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Assessing Student Learning with Technology: A Descriptive Study of Technology-Using Teacher Practice and Technological Pedagogical Content Knowledge (TPACK)

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ASSESSING STUDENT LEARNING WITH TECHNOLOGY: A DESCRIPTIVE STUDY OF TECHNOLOGY-USING TEACHER PRACTICE AND TECHNOLOGICAL PEDAGOGICAL CONTENT KNOWLEDGE (TPACK)

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ABSTRACT

In 2013, a majority of states in the US had adopted Common Core State Standards under the Race to the Top initiative. With this adoption came the opportunity to utilize computer-delivered and computer-adaptive testing. Although the computer-based assessments were intended to assist teachers in designing classroom assessments and using student data to inform instructional practice, teacher-reported data indicated that the areas in which teachers are most unprepared, lack confidence, or are in need of development were assessment (DeLuca, 2012; Wayman et al., 2007) and technology (Brush & Saye, 2009; Kramarski & Michalsky, 2010).

The TAPS study was developed based on research in assessment literacy and in the technological pedagogical content knowledge framework. The purpose for developing this mixed-method study was the need to understand better how technology-using teachers assess student learning with technology. Two primary research questions facilitated a description of the assessment literacy and use of technology by 84 technology-using teachers. Participants in the study represented a diverse population of self-identified technology-using teachers. Quantitative and qualitative data were analyzed to provide insight into how technology-using teachers use technology to assess student learning. These data were analyzed for fitness with the TPACK theoretical model of teacher knowledge in order to fill an identified gap in the TPACK research (Cox & Graham, 2010).

The TAPS study shows that technology-using teachers who belong to professional-education organizations have higher levels of confidence in both assessment and technology. Quantitative and qualitative data collected in the study also provides insight

into the ways in which technology-using teachers think about, design, implement, and use the results of assessments in the classroom. Technology-using teachers exemplify TPACK, including attention to context at the macro, meso, and micro levels (Abbitt, 2011; Doering et al., 2009; Koehler & Mishra, 2009; Mishra & Koehler, 2005, 2006; Porras-Hernandez & Salinas-Amescua, 2013; Voogt et al., 2012). Future qualitative and quantitative research is needed into how preservice and inservice teachers use technology to assess student learning. Stakeholders in national, state, and local educational institutions need to consider how they are supporting the successful use of technology to assess student learning.

This dissertation, written under the direction of the candidate's dissertation committee and approved by the members of the committee, has been presented to and accepted by the Faculty of the School of Education in partial fulfillment of the requirements for the degree of Doctor of Education. The content and methodologies presented in this work represent the work of the candidate alone.

Lara Elaine Ervin-Kassab	December 8, 2014
Candidate	Date

Dissertation Committee

Patricia Busk	8 December, 2014
Chairperson	
Caryl Hodges	December 8, 2014
Kevin Oh	December 8, 2014

DEDICATION

To those who teach.

You care deeply,

Persist in the face of challenge,

Innovate for the benefit of students,

Encourage and support those in need,

Inspire artists, scientists, writers, parents,

And all of our children to be

The best they can be.

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CHAPTER I

INTRODUCTION

In the 2013-2014 school year, the 48 states that participate in the Race to the Top Assessment Program (RTTA) were required to begin administration of new annual assessments (U.S. Department of Education, 2010). Full implementation of the assessments was required by the 2014-2015 school year (Whalen, 2011). According to the California superintendent's report on transitioning to the new test, these assessments differed from past assessments in several ways (Torlakson, 2013). The assessments were designed to include constructed response and performance measures in addition to the traditional multiple-choice format items. These assessments also were aligned to national Common Core State Standards, focused on college and career readiness, and utilized higher order thinking skills as opposed to the primarily content knowledge orientation of previous standards (Partnership of Assessment of Readiness for College and Careers (PARCC), 2013; Smarter Balanced Assessment Consortium (SBAC), 2013). Finally, the assessments were designed to be delivered and scored electronically. It was a stated goal of RTTA to have assessments that inform "teaching, learning and program improvement" (Whalen, 2011), and the electronic nature of the scoring was intended to facilitate timely delivery of results to inform instruction. Policymakers, such as Torlakson (2013), saw the transition to the new assessments as an opportunity to transform teaching and learning in the classroom.

Development of the New Online Assessments

Two consortia were formed to develop the items for the new assessment: the SBAC and PARCC consortia. These consortia, along with partners such as Measured Progress,

developed items not only for use in the summative end-of-year assessment but also for formative interim use with the intent that the results would guide instructional practice (Bruce, 2011; King, 2011; Measured Progress, 2014; PARCC, 2013; SBAC, 2013). Items also represented a shift in traditional testing by adding short open-ended and performance items to the traditional multiple-choice format of standardized tests. Sample items were available on consortia websites to serve as models for the development of items that were more effective and that could be instructionally useful (Whalen, 2011). Interim assessments, made up of fixed sets of items, were piloted in 2012-2013 (King, 2011). The model items, electronic administration, and timely results of interim assessments were intended to allow teachers to use information about student achievement to adapt instruction prior to the summative assessment (Measured Progress, 2014; PARCC, 2013; SBAC, 2013). The inclusion of electronically augmented performance and open-ended items was intended to facilitate a focus on analytic and critical-thinking skills representing the Common Core State Standards (Bruce, 2011; King 2011). The tests were designed with the intent of supporting instructional practice of Kindergarten to 12th-grade teachers. Using items as models to design embedded instructional assessments and using data from assessments to inform instructional practice are two high-impact pedagogical strategies teachers can use that increase student learning and achievement (Black & Wiliam, 1998b; Earl, 2003; Hattie & Timperley, 2007; Heritage, 2010; Wiliam, 2010).

Potential Gaps in Implementation

Although the computer-based assessments were intended to assist teachers in designing classroom assessments and using student data to inform instructional practice, teacher-reported data indicated that assessment (DeLuca, 2012; Wayman, Cho, Jimerson,

& Spikes, 2012) and technology (Brush & Saye, 2009; Kramarski & Michalsky, 2010) were areas in which teachers lack confidence and are most unprepared, apprehensive, or in need of development. Although the availability of technology at school sites across the US was high, a U.S. Department of Education report on the integration of technology indicated that since No Child Left Behind legislation was enacted in 2002, teachers were using technology less frequently for assessment in the classroom (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, 2009). Responses to a self-report survey in the Enhancing Education Through Technology Program Final Report indicated that the use of technology to "create tests or quizzes" increased from 31% in 2005-2006 to 38% in 2006-2007. Conversely, 14% of teachers in 2005-2006 reported using technology to test students and only 9% reported doing so in 2006-2007 (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, 2009, p. 33). These results implied that teachers were utilizing technology to create quizzes that were not delivered via technology. The new national tests were given electronically, although practicing teachers were stepping away from administering classroom assessments electronically. This disconnect between expectations and reality had the potential to result in an underestimation of student achievement due to the administration effect (Bebell & Kay, 2010; Russell, 1999; Russell & Plati, 2002), which will be described in the background and need section of this chapter. There is a gap between research on practices using technology in assessment, policymaker understanding of the state of technological assessment in classrooms, and teacher

pedagogical knowledge of the affordances and constraints in using technology to assess student learning in a given content area.

An increasing need for understanding the effect of technology on pedagogical practice was evident in teacher requests for professional development. According to a national survey of teachers in 2012, there was an increased need for professional development in technology (Project Tomorrow, 2013). In 2008, only 9% of teachers responding to the survey indicated that the need for additional professional development in effectively integrating technology into instruction was an obstacle to using technology in the classroom. In the 2012 survey, 33% of teachers responded that they needed more professional development in this area. Although the survey did not address directly assessment and technology, 45% of teachers indicated that they wanted to learn more about how to use technology to differentiate and personalize learning for students (Project Tomorrow, 2013). Differentiation is a pedagogical practice grounded in the ongoing assessment of student learning (Moon, 2005). In order to design curriculum and assessments that utilize technology, teachers indicated they needed more preparation. In order to provide preparation in the use of technology and assessment, a study into how practicing teachers used technology could provide examples and insight for professional developers and preservice-teacher-preparation programs.

Literature on technology integration supported the need for professional development for teachers (Chen, Looi, & Chen, 2009; Cuban, Kirkpatrick, & Peck, 2001; Ertmer, 2005; Gray, Thomas, & Lewis, 2010; Hechter & Vermette, 2013; Hew & Brush, 2007; Hughes, 2005; Kurt, 2013; Nadelson et al., 2013; Tsai & Chai, 2012). Ertmer (2005), Hew and Brush (2007), and Tsai and Chai (2012) cited a lack of "knowledge and

skills" around technology as one of the main barriers to teacher integration of technology in the classroom. Hughes (2005) proposed that experienced teachers hold "technology-supported pedagogy" and knowledge that could facilitate "innovative uses" of technology and that this knowledge would enhance professional development opportunities for less experienced peers. Hughes (2005) posited that effective professional development in the use of technology is content specific. The idea of educational technology use as content specific was central to the technological pedagogical content knowledge (TPACK) framework proposed by Mishra and Koehler (2006). The TPACK framework provides a structure for understanding the thinking behind planning and instruction using technology. Effective professional development that is designed to overcome barriers to technology use must consider the technological, pedagogical, and content bases of teacher knowledge. Research on how technology was being used in the field by "experienced peers" provided background to teacher technology knowledge (TK) as a resource for professional developers and preservice teacher educators, as well as educational researchers.

A need for greater pedagogy, knowledge, and skills was echoed in the research around effective teacher use of assessments and data (Bennett & Gitomer, 2009; Coburn & Turner, 2011; Daniel & King, 1998; DeLuca, 2012; Frey & Schmitt, 2007; Hoover & Abrams, 2013; Kohn, 2009; Lomax, 1996; Mandinach, 2012; Militello, Bass, Jackson, & Wang, 2013; Monpas-Huber, 2010; Popham, 2009; Quilter & Gallini, 2000; Remesal, 2011; Shepard, 2008; Siegel & Wissehr, 2011; Slavin, 2002; Stiggins, 2006; Swan & Mazur, 2011; U.S. Department of Education, Office of Planning, Evaluation and Policy Development , 2011; Volante & Beckett, 2011; Young & Kim, 2010). Several studies of

teacher use of data indicated that large-scale data were not being utilized as envisioned by policymakers such as Torlakson and Whalen (Hoover & Abrams, 2013; Leighton, Gokiert Cor, & Heffernan, 2010; Militello et al., 2013, Monpas-Huber, 2010; Volante & Beckett, 2011; Young & Kim, 2010). Based on these findings, there was a need to understand teacher pedagogical knowledge in the form of assessment literacy. Understanding teacher confidence in using student achievement data could have informed professional development providers and administrators of potential knowledge and skill barriers to using the data from the new assessments to inform instruction.

