4	70	22.8
Active Hands-On Learning Creation (AHON-C)	14	6.7	46	15.0
TOTAL STUDENT AND TEACHER ACTIVITIES	**209**	**100.0**	**307**	**100.0**

Note. [a]*n* represents the number of mentions within the teachers' techno-activities; % represents the proportion of each group's total, respectively.

Designing and preparing for lessons. The most common tools for both preservice and inservice teachers were computers, word processing software, and the Internet. Teachers, especially preservice teachers who had less classroom experience, valued the Internet because they described it could provide numerous resources for lesson planning and creation. Teachers also valued these tools for greater efficiency and flexibility. Several inservice teachers mentioned the use of class websites when they designed and prepared for lessons. Teachers usually built these sites themselves and added additional tutorials and materials on them, which they could efficiently reuse. They valued it as a chance to extend learning for students because students could access these teaching materials at home.

Teaching lessons. Both preservice and inservice teachers described commonly using the projector, presentation software, and computers for in-the-moment teaching. According to the teachers, these tools provided greatly enhanced visual effects in their teaching. Some teachers, especially preservice teachers, valued projection tools and used videos and other multimedia materials extensively because they felt it engaged student learning to a larger extent. Inservice teachers, on the other hand, valued these tools more because they facilitated knowledge-skill development and/or practice. Several inservice teachers also mentioned projectors and multimedia were great tools to tailor learning towards student needs.

Grading and assessment. Inservice teachers most commonly used the clicker, while preservice teachers most used the spreadsheet. Inservice teachers most valued grading and assessment tools for increasing efficiency and monitoring student progress. Preservice teachers, on the other hand, most valued these tools for supporting data interpretation and sense making.

Communicating with students and parents. Classroom websites and email were both the most often used communication tools for preservice and inservice teachers. Preservice teachers also applied media creation tools/software and word processing for communicating with students and parents. Both preservice and inservice teachers valued communication tools for supporting easy communication.

Depictions of student use and reasoning within teachers' valued technology-supported lesson activities. Our coding of the technology-supported activities teachers valued that targeted students' use yielded two categories, passive and active uses, and were further sub-categorized as follows:

- Passive hands-off learning (PHOFF)–Technological support for instructional moves and learning engagement with subject content, especially to attend to learner needs and variability.
- Passive hands-on learning (PHON)–Learner use of technology to learn subject content and/or revise/practice facts and procedures.
- Active hands-on learning for participation (AHON-P)–Authentic, learner-driven digital activities and learning environments that are typically content-centered and may recognize and accommodate learner variability, such as artificial intelligence-sensitive personalized learning.

- Active hands-on learning for creation (AHON-C)–Digital learning activities that maximize active, deep learning, such as cognitively complex tasks that necessitate creativity, critical thinking, problem solving, communication, or collaboration and involve learner agency.

Of the technology activities described by both preservice and inservice teachers, 26.1% and 37.8%, respectively, were coded as active types (see Table 1). While preservice and inservice teachers had nearly identical representation of AHON-P activities, preservice teachers described more PHOFF activities, and inservice teachers reported more AHON-C activities, in comparison to each other. A prominent pattern revealed that inservice teachers tended to value students' passive and active learning with technology because it led to knowledge acquisition and/or higher-order thinking; whereas preservice teachers valued it because they thought the technology supported modes of presentation and would engage students.

Passive hands-off learning involved learners who were hands-off the technology tools, such as when students sat in desks and watched, listened, or read digital information presented by teachers. Preservice teachers described these activities at three times the frequency of inservice teachers. Common tools described by both preservice and inservice teachers included projectors, video, multimodal content, and classroom websites. Yet, preservice teachers identified a wider variety of technology tools for PHOFF than inservice teachers, such as the Internet, presentation software, and other specific software like spreadsheets and word processors.

For passive hands-on learning, learners put their hands on technologies to play games to learn content or complete subject-related assignments via instructional software. Inservice teachers described PHON activities more often than preservice teachers. They also mentioned many more content-specific tech tools such as Compass Learning, digital textbook content, and Fastt Math software for PHON as compared to preservice teachers. These technology tools were adopted by inservice teachers to support students in developing or practicing their knowledge/skills because they thought that these would help to promote students' knowledge and/or skill acquisition. Preservice teachers generally valued students' passive use of technology to increase their engagement in learning activities.