Studies of teacher practices indicated that increasing teacher pedagogical content knowledge (PCK) in assessment could result in increased student learning (Black & Wiliam, 1998a, 1998b; Jones & Moreland, 2005; Park & Oliver, 2007). Definitions of PCK have included components of assessment since the coining of the term (Edwards, 2013, Jones & Moreland, 2005, Park & Oliver, 2007; Shulman, 1986). Specific PCK in assessment includes knowledge of "specific instruments, approaches, or activities" (Park & Oliver, 2007, p. 266). Edwards (2013) connected assessment capabilities in assessment with the descriptor of "assessment literacy." Edwards (2013) then connected PCK to assessment literacy (capability) stating "because of the nature of PCK and the integral role of assessment in teaching and learning, the development of PCK is a useful way of viewing the development of assessment capability for teachers." Investigating the PCK of technology-using teachers through inquiry into assessment literacy confidence and beliefs provided insights into strengths and gaps that could inform the design of trainings and coursework.

Literature on the use of technology to assess student learning was primarily non-empirical (Bennett, 2011; Cowan, 2012; Parhizgar, 2012; Redecker & Johannessen, 2013; Shapiro & Gebhardt, 2012; Swan & Mazur, 2011; Tierney, 2006; Webb, Gibson, & Forkosh-Baruch, 2013). The few studies of teacher uses of technology to assess student learning were small-scale qualitative studies, focused on the use of technology tools and only briefly addressed the assessment literacy (PCK) of the teacher using the tool (Bennett & Gitomer, 2009; Feldman & Capobianco, 2008; Johanneson, 2013). Professional development providers, administrators, preservice teacher educators, and researchers had very few examples of and insight into the complex, "wicked problem" (Koehler & Mishra, 2008) of how teachers integrate technology into their existing PCK of assessing student learning.

In educational research, little was known about how practicing teachers think about, understand, and use assessments (Young & Kim, 2010). The addition of technology as a mode of delivery of assessments and a provider of assessment results led to a need to understand teachers' PCK and confidence in using technology for assessment in order to address barriers to integrating both technology and assessment in the classroom. Research into the ways practicing teachers thought about and integrated technology into their practice (Koehler & Mishra, 2009) could have informed researchers, professional developers, and teacher educators about the complex nature of teaching and assessing with technology. Canvassing self-identified technology users, through professional organizations for technology-using teachers, provided a high likelihood of finding examples of teachers using technology for assessment. Two professional organizations of self-identified technology using teachers researchers could contact were the International

Science and Technology in Education (ISTE) and Computer Using Educators (CUE). To anticipate how the new computer-based and performance-based tests affect instructional practice, research into examples of how teachers who self-identify as technology users assess student learning using technology was needed.

Purpose of the Study

The purpose of this mixed-methods descriptive study was to provide examples of and describe how technology-using teachers understand and use technology to assess student learning. Within this purpose, technology-using teacher confidence in assessment literacy was investigated through a large-scale survey designed to provide insight into teachers' practices and concepts of the design, development, purposes, uses, analysis, and pedagogy of assessment. Respondents were asked to indicate agreement with position statements about and confidence items on the use of technology and assessment. Survey respondents were presented with open-ended items and frequency measures to gather examples of how technology was being integrated with pedagogy and content knowledge in the classroom for assessment purposes. Participants were invited to provide further insight into their technological assessment practices by participating in semistructured telephone interviews. The data gathered in this study were analyzed in order to understand how assessment and technology reflect the work of teaching with technology. The results section of chapter five presents an analysis of results using the TPACK framework as a lens, embedded in the research questions of the study. Finally, qualitative data collected within this study were examined as evidence of teacher practices, confidence, and philosophical beliefs around technology, assessment, and learning (Dexter, Anderson, & Becker, 1999; Shapely, Sheehan, Maloney, & Caranikas-Walker,

2010). Literature in both technology and large-scale assessment (Bennett, 1997; Pellegrino & Quellmalz, 2010; Puentedura, 2009) and TPACK (Koehler & Mishra, 2008; Mishra, Koehler, & Kereluik, 2009) had posited that technology can transform assessment and teaching. Qualitative data collected in the interview and open-ended items on the survey were analyzed for components of the TPACK framework to illustrate the intersection between PCK and TK. In addition to providing insight into the planning and instruction processes of teachers, this research addressed the call for more research about the TPACK framework and its component parts (Angeli & Valanides, 2009; Cox & Graham, 2009; Mishra et al., 2009).

Theoretical Framework

In 2005, with revisions in 2006, Mishra and Koehler developed a framework to explain the complex nature of the use of technology in teaching. They proposed that the introduction of technology to educational practice adds the domain of technology to Shulman's (1986, 1987) pedagogical content knowledge (PCK) framework (Figure 1). The sections that follow outline how assessment practices connect to the eight domains of teacher knowledge within the TPACK framework. These domains consist of Shulman's original constructs of pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK) augmented by the addition of technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and technological pedagogical content knowledge (TPACK). Recent conceptualizations of the TPACK framework have added an eighth construct, context, that surrounds TPACK (Doering, Scharber, Miller, & Veletsianos, 2009; Doering,

Veletsianos, Scharber, & Miller, 2009; Porras-Hernandez, & Salinas-Amescua, 2013) as shown in Figure 1

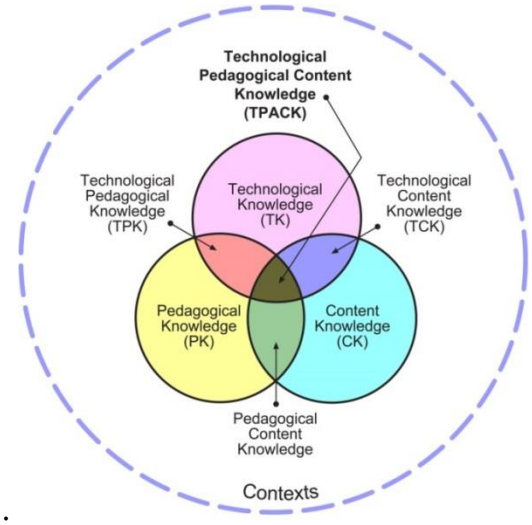

Figure 1. Graphic representation of the technological pedagogical content knowledge framework. © 2012 by tpack.org

Pedagogical Knowledge (PK)

Pedagogical knowledge (PK) describes the knowledge teachers have about how to teach and how learning occurs. PK includes a working knowledge of cognitive psychology, strategies for explaining content concepts, classroom management, and organization (Shulman, 1987). Generalized assessment literacy exemplifies PK contained in the design, development, and validity of various assessment types. The assessment literate teacher understands the pedagogy underlying fixed-response, open-ended, and performance assessments as well as the strengths and weaknesses of each type of assessment (DeLuca, 2012; DeLuca & Klinger, 2010; Mertler, 2009). Items included in the survey portion of this study attempted to measure respondent pedagogical knowledge in relation to assessment through confidence and Likert-scale self-reporting items.

Content Knowledge (CK)

Content knowledge is described as being deeper than the recall of facts; rather, teachers need to know the structure of knowledge within the specific content area they are teaching (Shulman, 1986, p. 9). This structure includes ways in which the content areas are organized and conceptualized, how new content is added to the body of knowledge, controversies and unresolved questions, and an understanding of essential knowledge within the content area.

Content knowledge is essential to assessment practice as teachers must determine what topics are essential and what topics are less of a priority in a content area. Assessments should reflect this prioritization as well as an understanding of common student misconceptions about both general and specific topics within that content area. Teachers also need to understand learning progressions (Black, Wilson, & Yao, 2011; Heritage, 2010; Hess, 2011; Popham, 2009; Wilson, 2009) in order to analyze and address student learning of topics and concepts accurately. Learning progressions are "major building blocks" of a given topic or skill laid out in a progression representing how students typically learn the material (Heritage, 2010, p. 41). Content knowledge is necessary to the development and use of learning progressions. Several survey items in this study were designed to elicit evidence of participant confidence in the area of content knowledge.

Pedagogical Content Knowledge (PCK)

Pedagogical content knowledge is the intersection between content knowledge and pedagogical knowledge but is distinct from its component parts. Pedagogical content knowledge is conceptualized as the knowledge of not only what to teach and general

strategies but also in knowing the how teaching and learning occur within a given content area (Shulman, 1987). Pedagogy and content intersect, creating a concept in which the practices and content knowledge of teachers influence one another to create a third type of knowledge for teaching (Figure 2).

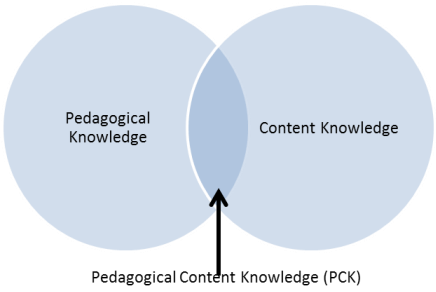

Figure 2. Graphic representation of pedagogical content knowledge.

Magnusson, Krajcik, and Borko (1999) and Grossman (1990) divided PCK into five distinct components, one of which is assessment. For the purpose of this study, PCK was conceptualized at the more general, three-component level, as described by Shulman (1986, 1987). In addition to simplifying the focus of the study, Shulman's three-component construct frequently has been used within research into the thought processes and actions of teachers, primarily in studies of preservice and science teachers (Grossman,1990; Magnusson et al., 1999; Park & Oliver, 2008; Veal & MaKinster, 1999).