A majority of the active uses were activities involving participation (AHON-P) for both preservice and inservice teachers. For AHON-P, teachers described students doing subject-specific, technology activities/projects such as using LoggerPro to collect science data, conducting online research, creating and showing presentations of their work using digital projection, engaging in assessments using clickers, and typing/taking notes. Both groups of teachers reasoned that the AHON-P activities enabled students' higher-order cognitive skills and supported their knowledge-skill development and/or practice. Inservice teachers commonly reported using computers and content-related software or hardware to promote students' knowledge acquisition and higher-order cognitive skills. Whereas, preservice teachers reasoned that these participatory activities supported students' use of content/multimedia representations, and they cited the internet and projectors as common tools for this. Even among these more hands-on, participatory activities, preservice teachers leaned toward showing or demonstrating activities for students.

Inservice teachers generated more active, creation uses than preservice teachers. Teachers described students creating multimodal expressions of learning, such as presentations, graphs, and graphics; publishing writing with word processing, blogs, or wikis; and organizing/mapping their thinking and ideas with storyboard or mindmapping software. These learning activities positioned students with agency in a range of creative, thinking, problem solving, communication, or collaboration decisions. Both preservice and inservice teachers mentioned similar technology tools (e.g., media creation software/tools, word processing and presentation software) that enabled student creation activities. Both groups of teachers also highly valued student use of technology for creating learning products. Not surprisingly, inservice teachers who mentioned AHON-C more often described many more additional reasons for creation activities such as supporting their content/multimedia representation, enabling higher-order cognitive skills, and fostering collaborative learning, when compared to preservice teachers.

Teachers' TPACK Knowledge Underlying the Valued Technology-Supported Lesson Activities

Overall, both preservice and inservice teachers relied most on TPK (90.5% and 72.3% respectively) to justify their reasoning for using certain technologies in their instructional decision-making. High percentages of TPK may indicate that both preservice and inservice teachers have a better understanding on how technology may be applied for general pedagogical purposes, in comparison to other TPACK knowledge categories. However, preservice teachers typically reflected their *knowing* of TPK while inservice teachers' rationales mostly on *enacting* their TPK. The difference implies that although preservice teachers had higher reference of TPK in their reasoning, they were anticipating what they might do in the future rather than enacted uses described by inservice teachers. We suspect preservice teachers' more limited technology and instructional implementation experiences reduce their abilities to have enacted TPK in practice.

Inservice and preservice teachers' rationales considered TCK 17.9% and 4.3%, respectively, considered TK 7.4% and 3.8%, respectively, and TPACK 2.4% and 1.1%, respectively. This may imply that the inservice teachers were given more exposure to technology and content-specific technologies and their possible uses in their school contexts than preservice teachers had in the teacher preparation programs.

Although TPACK represents a synthesized form of knowledge that some argue underlies well-reasoned technology integration in teaching, only 3.5% of preservice and inservice teachers included all aspects of TPACK knowledge in rationalizing their valued technology-supported instructional activities.

Discussion

This investigation is unique because it examined multiple layers related teachers' technological activities for teaching and learning: (a) the technology use activity, (b) the technological tools embedded within the activity, (c) the reasoning for use of the techno-activity, and (d) the underlying knowledge teachers used to design such activities. This study also was conducted with data from both preservice and inservice teachers, which allowed us to examine each as a professional group but also explore if similarities or differences existed based on professional experience.

The majority of preservice teachers' techno-activities were teacher-focused, reflecting these teachers' predominant use of technology for in-the-moment instructional use. Some past research trends show teachers moving away from using technology for instructional preparation or professional learning toward adopting it more often for classroom instructional use (Hu & Yelland, 2017; Ottenbreit-Leftwich et al., 2012). Technologies used within lessons, such as preservice teachers' commonly cited projectors, presentation software, computers, and video, provide students exposure to technology, albeit in the hands of the teachers. In fact, preservice teachers' reasoning for using these teacher-focused, techno-activities centered on aspects of presentation/showing, in that they valued showing multimedia content information, and felt presentations supported visual needs and enhanced students' engagement. Preservice teachers also generated student-focused techno-activities categorized as passive hands-off learning. These activities were almost identical in nature to their teacher-focused teaching lessons activities, tools, and rationales with the exception that the descriptions were student-forward and learning-forward (vs. teacher- and instructionally-focused). Using technologies for presenting information is common in the literature (Polly, 2014).