Although Shulman's (1987) work incorporated a brief discussion of assessment within the PCK framework, researchers have continued to elaborate on the connections between pedagogical content knowledge and assessment practices (Abell & Siegel, 2011; Brookhart, 2011; Edwards, 2013; Jones & Moreland, 2005; Magnusson et al., 1999; Park & Oliver, 2008. The description of the pedagogy, philosophy, and practical applications

of teacher knowledge of assessment based in PCK is often called "assessment literacy" (DeLuca, 2012; Edwards, 2013; Mertler, 2009). Although assessment literacy is described in many different ways by various researchers (Abell & Siegel, 2011; Brookhart, 2011; DeLuca & Klinger, 2010; Leighton et al., 2010; Mertler & Campbell, 2005; Popham, 2009; Stiggins, 1991), all of the definitions include several core components: a teacher's knowledge of what to assess (content), how to assess and evaluate qualities of assessments (pedagogy), how to interpret results in content areas, and how results influence instruction (pedagogical content knowledge). These elements are present in the 1990 Standards for Teacher Competence in Educational Assessment of Students (American Federation of Teachers, National Council of Measurement in Education, & National Education Association, 1990). Although criticism about explicit mention of PCK in the Standards is present (Brookhart, 2011), several of the assessment behaviors described in the standards align well with several domains of TPACK (Table 1).

Pedagogical content knowledge is essential to assessment literate practices. It is within the construct of PCK that one can see the transformation of content knowledge and pedagogical knowledge into a new and distinct form that is more than its constituent parts. In order to assess student learning accurately, teachers need to know content and expected learning progressions for topics within that content, as well as appropriate measures for accurately assessing student learning (DeLuca & Klinger, 2010; Mertler, 2009). The combination of pedagogical understandings of assessment design and the psychology of learning combined with content-focused learning progressions exemplify pedagogical content knowledge. Teachers who effectively use assessments set clear

Table 1

C, CK, P, PCK Elements Embedded within the Activities and Knowledge Described in the 1990 Standards for Teacher Competence in Educational Assessment of Students

TPACK Element	Activities and Knowledge
Context	Understand students' cultural backgrounds, interests, skills, and abilities as they apply across a range of learning domains and/or subject areas. Use and evaluate assessment options available to them, considering among other things, the cultural, social, economic, and language backgrounds of students.
Content Knowledge	Clarify and articulate the performance outcomes expected of pupils. Identify gains and difficulties pupils are experiencing in learning and performing learning goals.
Pedagogical Knowledge	Assessment options (used) are diverse and include text- and curriculum-embedded questions and tests, standardized criterion-referenced and norm-referenced tests, oral questioning, spontaneous and structured performance assessments, portfolios, exhibitions, demonstrations, rating scales, and so on. Know and follow appropriate principles for developing and using assessment methods in their teaching.
Pedagogical Content Knowledge	Give contingent, specific, and credible praise and feedback. Analyze assessment information gathered before and during instruction to understand each student's progress to date and to inform future instructional planning.

learning targets based on formal or informal learning progressions, monitor student progress, and determine the level of understanding students have about a content area (American Federation of Teachers et al., 1990; Brookhart, 2011; Earl, 2003; Wiliam, 2010). Confidence and Likert-scale items about planning and implementing assessments provided opportunities for obtaining information regarding PCK in this study.

Technological Knowledge (TK)

Technological Knowledge (TK) refers to the ability to explore, learn about, and use technology. Technology constantly changes, and teachers need to have a certain amount

of knowledge about hardware and software in order to trouble-shoot and investigate new technologies (Mishra & Koehler, 2006). Technological knowledge is focused on adaptability, creativity, and the ability to recognize the uses technology can have in schools (Koehler & Mishra, 2008). The survey in this study included items designed to measure respondent confidence, frequency of use, and skill with technology. These items reflected TK.

Technological Content Knowledge (TCK)

Technological content knowledge (TCK) describes the knowledge of what and how given technologies shape or are used within a content area (Mishra & Koehler, 2006). For instance, a biological sciences teacher would have procedural content knowledge around how to use compound microscopes (technology) to investigate the parts of a cell (essential content). The same biology teacher also would have an understanding of how biotechnology is adding to the body of knowledge about science and how the technology fundamentally affects ideas about the study of biology. TCK also involves an understanding of how the technology is both "an influence and constraint" within a content area (Koehler & Mishra, 2008, p. 16). Technology has constraints and limitations in a content area, for instance carbon dating can give an idea but not an exact time of death of a life-form because the half-life of C14 is conceptualized in a range of years, not months, days, or hours. Technology provides affordances around accessing information as well as the ability to investigate content in greater depth, for instance scanning electron microscopes are able to display smaller structures in greater detail than compound microscopes. Additionally, Koehler and Mishra (2008) explained that TCK also involves how technology supports and shapes representations within a content area. They cited the

use of technology as a metaphor to explain a content concept with the example of a heart described as a pump (p. 17). Prior to the pump technology becoming part of the general knowledge of a population, the metaphor of a heart as a pump would not have been understood. Additional research into TPACK has utilized the definition of TCK as situated in the use of technology to represent content (Baran, Chuang, & Thompson, 2011; Cox & Graham, 2009). Although not all content-area teachers assess technology knowledge explicitly, an understanding of the role of technology in a content area is often present in the curriculum.

The development of assessment items may use technology as a metaphor or may involve students understanding of how technology affects the content area. Teachers must understand the role of technology within the content area in order to generate contextually appropriate assessments. Understanding how historians use technology to read, analyze, and interpret historical sources would lead to the construction of an assessment that demonstrates TCK for the content area of history. Several items in the survey for this study elicited knowledge of the affordances, constraints, and content area application of technology in the attempt to measure TCK.

Technological Pedagogical Knowledge (TPK)

Technological Pedagogical Knowledge (TPK) refers to knowledge around how to use technology for instruction, classroom management, instructional design (general), and assessment. TPK also includes an understanding of how the use of technology can influence teaching and learning in the classroom (Koehler & Mishra, 2005, 2008; Mishra & Koehler, 2006). The repurposing of a technology for use in a pedagogically appropriate manner in the classroom requires a solid knowledge of pedagogy and a

creative approach to technology (Koehler & Mishra, 2008). For instance, the use of spreadsheets as gradebooks is an example of a repurposed technology that is now so much a part of teaching practices as to be unnoticeable as a technology. Student response systems, which were applied in the business world as marketing tools, can now facilitate immediate and specific feedback to both teachers and students when used for assessment (Boscardin & Penuel, 2012; Penuel, Boscardin, Masyn, & Crawford, 2007).

Affordances and constraints enter the conceptualization of TPK and assessment in the application of a given technology for a specific type of assessment. If the learning goal for a specific content topic requires students to evaluate a concept critically, the use of student response systems is not appropriate pedagogically as the technology constrains the types of answers students can provide. Having a shared discussion board or online workspace would be a much more appropriate pedagogical tool for assessing critical thinking; however, it would not be the technology of choice for a learning goal that requires verbal interaction. TPK functions in teacher decision-making about technologies to use for learning and for the format of assessments. The survey portion of the proposed study contained items designed to measure the TPK of respondents. TPK was revealed through open-ended-item responses and interview data.

Technological Pedagogical Content Knowledge (TPCK or TPACK)

The intersection of technology, pedagogy, and content knowledge creates a new type of knowledge, technological pedagogical content knowledge, or TPACK (Koehler & Mishra, 2006). Teachers exemplify TPACK in designing and delivering instruction and assessment in ways that not only utilize but also are integral to student learning. Koehler and Mishra (2008) stated that

> TPACK is the basis for effective teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (pp.17-18)

Mishra and Koehler (2006, 2008) described this balance as an equilibrium between elements; however, Doering, Scharber et al. (2009) posited that the balance of interactions within TPACK is both content and knowledge dependent. Doering, Scharber et al. (2009) described teachers as having a pedagogically-dominated knowledge base or technology-dominated knowledge base that would influence the decisions around how and for what purposes teachers use technology. Whether the teacher plans a lesson focused on pedagogy with technology as a supporting role or vice versa depends on both what is known by and the philosophy of a teacher. These knowledge bases also may be constrained by access to technology, causing a more pedagogically dominated knowledge base to be enacted. The responses to open- and closed-ended items provided additional evidence for the observation made by Doering, Scharber et al. (2009).

TPACK is complex, requiring not only knowledge of the three domains of knowledge but also insight into the affordances and constraints of the domains (Koehler & Mishra, 2008). Examining the use of technology for assessment is an ideal area for investigating TPACK thinking. Figure 3 represents a potential frame for how the three knowledge domains are present within the design and development of a technological assessment. As a teacher or test developer moves through the process of developing an assessment, considerations of content, affordances, and constraints of technology and pedagogical practice in assessment-type construction constantly interact with one

another. As the three domains interact in the development of an assessment, they have the potential to be transformed. Specific PK, CK, and TK assessment behaviors can interact to facilitate the development of interactive, technology-enhanced, cognitively-challenging performance items that would sit in the TPACK domain (Figure 3). Open-ended survey and interview items were designed to elicit evidence of participant TPACK.

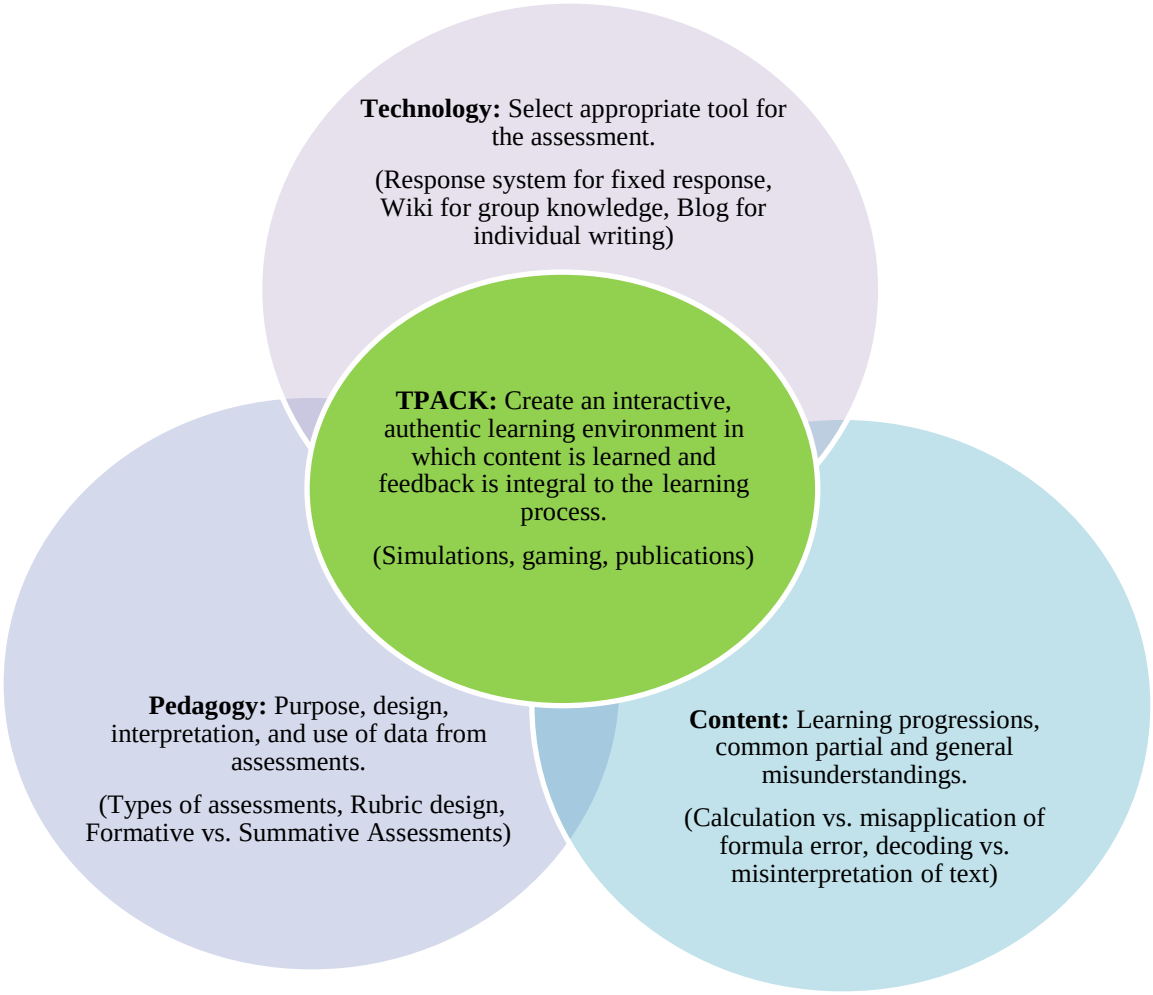

Figure 3. Graphic representation of the alignment of assessment practices and TPACK

Contexts (C)

The most recent addition to the conceptual framework for TPACK has been an understanding of how context shapes the thinking and actions behind teacher use of

technology. Doering, Scharber et al. (2009) conducted a study in which the metacognition and TPACK conceptualization of 20 geography teachers participating in professional development was studied. In addition to providing insight into how the TPACK framework could map onto the thinking and planning of teachers, it was noted that context also had an effect on choices that were made around using technology in the classroom. Doering, Scharber et al. (2009) described the factors of classroom culture, school and district policy, and student characteristics as being important considerations in the use of the types of knowledge inherent in the framework (p. 336). Context has been interpreted as the availability and access to technology and how access to various technology tools affords or constrains the use of TPACK in the classroom.

In 2013, Porras-Hernandez and Salinas-Amescua published an article that proposed examining context in TPACK at macro, meso, and micro levels, with considerations for teacher and student perspectives. They described macro-level contextual factors as being national or global political, social, and economic factors. Examples of macro-level factors would be the global digital divide and No Child Left Behind (NCLB) or Race to the Top (RTTA) in the United States. Meso-level factors influencing teacher TPACK were described as more localized community or school-level conditions. Some of these conditions are influenced by macro-level factors; local pressures on a teacher would be affected by a school being designated as under performing in NCLB. Other factors may be independent of larger initiatives, such as parent, peer, or principal attitudes and beliefs about technology. The micro-level factors were described as those factors that occur at the classroom level. Knowledge of student backgrounds, interests, and learning styles might be a micro-level student-centered factor. Teacher epistemological beliefs about

technology, learning, and students also may play a role in the micro-level context in TPACK.

Context has been represented in assessment research in several ways. One context-related element in assessment knowledge is the question of how assessment is perceived in the culture of the classroom. Heritage (2010) posited that the effective use of formative assessment in the classroom depends on the classroom climate established by the teacher. Students in the classroom need to perceive assessment as a positive, valuable, and meaning-making endeavor. Another element in which context plays a role in assessment practice is in the design of assessment items. Design principles for equitable assessment items include considerations of linguistic complexity (Abedi, 2004; Popham, 2003, p. 69) and cultural validity (Basterra, Trumbull, & Solano-Flores, 2011). Both considerations are necessary to ensuring that the core content construct is being measured, rather than language or culture. The addition of technology to the assessment has implications for considering the context of the "digital divide" in both the comfort that comes from access to technology (Warschauer, Knobel, & Stone, 2004; Warschauer & Matuchniak, 2010) and in the digital literacy of students who will be completing the assessment (Schleicher, 2011). Within the study, context was represented in survey items about classroom culture and knowledge of students. Additional information around the limitations and affordances of context was collected through two survey questions around support for technology use in the classroom.

Background and Need

Assessment of student learning has been a focus of educational research for decades (Black & Wiliam, 1998a; Brookhart, 2011; McMillian, 2001; Stiggins & Bridgeford,

1985). The NCLB act of 2001 focused national attention on the assessment of student achievement with repercussions for schools and teachers whose students did not achieve certain scores on standardized tests. In 2010, federal funding was tied to state participation in an augmentation of NCLB through the RTTA fund. Online tests required under RTTA were piloted in 2012-2013. Policymakers expressed hope that the new standards, technology, and tests would influence teacher assessment practice (Torlakson, 2013). In order to understand how these hopes could become a reality, teacher assessment and technology practices needed to be studied.

The concept of assessment literacy, or the ability of teachers to design, develop, administer, analyze, and act upon assessments, was an important part of the essential work of teachers. Pedagogical content knowledge (PCK) as proposed by Shulman in 1986 was the core work of teachers in which pedagogical knowledge (how to teach an idea) intersects with content knowledge (what is being taught). Assessment of student learning exemplifies this intersection as teacher actions in analyzing, selecting, and constructing assessments reflect both pedagogical knowledge (of assessment types and purposes) and content knowledge (student understandings and misconceptions). The knowledge and use of appropriate assessment practices by teachers has been referred to as assessment literacy (DeLuca & Klinger, 2010; Edwards, 2013; Plake, Impara, & Fager, 1993; Popham, 2009; Stiggins, 1995, 2006).

The construct of assessment literacy of inservice and preservice teachers has been surveyed in Canada (DeLuca & Klinger, 2010) and in the United States (Mertler & Campbell, 2005; Plake et al., 1993). Large-scale survey research of teacher assessment literacy has been sparse; some studies of teacher assessment literacy in the United States

have focused on investigating classroom assessment practices (McMillian, 2001; Stiggins & Bridgeford, 1985). Stiggins and Bridgeford (1985) administered a descriptive questionnaire to 228 teachers representing a range of grade levels, geographic locations, and socioeconomic environments in the United States. The researchers solicited information on performance assessments, teacher-created assessments, published assessments, and how teachers utilized these various assessments. Recommendations from this study included supporting teachers with more assessment training and knowledge as well as more research on teacher assessment practices in the classroom. In 2001, McMillian (2001) published a study in which Virginian secondary teachers' assessment and grading practices were investigated using a survey of 34 closed-ended items. Recommendations from this study also included focusing research on classroom practices and awareness of the classroom frame as a need within instruction in assessment.

Studies have shown that teachers utilized teacher-made assessments for grading and decisions about instruction (Plake et al., 1993; McMillan, 2002; Stiggins & Bridgeford, 1985). Teachers utilize assessments in grading decisions (Brookhart, 2007), during instructional decisions, and formatively in the classroom (Black & Wiliam, 1998a). Although assessment has been observed to be between 30% and 50% of teaching time (Stiggins, 1995), teachers still reported that assessment is an area in which they needed more professional development (DeLuca, 2012; Wayman et al., 2012. Informal, observational assessments of student learning in the classroom are valued by teachers (Stiggins & Bridgeford, 1985); however, information from large-scale standardized tests was often seen as having "limited usefulness"(Young & Kim, 2010, p. 3) for instruction

due to the time lag between testing and results as well as a lack of alignment to curriculum. The online format of the Common Core State Standards assessments was intended to address the time-related limitations of the use of annual tests (King, 2011; Whalen, 2011). Although the technology addressed the timeliness of delivery of data, there was limited research on whether teachers have the knowledge, skill, and confidence to use the assessment data to improve instruction (Coburn & Turner, 2011; Daniel & King, 1998; DeLuca, 2012; Hoover & Abrams, 2013; Leighton et al., 2010).

Teachers needed assessment literacy and technology knowledge in order to understand the difference between the interim and summative online assessments provided by testing consortia. Measured Progress, one of the contractors developing interim assessment items and tests, had online options for delivering assessments. These assessments were delivered using pencil-and-paper or student-response systems. Districts selected items to create their own interim assessments for teachers to administer in grades three through eight and high school (Measured Progress, 2014). The summative assessments created by PARCC and SBAC utilized online metrics and analytics that provide more specific information about individual student strengths and weaknesses (PARCC, 2013; SBAC, 2013). The interim assessments developed by Measured Progress and independent districts were computer-based tests (CBT), whereas those developed by the larger consortium were computer-adaptive tests (CAT).

CBTs were delivered electronically and were analogous to paper-and-pencil tests (Parhizgar, 2012). These tests may have had some augmentation in providing online dictionaries and other electronic support materials, but all students received the same items in the testing experience. CATs provided a different level of diagnosis of a

student's knowledge or ability (Shapiro & Gebhardt, 2012). CATs provided students with items based on how they respond to previous items. If a student responded incorrectly on an item measuring a given construct, the computer adaptively selected an easier item as the next item. Conversely, if a student responded correctly to an item, the computer provided one of a higher level of difficulty. Results from CATs were more fine-grained than CBTs regarding a given student's strengths and weaknesses on a construct. If teachers were expected to utilize information from interim (CBT) and summative (CAT) assessments, it was important for them to know the difference between the two modes. This assessment literacy knowledge was a survey item within this study.

Another facet of computer-based testing that could have led to misinformed instructional decisions was a disconnect between the mode of instruction and the mode of assessment administration. Research on the effects of modes of administration of assessment has shown that administering an assessment electronically when instruction was presented in an analog format, or vice versa, can lead to inaccuracies in measuring student achievement (Bebell & Kay, 2010; Russell, 1999; Russell & Plati, 2002). It was unclear whether teachers were aware of this disconnect that could affect students' ability to do well on a computer-administered test. Also unclear was whether teachers were aware of the potential to underrepresent student achievement by delivering instruction in an electronic mode but having student assessments delivered through paper-and-pencil mode or vice versa. In the body of research, the disconnect between modes of instruction and modes of assessment led to underrepresentation of student achievement (Bebell & Kay, 2010; Russell, 1999; Russell & Plati, 2002). The national consortia tests were designed to be delivered online and teacher evaluations were tied to student achievement

on the tests through RTTA (U.S. Department of Education, 2010). In order to plan instruction that would result in accurate achievement scores on the national tests, teachers needed to understand the importance of aligning the modes in which students were assessed in the classroom with the modes in which the tests were delivered. Within the study, teacher confidence in utilizing technology and understanding the differences in formats of national tests was measured. Additional closed-ended frequency items were intended to reveal patterns of use of technology in assessing student learning.