Preservice teachers showed some emergence of active, student-focused, hands-on learning activities, especially those for participation. Yet, their common tools, the internet and projectors, and their valuing these technologies for supporting students' representation of content trends again toward presenting/showing, albeit by active students. Thus, we did not find it surprising that in our analysis of their knowledge components, their descriptions heavily represented TPK, the knowledge of technologies for general pedagogical tasks. Their focus on presenting and showing digital information is likely the most common of all general pedagogical strategies. This prominent pattern among preservice teachers may reveal gaps in their teacher preparation, such as a lack of modelling of student-focused techno-activities and/or content-forward technological activities.

Inservice teachers in our sample generated more student-focused activities, a trend that differs from the extant literature (e.g., Polly, 2014; Pringle, Dawson, & Ritzhaupt, 2015; Tondeur et al., 2016). The inservice teachers' abilities to identify and value student-focused activities, especially those that actively put the technology in the hands of the students, aligns with similar emphasis in national plans (Office of Educational Technology, 2016) and efforts to increase student agency (Ito et al., 2013; Reich & Ito, 2017) and rebalance digital inequities in which students of color or of lower socioeconomic levels tend to have passive technological experiences (Hohlfeld, Ritzhaupt, Dawson, & Wilson, 2017). Yet, inservice teachers still described numerous examples of passive, hands-on learning, especially reasoning that it supported knowledge or skill practice with games or learning software, which are exactly the types of activities other researchers have found to be predominant techno-activities for students of color or with lower SES (Hohlfeld et al., 2017; Warschauer & Matuchniak, 2010). While this research shows the range of activities and rationales, further research is warranted to examine if teachers' reasoning for technology use changes when considering students with different characteristics.

Preservice and inservice teachers often expressed different reasoning for similar techno-activity categories. Inservice teachers tended to value technology's aptitude to support students' cognitive and knowledge development or practice, while preservice teachers valued instructional presentation or increasing students' engagement. This pattern of inservice teachers thinking more specifically about students' knowledge development accords with inservice teachers' inclusion of more content-specific tools or activities and, accordingly, a higher percentage of TCK they drew upon to think of their activities, as compared with preservice teachers. A range of possible explanations for these differences exist and warrant continued future research. For example, these results may reveal differences in the teachers' respective learning experiences: teacher education and professional development, respectively. On the other hand, a professional maturation process may explain the differences, in that it just takes teachers time in the field as professionals to broaden their techno-activity repertoires to prioritize student-focus. Indeed, Gurevich, Stein, and Gorev (2017) who conducted one of the few longitudinal studies of preservice to inservice teacher trajectories, found such an expansion of tools and activities among the novice teachers. Alternatively, inservice teachers' valuing of knowledge and skill development with techno-activities may stem from standards-based and high-stakes environments within U.S. schools in which they must ensure their lessons align with standards and lead to achievement. It is encouraging that inservice teachers claim to value active, hands-on activities for knowledge development because this stance aligns with the research base (National Academies of Sciences, Engineering, and Medicine, 2018).

While the teachers articulate a range of affordances, the teachers' emic reasoning and values that emerged from our analysis reflect teacher perspectives. Sharing these teachers' reasoning categories with preservice or inservice teachers in learning contexts may nudge teachers to consider the value(s) technology offers when designing techno-activities and adopting tools, such as during lesson planning design sessions (Janssen et al., 2019). Ultimately, teachers may develop deeper justifications for their technological work in the classroom.

In addition to the aforementioned research directions, we suggest continued examination of teachers' reasoning by subject area teachers to determine how content- or domain-specific technologies within disciplines affect reasoning and decision-making, such as studies conducted in music (Crawford, 2010), social history (Voet & De Wever, 2017), science (Wilkerson et al., 2016), and mathematics (Niess & Gillow-Wiles, 2017). Such studies might also distinguish the instructional lesson outcomes in terms of high or low-level uses (e.g., Sherman, 2014; Voet & De Wever, 2017) because categories of teacher reasoning and TPACK do not necessarily infer deeper cognitive learning activities in practice. We also suspect that the contexts in which teachers teach will impact their valuing of technology, as illustrated by Guzey and Roehrig (2009). Thus, studies can also closely account for a school's technological context as well as the student populations teachers serve while examining the teachers' technological reasoning and action.

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