The design of the summative assessments took advantage of the affordances that electronic delivery provided. The summative assessments designed by both SBAC and PARCC utilized CAT, in which student responses determined the next items presented to students, dependent upon correct or incorrect responses (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, 2011). Although CAT had the potential to provide teachers with very useful and targeted information about individual student skills and knowledge, it was unclear how the data were going to be communicated to teachers. Teacher educators and professional development personnel needed to know whether teachers had the confidence in their assessment literacy embedded in technological pedagogical content knowledge to utilize the data from both summative and interim (benchmark) assessments. This confidence would have affected teacher abilities to improve instruction using practices recommended by assessment researchers such as Brookhart (2011) and Popham (2009).

Teachers reported being unprepared to utilize technology in teaching (Brush & Saye, 2009; Kramarski & Michalsky, 2010). This study canvassed self-identified technology-using teachers in an attempt to overcome this obstacle. The technological pedagogical

content knowledge (TPACK) framework was used to illustrate teacher knowledge for incorporating technology into classroom instructional practice of technology-using teachers; however, little was known about the role TPACK played in assessment (Mishra & Koehler, 2006). The pedagogical focuses of TPACK and assessment literacy were frames for investigating practices that could inform professional development in technology to guide teacher practice. A deeper understanding of the interplay between assessment literacy and TPACK could be very valuable for teacher educators and technology developers.

The TPACK framework has been a growing subject of study in both preservice and inservice teacher contexts (Abbitt, 2011; Chai, Hwee, Koh, & Tsai, 2010. The framework has been the subject of scrutiny and critique (Angeli & Valanides, 2009; Cox, 2008 Cox & Graham, 2009), and a need for more studies around how the framework was enacted has been expressed (Abbitt, 2011; Ertmer, 2005; Harris et al., 2010; Mishra & Koehler, 2010).

Little was known about how teacher practice reflects the research on the potential uses of technology in assessing student learning. In the 2009 Enhancing Education Through Technology (EETT) final report, EETT professional development funds were reported as most frequently being used for training on grading with technology, followed by training on technological curriculum development, locating resources on the Internet, and new teaching methods (U.S. Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service, 2009). There was little detail around whether the grading training was in the use of electronic gradebooks or in developing assessments to grade electronically. Implementation

findings from the same report revealed teacher reports of increasing the use of technology to develop and present curricula, while decreasing the use of technology for student assessment. With the increased focus on using computer-delivered and computer-adaptive standardized tests, it was important to learn about teacher confidence and understanding around planning for and delivering assessments using technology.

There was a need to measure teachers' confidence in assessment and technology, to gather examples of use of technology to deliver and assess student learning, and to explore how the confidence and examples represent technological pedagogical content knowledge. This understanding could inform how districts and states should roll out the new assessment system, how teacher preparation programs might prepare preservice teachers to use technology, and the development of training to support inservice teachers in effectively utilizing all aspects of the technology-focused assessment system. Examples of effective use of technology also could facilitate the effect formative assessment practices described by Black and Wiliam (1998a). These practices could result in increased student achievement. Early adopters of technology for use in assessing student learning were often members of technology using educator networks; it was primarily within this population that initial research took place. Without an understanding of a baseline of teacher assessment literacy, curriculum-embedded teacher-created assessments, and confidence in using data from large-scale assessments, the models and results of the new assessments may not have been used as policy and development representatives proposed.

Research Questions

Two questions and nine second-order questions guided the study:

1. How do self-identified technology-using teachers design, deliver, and use assessment technology?
    a. What technologies do technology-using teachers use to assess student learning?(TK)
    b. How do technology-using teachers develop assessments? (PK, PCK)
    c. How do technology-using teachers deliver assessments using technology? (TPK, TPACK)
    d. For what purposes do technology-using teachers use assessments?(PK, TPK)
    e. What do technology-using teachers do with assessment results?(PK, TPACK)
    f. What are the barriers to using technology to assess student learning?(TPACK, Context)

2. What is the assessment literacy of technology-using teachers?
    a. How confident are technology-using teachers in assessing student learning? (PCK, PK)
    b. What are the knowledge and beliefs about using technology of technology-using teachers?(TPK, TCK, TPACK)

c. How has the technology used in assessment affected assessment practices, knowledge, and beliefs of technology using teachers?

Educational Significance

Exploring teacher confidence and beliefs about assessment, technology, and the use of technology to assess student learning provides insight for teacher educators, professional developers, administrators, academic researchers, and practitioners to anticipate potential barriers to using large-scale, technology-delivered assessments to improve instruction. Understanding teacher confidence in using technology for assessment provides information researchers should use to interpret potential pencil-and-paper and computer-administration effects on scores in high-stakes testing (Russell, 1999; Russell & Plati, 2002). Investigating teacher pedagogy, knowledge, and examples of using technology for assessment should inform professional development and preservice teacher education to help teachers capitalize on the affordances of technology in assessment.

Examples of ways in which teachers employ technology to assess student learning will add to the body of literature around the TPACK framework. Researchers have expressed a need for further examples and measures of TPACK (Mishra, Koehler & Henriksen, 2011; Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013). The survey utilized in this study was a new measure of TPACK that was focused on assessment. Qualitative data collected through open-ended items and interviews answered the call for more research into the TPACK framework. The results of an examination of the TPACK framework and teacher thinking and processes around technology use in virtual and

physical classrooms could be utilized in the development and delivery of training in technology in both preservice and inservice teacher development programs.

The study has the potential to inform researchers, administrators, professional development providers, and teacher educators about classroom teacher confidence in assessment literacy, models for using technology to assess student learning, and the application of the TPACK framework to assessment practices. This knowledge could be used to design learning opportunities that decrease barriers to use of technology to assess student learning.

Definition of Terms

Within the bodies of literature around both assessment and technology, various terms have been defined differently. For the purpose of this study, the following definitions were utilized:

Assessment refers to vehicles for collecting data on student learning, understanding, or achievement. In this study, participants were asked to describe an assessment in order to understand better participant beliefs and knowledge of assessment. Assessment refers to a range of activities, including but not limited to formal testing, checks for understanding, performance assessment, progress monitoring, diagnostic, formative, and summative activities (Brookhart, 2011; Popham, 2009; Wiliam, 2010).

Assessment literacy is the base of pedagogical content knowledge participants have around the design, development, administration, analysis, and interpretation of assessments. Assessment literate individuals understand types, purposes, limitations, and advantages of different assessment tools. Assessment literate individuals have a working knowledge of how to align learning objectives and assessment criteria, construct different

types of assessment items, analyze pre-existing assessment items for validity to the construct being measured, read and analyze data provided by large-scale as well as text and teacher-created assessments (DeLuca & Klinger, 2010). Assessment literacy is nested within teacher pedagogical content knowledge (Edwards, 2013; Jones & Moreland, 2005). Within this study, assessment literacy was defined as the knowledge and use of appropriate assessment practices by teachers (DeLuca & Klinger, 2010; Plake et al., 1993; Popham, 2009; Stiggins, 1991, 2006). Assessment literacy was investigated through items within the survey and interview. Teacher knowledge of assessment types, construction, design, validity, and philosophies of assessment were investigated through closed items. Teacher assessment practices were investigated in closed items; however, open-ended items were designed to elicit examples of practices that could reveal levels of assessment literacy as well. Follow-up interviews focused on gathering data around practice in order to inform a deeper understanding of the assessment literacy of participants.

Content knowledge (CK) is described as being deeper than the recall of facts; rather, teachers need to know the structure of knowledge within the specific content area they are teaching (Shulman, 1986, p. 9). Within this study, the structure included ways in which the content areas are organized and conceptualized, how new content is added to the body of knowledge, controversies and unresolved questions, and an understanding of essential knowledge within the content area.

Context (C) has been interpreted as the availability and access to technology (tpack.org) and how access to various technology tools affords or constrains the use of TPACK in the classroom (Porras-Hernandez & Salinas-Amescua, 2013). Within the

proposed study, context was represented in survey items about classroom culture and knowledge of students. Context also surfaced in coded interview data around technology, policy, culture, and students.

Formative Assessment describes the activities, both formal (recorded) and informal (observational) in which teachers collect, synthesize, and act upon evidence of student learning. Formative assessment practices include clear learning goals focused fewer items in depth, a plan for determining progress toward learning goals, the ability to provide timely, specific feedback on progress, and analysis skills for modifying instruction based on the results of the assessment (Brookhart, 2011; Earl, 2003; Wiliam, 2010). Within the literature on formative assessment, peer and student use of assessment information to drive their own learning is an emerging strand of practice (Black & Wiliam, 2009a; Wiliam, 2010) at advanced levels of understanding and implementation of formative assessment practice.

Pedagogical knowledge (PK) describes the knowledge teachers have about how to teach and how learning occurs. PK includes a working knowledge of cognitive psychology, strategies for explaining content concepts, classroom management, and organization (Shulman, 1987).

Pedagogical content knowledge (PCK) is the intersection between content knowledge and pedagogical knowledge but is distinct from its component parts. Pedagogical content knowledge is conceptualized as the knowledge of not only what to teach and general strategies but also in knowing the how teaching and learning occur within a given content area (Shulman, 1987).

Summative Assessment describes an assessment that is used as an ending point for a unit, lesson, or course. Summative assessments often cover a broad range of knowledge and practice. These assessments, in practice, do not inform further teaching of content to a given set of students who complete the assessment. Summative assessments may inform teaching practice in general, but are designed and developed to be end-point assessments (Brookhart, 2011; Earl, 2003).

Technological Content Knowledge (TCK) describes the knowledge of what and how given technologies shape or are used within a content area (Mishra & Koehler, 2006).

Technological Knowledge (TK) refers to the ability to explore, learn about, and use technology. Technology constantly changes, and teachers need to have a certain amount of knowledge about hardware and software in order to trouble-shoot and investigate new technologies (Mishra & Koehler, 2006). Technological knowledge is focused on adaptability, creativity, and the ability to recognize the uses technology can have in schools (Koehler & Mishra, 2008).

Technological Pedagogical Content Knowledge (TPCK or TPACK) The intersection of technology, pedagogy, and content knowledge creates a new type of knowledge, technological pedagogical content knowledge, or TPACK (Mishra & Koehler, 2005, 2006). TPACK was operationalized as the design and delivery of instruction and assessment using technology that not only utilizes but also is integrated into the pedagogy and content knowledge to foster student learning.

Technological Pedagogical Knowledge (TPK) refers to knowledge around how to use technology for instruction, classroom management, instructional design (general), and assessment. TPK also includes an understanding of how the use of technology can

influence teaching and learning in the classroom (Koehler & Mishra, 2005, 2008; Mishra & Koehler, 2006).

Technology can describe tools and techniques for instruction (Koehler & Mishra, 2009). In this study, technology referred to computerized, digital, or electronic tools.

Summary

In 2013, a majority of states in the US had adopted Common Core State Standards under the Race to the Top initiative. With this adoption came the opportunity to utilize computer-delivered and computer-adaptive testing. Policymakers envisioned these computer-based tests as a powerful tool for teachers (Torlakson, 2013). Although the computer-based assessments were intended to assist teachers in designing classroom assessments and using student data to inform instructional practice, teacher-reported data indicated that the areas in which teachers are most unprepared, lack confidence, or are in need of development were assessment (DeLuca, 2012; Wayman et al., 2007) and technology (Brush & Saye, 2009; Kramarski & Michalsky, 2010). Little was known about how inservice teachers use and understand technology for assessment purposes.

The proposed study contributed to the understanding of how teachers use technology to assess student learning by canvassing several groups of educators for participation in a survey. Survey items were developed with assessment literacy and the technological pedagogical content knowledge (TPACK) framework as bases. Quantitative and qualitative methods were utilized to investigate the knowledge and practices of teachers in order to fill an identified gap in the TPACK research (Cox & Graham, 2010) as well as to provide an additional measure of TPACK (Koehler & Mishra, 2009; Voogt et al.,

2013). Using the primarily pedagogical lens of assessment practice to investigate technology use broadened the field of TPACK research.

Gaining a better understanding of technology and assessment literacy in practice contributed models to meet the needs of professional development experts, teacher education faculty, and policymakers. Although there has been an emphasis on teacher use of technology and assessment to improve teaching and learning, few models and examples exist for actual practices. The study began the investigation into teacher practice by providing examples of use as well as opening up avenues for sharing these practices with current and future teachers.

CHAPTER II

REVIEW OF THE LITERATURE

Teacher-reported data indicated that assessment (DeLuca, 2012; Stiggins, 2006; Wayman, Cho, Jimerson & Spikes 2012 and technology (Brush & Saye, 2009; Kramarski & Michalsky, 2010) were two areas in which they are most unprepared, apprehensive, or in need of professional development. Changes in national educational policy in the US in 2009 had resulted in the development of computer-delivered and computer-scored assessment items (e.g., SmarterBalanced Assessment Consortium, Partnership for the Assessment of Readiness for College and Careers). Educational policy leaders, such as California Superintendent of Schools Tom Torlakson (2013) had issued statements that the new online assessments would have facilitated classroom assessment practices. In a search of research into how classroom teachers use technology, the use of technology explicitly for assessment purposes was minimal. Similarly, research on assessment literacy and practice of teachers focused primarily on nontechnological pedagogical knowledge. Much of the research that dealt with teachers' use of assessment and technology was theoretical, device-based, or related to summative, large-scale assessments rather than classroom practice. A review of published research using several electronic databases and search engines (EBSCO, ERIC, GoogleScholar, Fusion) with the search terms "technological assessment," "e-assessment," "teacher use of technology to assess," and "technology assessment" primarily returned the results described above. The purpose of this study was, therefore, to address this gap in the literature through describing how technology-using teachers understand and use technology to assess student learning.

The introduction of the Technological Pedagogical Content Knowledge (TPACK) framework (Koehler & Mishra, 2005; Mishra & Kohler, 2006) had provided a conceptual framework for research into teachers' thinking about and use of technology in teaching. Several published literature reviews of existing TPACK research indicated that much of the research using this framework was theoretical in nature rather than empirical and focused on preservice teachers rather than experienced professionals (Abbitt, 2011; Chai, Hwee, Koh, & Tsai, 2010; Kelly, 2010; Kohler, Shin, & Mishra, 2012). Those studies that did focus on experienced professionals tend to be qualitative in nature, primarily consisting of case studies and analysis of observed teaching artifacts (e.g., lesson plans, observed lessons, etc.). This study also provided additional empirical research and insight into the technological pedagogical content knowledge of experienced teachers.

The purpose of this study was to describe how technology-using teachers understand and use technology to assess student learning. Within this purpose, technology-using teacher confidence in assessment literacy was investigated through a large-scale survey designed to provide insight into teachers' practices and concepts of the design, development, purposes, uses, analysis, and pedagogy of assessment.

The review of the literature that follows describes qualitative case-study research into the relationship between technology and teacher assessment practices, quantitative measures of teacher assessment literacy, and large-scale TPACK survey research focused on inservice teachers.

Teacher Use of Technology to Assess Student Learning

The empirical research on teacher use of digital technologies to assess student learning was sparse. A search with the terms "technology," "teacher," and "assessment"

yielded a plethora of studies about new teacher portfolios, theoretical articles on how teachers ought to be using assessment, and assessments of teacher technology-use patterns. Revising the search to include "e-assessment" resulted in numerous European studies focused on higher education. Adding the term "formative" to "assessment" again resulted in few empirical studies, and these primarily focused on the use of student response systems (SRS) or "clickers." Many of these studies focused on engagement levels of students, rather than the assessment capabilities and potential pedagogical shifts present in the use of technology for assessing learning. The following section describes three studies that focused on teacher use of technology specifically for assessment of student learning rather than for delivery of instruction.

In 2008, Feldman and Capobianco published case-study research within a larger grant study. The purpose of the research was to investigate how physics teachers use personal response systems in a technology-enhanced formative-assessment environment. The researchers reported that as the larger study progressed, the principal investigators noticed a potential area of research into what changes were necessary in teacher practices to facilitate the use of technology in formative assessment. To this end, the researchers attempted to answer two research questions: Were the physics teachers able to incorporate technology enhanced formative assessment using SRS into their practice and what did the physics teachers need to learn in order to do this?

The research took place in the context of a two-phase professional development project. The professional development consisted of a traditional workshop and an active research group as the teachers put their learning into practice. The part of the project within which the data were collected occurred in 1999-2001. Data were collected through

ethnographic research methods and collaborative conversations. Multiple data points were used to develop a rich story of how the process of integrating SRS into the physics curriculum might take place.

Eight high-school teachers from the Northeastern US participated in the study. There were more men (5) than women (3) in the study, and a range of experience and grade levels taught were represented. Data were collected on each of the participants through observations, artifact gathering, and notes from collaborative conversations and interviews that took place during the first year of the grant study.

Teachers' concepts of formative assessment changed "dramatically" over the course of the first year of the study. Researchers reported that teachers developed stronger understanding of formative assessment and utilized the SRS for formative learning purposes such as reviewing material for exams, midstream formative assessment, and quiz games. Additionally, teachers demonstrated techniques for activating prior knowledge and engaging students in content through using SRS to survey student attitudes and feelings, stimulate classroom discussion, introduce new ideas, and have students make predictions about phenomena.

Although participants in the project had success with the SRS and experienced growth in their understanding of formative assessment practices, there were also areas of concern for implementing SRS. Logistics for learning the hardware and the software (timing, resource allocation, and professional development) represented barriers teachers had to overcome. The researchers provided assessment items for use in physics classrooms with SRS, and teachers indicated they wanted assessment items with "better fit" with their context or topic matter. Teachers also struggled with constructing quality

assessment items for use with SRS. Participants found it easy to complete the first steps in construction, relating the assessment item to the topic taught and using language with which students are familiar. Participants struggled with managing the creation of engaging, challenging, but not frustrating assessment items and with designing multiple-choice answers to reveal student misconceptions of the content.

Although the research within this study was dated in terms of technology research, both technological and pedagogical shifts were present for teachers. The SRS study also compiled ways in which teachers were using the technology in their day-to-day classrooms. The Teacher Assessment Practices Survey (TAPS) study included open-ended items and interview questions that were intended to elicit similar data.

A more recent study of SRS in K-12 classrooms was conducted by Irving, Sanalan, and Shirley (2009). This research was also a qualitative study nested within a larger study of connected classrooms. The connected-classroom study sought to examine the effect of connected-classroom technology and interactive pedagogy on mathematic semantics and science achievement, professional growth of teachers, student self-regulated learning, and student dispositions toward mathematics and science. The purpose of the smaller, descriptive case study was to examine how connected-classroom technology was congruent with physical-science teaching and what benefits teachers perceived in the use of connected-classroom technology.

Three physical-science teachers who completed the first year of a professional-development intervention were selected purposely for study. These three teachers represented different teaching contexts, grade levels, and experience teaching. Data were collected utilizing an 85-item technology use and professional development survey,

telephone interviews, classroom observations (lesson taped and transcribed), and student focus groups. All three teachers were provided with connected classroom technology in the form of SRS, attended a weeklong summer institute at a large Midwestern university, and participated in online web-based training and community support.

Teachers reported using technology as congruent to their teaching practice when they started using the technology in the classroom. As they became more comfortable with the technology, they realized the potential data it could provide them about student learning. Teachers reported using the SRS to engage in preplanned assessments, for test preparation, initial assessment, differentiation, warm-up questions, and using the associated scientific probeware for data collection. All three used the data collection, aggregation, and display features to conduct inquiries with classes.

All three found the SRS to be better at predicting student understanding than previous teacher practices of interpreting student responses. Each participant made statements that the SRS provided more accurate profiles of student understandings than their nontechnological practice. Participants reported that both teachers and students benefit from SRS questions and answers, that questions prompted discussions, and that it revealed patterns in wrong answers. The timeliness of being able to see student responses was reported as not only powerful for instruction but also as an agent for increasing student engagement. Teacher uses of the SRS technology exemplified a range of use from on-the-fly informal assessment to embedded formative assessment. This range reflected theoretical assessment work with embedded formative assessment as an ultimate outcome (Bennett, 1997; Wiliam, 2010).

Another technology that was being used widely in K-12 environments with very little formal study was that of learning management systems (LMS). LMS were systems in which instruction could be delivered, students could interact with one another via chats and discussion boards, and student work could be submitted for review and feedback. Some popular LMSs were Blackboard, Moodle, and WebCT. Johannesen (2013) noted these systems are used extensively in education but were not being studied as assessment tools. Much of the research on LMS had been done at the higher education level as well. LMS had been adopted by many K-12 school systems, but little had been done to examine how they were used in these systems. The purpose of the study Johannesen (2013) proposed was to describe and understand emerging teaching practices with LMS.

Johannesen (2013) used an explorative case study focused on how eight Norwegian "teachers in primary school used LMS in formative and summative assessment, in particular whether LMS tools for multiple-choice questions (MCQ), portfolio methods, and collaborative writing can and will be used for assessment purposes" (p. 302). These teachers were selected strategically from three primary schools participating in a national project to increase the use of technology in schools. Data were gathered during one school year through an initial semistructured interview, participant logs of activities and uses of the LMS, and follow-up interviews.

Three themes emerged in the coding of the data. Teachers utilized LMS for assessment, for collaboration with other teachers to document student achievement, and as a data point within teacher-student-parent conferences. Although teachers primarily used LMS to automatize documentation, the use of the LMS portfolio as the center of the teacher-student-parent conference led to a focus on self-assessment and self-regulation

for students. The use of portfolios in one teacher's conferences indicated a disconnection between what students rated as their performance and what the summative assessment showed. The collaborative examination of portfolios led the teacher to reflect that she may want to be more explicit in helping students set goals and reflect on achievement using the LMS portfolio.

Although all three studies (Feldman & Capobianco, 2008; Irving et al., 2009; Johannesen, 2013) revealed that teachers initially used technology in assessment as a tool to automate existing practices, they also provided evidence that continued use of technology could influence the development of assessment practice. In all three studies, participants developed deeper understandings of how technology could provide depth and accuracy about student achievement and learning. The research on teacher use of technology in assessment consisted of case studies. Although case studies were informative, a large-scale study of teachers provided more insight into teacher assessment literacy and practices Additionally, the case studies in the literature described participant uses of technology during and after interventions rather than in postintervention practice. The TAPS study was intended to generate further examples of how technology is affecting teacher conceptualizations of and practices with assessment. Open-ended items and follow-up telephone interviews provided a range of example practices as well as detail and depth about teacher thinking about assessment so that future researchers and professional development providers could utilize these examples.

Measures of Teacher Assessment Literacy

In a seminal publication, Black and Wiliam (1998a) revealed that teacher use of formative assessment effected student achievement. Their review of research into teacher

practice illustrated the power of assessment when done well. Although this publication sparked a focus on teacher assessment practices in educational literature, very few studies measured teacher assessment literacy. The following short review investigates three measures that focus on teacher literacy, rather than attitudes toward assessment or ideal assessment practices.

In 1987, the National Council for Measurement in Education (NCME), the American Federation of Teachers (AFT), and the National Education Association (NEA) came together to establish a set of competency standards in assessment for teachers. The standards were finalized and published in 1990. These standards outlined what teachers at all levels of education should know and be able to do in order to assess student learning. The seven standards are

1. Teachers should be skilled in choosing assessment methods appropriate for instructional decisions.
2. Teachers should be skilled in developing assessment methods appropriate for instructional decisions.
3. The teacher should be skilled in administering, scoring, and interpreting the results of both externally produced and teacher-produced assessment methods.
4. Teachers should be skilled in using assessment results when making decisions about individual students, planning teaching, developing curriculum, and school improvement.
5. Teachers should be skilled in developing valid pupil grading procedures that use pupil assessments.
6. Teachers should be skilled in communicating assessment results to students, parents, other lay audiences, and other educators.
7. Teachers should be skilled in recognizing unethical, illegal, and otherwise inappropriate assessment methods and uses of assessment information. (http://www.unl.edu/buros/bimm/html/subarts.html)

These standards form the base of knowledge utilized in survey research into teacher assessment literacy since 1990. In 1993, one of the first large-scale attempts to measure teacher assessment literacy was undertaken by Plake, Impara, and Fager under the

auspices of the NCME. Earlier researchers had indicated that teachers spend 30 to 50% of their teaching time in assessment-related activities (Stiggins, 1991); however, the researchers based the study on a 1980 study in which teachers still reported feeling underprepared for the assessment components of the profession.

The stated purposes of the study undertaken by Plake et al. (1993) were to (a) measure teachers' competency levels in the assessment areas addressed in the *Standards for Teacher Competence in Educational Assessment of Students* (AFT, NCME, NEA, 1990), (b) identify a target assessment area based on the results of measuring teachers' competencies, and (c) develop a training prototype directed at the identified target assessment area. The published results of the study focused on the first purpose outlined above.

The researchers developed a two-part national survey. Part 1 contained 35 items that used scenarios and application questions aligned to the seven standards outlined in the NCME, AFT, and NEA document. Therefore, these items had "right" and "wrong" answers, rather than utilizing self-assessment Likert-type response options. Part 2 of the survey contained items that elicited demographic information as well as open-ended items about participant perceptions of assessment.

Surveys were returned from 555 teachers in 98 school systems in 45 states in the US. The majority of participants reported having taught between 6 to12 years. A Kuder-Richardson Formula 20 statistical procedure was completed on the items from part 1, resulting in an internal consistency of .54. Subscales representing each of the seven standards had low internal consistency. Participant responses indicated that teachers had the highest competency on the standard of administering, scoring, and interpreting test

results. The lowest overall test performance was for the standard regarding communicating test results. Additional areas of teacher strength were selecting assessments, communicating the reason for a score to a parent, acceptable test-taking practices, and ethics of testing. Areas of weakness, in which less than 30% of participants answered the item correctly were using assessments in grading, taking steps to increase reliability, and two of the items for recognizing unethical practices.

Participant responses on part-2 items showed that teachers were positive about the role of assessment in the classroom. Many reported having had some preparation in assessment (almost 70%); however, the average recency of that training was more than 6 years. Almost 30% reported having no training at all in assessment. Approximately 54% reported being comfortable interpreting information from standardized tests. The preferred mode for receiving training on assessment was inservice training at 59%. The response rates for interest in gaining more knowledge of assessment were high, with 35% indicating they were very interested and 50% reporting being somewhat interested in gaining more knowledge of assessment in contrast to only 10% indicating no interest at all.

Correlation between comfort with interpreting standardized test information and previous classes was statistically significant. Those who were least comfortable also were least interested in becoming more proficient. Borderline respondents were proportionately more interested in becoming more knowledgeable in assessment.

In 2005, Mertler and Campbell published a study utilizing an adaptation of the instrument developed by Plake et al. (1993) to survey 67 preservice secondary-education and 197 inservice teachers representing all grade levels in and near a large Midwestern

university. The Classroom Assessment Literacy Inventory contained the original 35 scenario and application items from the Plake et al. (1993) study, with minor rewordings. Consistency for the instrument was reported for a prior study by Campbell, Murphy, & Holt (2002), with preservice teachers. The consistency level for preservice responses on the Campbell et al. (2002) survey (.74) was higher than that of Plake et al. (1993) survey (.54). Mertler and Campbell (2005) sought data on whether there was a difference between preservice and inservice teacher assessment literacy.

Descriptive analyses for individual items as well as the seven standards were obtained on the responses. Findings were consistent with Plake et al. (1993) and Campbell et al. (2002). Inservice teachers averaged 22 correct items (23 for Plake et al., 1993). The highest mean area for inservice teachers was on administering and scoring standardized tests and the lowest was on developing valid grading procedures. Internal consistency on the Mertler and Campbell (2005) study was reported as .57. Preservice results were similar to the inservice results on the standard on the highest mean (choosing appropriate assessment methods) and the lowest (developing grading procedures) item. Reliability and consistency for the preservice teachers was reported as .74. Statistically significant differences between the two populations were found on five of the seven standards. In all cases, inservice teachers had higher means than preservice teachers. Both groups had the lowest means in developing grading procedures and communicating assessment results.

There was higher item-response consistency for preservice teachers than for inservice teachers on the survey given in the Mertler and Campbell (2005) study. The preservice participants were completing a course in assessment at the time they took the

survey, which may provide an explanation for the higher consistency. Results for both surveys were similar, with high levels of consistency. The core items in both surveys consisted of scenario analysis and application questions. Items in the second half of both instruments centered on self-reported data in interest and proficiency. The TAPS study focused primarily on self-reported confidence and agreement with statements about assessment to provide insight into the currency of the interest and proficiency results of the Plake et al. (1993) and Mertler and Campbell (2005) studies. A majority of participants were inservice teachers. Analysis was conducted based on experience in teaching, grade level, and subject taught in order to add to the body of research of assessment literacy and experience provided by the Mertler and Campbell (2005) study.

Survey research into teacher assessment literacy had used self-assessment, rather than scenario and application questions. In 2010, DeLuca and Klinger published a study of preservice teacher assessment literacy in order to provide insight into assessment education in a single-subject teacher-preparation program. The instrument they designed and used had 57 fixed-response items. The majority of the items were scaled items with a confidence scale of 1 (*not at all confident*) to 5 (*very confident*). The scaled items were broken into three component areas: practice, theory, and philosophy. Additional items collected demographic data and ranking items to inform programmatic decision making.

Surveys were completed by 288 preservice teachers for purpose of participating in the study. The participants represented different subject areas, elementary- and secondary-education departments, and different levels of progress in the program (junior or senior standing). Some participants were enrolled in an assessment course, some had completed the course, and some had not enrolled in an assessment course.

Analysis of participant responses indicated that test design and marking or grading as well as summative assessment practice and assessment types were areas of greater confidence. Low confidence responses were present for mandated assessment practices, assessment for learning, and providing rationales for assessment decisions. Preservice teacher confidence also was high for validity practices but low for reliability. Increased confidence correlated with completion of the course in assessment; however, patterns of confidence for given items remained similar.

Responses to survey items showed that preservice teachers struggled with shifts in practice that did not match their experience as learners. Differences were greatest between practical and theoretical knowledge; there was much greater confidence in assessment of learning practice (summative) rather than assessment for learning practice (formative). Participants who did not have the assessment course also relied on mentor teachers to provide information and support around assessment practices.

The TAPS study built on the DeLuca and Klinger (2010) research, utilizing many of the items from their survey along with items from the Schmidt et al. (2009b) TPACK survey. The TAPS study could inform professional development and teacher-preparation coursework in assessment literacy for both preservice and inservice teachers.

Measures of Inservice Teacher Technological Pedagogical Content Knowledge

As a frame for understanding the technology integration practices of teachers, TPACK has been used in empirical research since its inception in 2006. Early published work utilizing the terms “technological pedagogical content knowledge,” “TPCK,” and “TPACK” primarily was theoretical. A search for these terms in an online research tool in 2013 found over 1,500 peer-reviewed publications. The addition of the phrase

"inservice teacher" as a secondary search filter resulted in narrowing the publications to 194. A review of these research results indicated a lack of empirical studies of inservice-teacher TPACK using survey methodology. Although there were many survey studies into the TPACK of preservice teachers from many different nations, there was a very limited body of empirical research into large-scale inservice-teacher practice using surveys.

A majority of surveys used to measure TPACK in both preservice and inservice teaching populations were modified versions of a survey designed by Schmidt et al. (2009b). The Survey of Preservice Teachers' Knowledge of Teaching and Technology was a collaborative effort to produce a course-independent measure of TPACK. Previous measures of TPACK cited in the research consisted of a course-specific measure created by Koehler & Mishra (2005), a design-based performance assessment (Angeli & Valanides, 2005), and a large-scale survey of online teachers (Archambault & Crippen, 2009). Although the survey of online teachers, which is included in this literature review, was informative, it was very context-specific and did not fit with models of preservice-teacher education. Schmidt et al. (2009a) intended to design a survey that would be able to be used as a self-assessment of preservice-teacher TPACK. The instrument could then be used to inform program improvement in teacher-education programs, as well as potentially guiding the development of technology training and professional development for inservice teachers.

The survey was designed to collect data across the seven domains of TPACK with early-childhood and elementary-education preservice teachers as the target user. The survey was developed with the intent that it could be used longitudinally throughout

preservice-teacher-preparation programs. Forty-four items were developed, reviewed by three TPACK experts for content validity, and revised for inclusion in the instrument. Ultimately, 75 items were included in the instrument. These 75 items were broken into three sections: the first elicited demographic information, the second contained TPACK specific items, and the third focused on program-evaluation-type questions about faculty modeling of TPACK practice. The TPACK focused portion of the instrument used a Likert scale, with a range of response options from 1 (*strongly disagree*) to 5 (*strongly agree*) for statements regarding the participant's perception of her or his ability.

The instrument was administered online to 124 preservice teachers who completed an introduction to technology in education course in a large Midwestern university. A majority of the participants were elementary-education majors; only 14.5% were early-childhood majors. There were more female participants than male, and a majority of the responses were from freshmen and sophomores.

Although the sample was too small to provide reliability using a factor analysis, internal consistency measures such as Cronbach Coefficient Alpha indicated a strong internal consistency for 47 of the items. Twenty-eight of the original items were dropped due to issues with reliability and construct validity, resulting in the instrument that would be used as a model for future surveys of TPACK. A secondary analysis of the 47 items resulted in internal consistency ranging from .75 to .92 for the seven domains present in the TPACK model.

Issues with the instrument have been presented in later critiques of the TPACK model (Angeli & Valanides, 2009; Cox & Graham, 2009) primarily focused on the difficulty in separating some of the domains. In the Schmidt et al. (2009a) study, a

Pearson product-moment correlation revealed that the domain of TPACK was statistically significantly correlated to three other domains: TPK (r=.71), TCK (r=.49), and PCK (r=.49). Other studies of TPACK using survey methodology also displayed high correlations for several of these domains (Archambault & Crippen, 2009; Doukakis et al., 2010). There were only three items included in the Schmidt et al. (2009b) survey that addressed assessment practices. All three items were placed in the PK domain. The first item related to assessment was "I know how to assess student performance in a classroom." The second item was "I can assess student learning in multiple ways," and the third was "I am familiar with common student understandings or misconceptions" (p. 133). For the first two PK assessment items, relatively high factor loadings were reported, .79 and .77, respectively. The item regarding familiarity with student misconceptions had a factor loading of .68. The lowest overall factor loading for the instrument was on classroom management, with a load of .58. These findings indicate that the items load on the PK domain strongly.

Assessment practices were only a small component of the Schmidt et al. (2009a, 2009b) study. This instrument has been used extensively as a starting point for many other TPACK measures, continuing a minimal focus on investigating how assessment practices intersect with the TPACK framework. The TAPS study was intended to provide insight into this phenomenon and also had the potential for providing data on the relationship issues between TPACK domains that has been cited as a difficulty across multiple studies (Archambault & Crippen, 2009; Doukakis et al., 2010; Graham et al., 2009; Lin, Tsai, Chai, & Lee, 2013).

At the same time as the Schmidt et al. (2009a) instrument was being developed, an instrument to measure the TPACK of online teachers was being created. During the first part of the 21st century, online education options for K-12 students were expanding rapidly. Earlier online offerings were primarily in higher education, so very little was known about how K-12 teachers would make the transition to online schools. Archambault and Crippen (2009) designed a study to examine the role and preparation of teachers in K-12 online environments. With the rapid growth of online environments, this study was important in investigating how prepared teachers were to meet their new instructional roles.

Archambault and Crippen (2009) developed an instrument to measure the perceived TPACK knowledge level of online teachers. They hoped that the self-ratings provided on the instrument would provide insight into the TPACK framework. To this end, they designed a web-based survey consisting of 24 Likert-type survey items. They investigated construct validity with experts in TPACK as well as with teachers. A think-aloud protocol with local participants revealed that it was difficult for teachers to separate pedagogy from content, a criticism present in many of the studies of TPACK.

Archambault and Crippen (2009) invited 1,795 online teachers to participate in the survey. Participants responded to items with the prompt of "How would you rate your own knowledge in doing the following tasks associated with teaching in a distance education setting?" The scale was a 6-point scale, representing the self-rating of "*poor*" to "*excellent*." Open-ended items were included to provide additional insight into the thinking behind the self-ratings. Surveys were completed by 596 online K-12 teachers representing 25 states in this national study.

Descriptive and inferential statistics were obtained for this study. Self-ratings were the highest for the domains of pedagogical knowledge (PK), content knowledge (CK), and pedagogical content knowledge (PCK). Participants reported being most comfortable with the domains that aligned with traditional teaching methods. Self-ratings dropped almost one point when technology was integrated into an item. This disconnect with technology also was present in the open-ended questions.

As predicted in the think-aloud protocol, there were high correlations between the CK, PK, and PCK domains. High correlations also were present between technological pedagogy (TP) and technological content (TC, .74) and between TPACK and TP (.78) and TC (.73). The lowest correlations were between TK and PK (.28) and between TK and TC (.32). Due to the high level of correlation across several domains, Archambault and Crippen (2009) called for further study into the independence of the domains.

Several items in this instrument addressed the idea of assessment. These items were considered present in three domains: TPACK, PCK, and PK. The assessment item with the strongest alignment to the domain average also was the lowest-rated item. This item result provides consistency with the overall result of weaker self-ratings for items including technology. Other assessment items were consistently lower than the domain average.

Although it did not use the instrument designed by Schmidt et al. (2009a, 2009b), the Archambault and Crippen (2009) study presented similar issues with the TPACK framework. The areas of the framework in which there was great overlap (TPACK, PCK) often had high correlation to their component domains (PK, CK). The proposed study

provided insight into the overlapping components through an examination of qualitative data about how teachers think about and use technology to assess student learning.

An intensive literature search for "TPACK," "inservice teacher," and "survey" search terms resulted in two large-scale survey studies. These two studies used modified versions of the Schmidt et al. (2009a, 2009b) survey to measure the TPACK of inservice teachers in specific content areas. Doukakis et al. (2010) investigated the integration of technology and pedagogy in computer-science teachers in Greece. Lin, Tsai, Chai, & Lee (2013) studied pre- and inservice science teacher self-perceptions of TPACK in Singapore.

More than 900 computer-science teachers from 13 regions of Greece were invited to participate in the survey. Of these, 635 completed the online survey that used the TPACK framework to investigate how technology is integrated with teaching. The survey contained 24 items about TPACK with an additional 10 demographic questions. Some participants then completed a 196-item content-specific measure as well. The computer-science teachers were described as primarily teaching algorithms and programming. Results of the survey were reported descriptively, with a relatively high overall mean of 4.05 (out of a Likert-type scale of 1 *strongly disagree* to 5 *strongly agree)*. The lowest reported mean was for PCK (3.51) and the highest mean was for CK (4.18). TK was the second lowest mean (3.68). Although the TK mean is low for a population of computer-science teachers, additional information from the demographics portion of the survey provided some insight. A large number of teachers reported not using technology in their teaching not even as demonstration. This lack of use of technology could influence their self-perception of TK. It also may effect the results of correlational data. Correlations

were reported as strongest between PK and TK (.74) and between TPACK and TPK (.71). The lowest correlation reported was between PK and TCK (.28). The researchers did not provide additional information about the conditions or environment in which the computer-science teachers in Greece teach, so it is unclear to what extent the TK, TCK, and TPK scores are related to access to or use of technology. The TAPS study included invitations to international teachers, so the inclusion of items that would inform the interpretation of data, like questions about access and availability, were important to include.

A study of content-area inservice teachers in Singapore was conducted by Lin et al. (2013). The purpose of this study was to investigate the TPACK framework with the context of the specific content area of science. The study was designed to provide correlational and validation data on the domains of TPACK. Structural equation modeling was utilized to reveal the model and factors (domains) of TPACK.

The Schmidt et al. (2009a, 2009b) survey was translated and modified for use with a Singaporean audience. The Likert-type scale was expanded to seven agreement options ranging from 1 and 7 (anchors not reported) and eight items were removed due to concerns about skewness. The final version of the instrument had 27 items.

Science teachers in Singapore from multiple teaching environments were invited to participate in an online survey of TPACK. Surveys were returned from 222 pre- and inservice science teachers. These teachers had a range of experience from 1 to 32 years, with a variety of teaching assignments. Demographic data were collected to allow for analysis of the role experience, gender, and age play in TPACK. These data were not presented in the research.

Structural equation models indicated that the seven-domain model of TPACK is acceptable, based on chi-square and degree of fitness statistical analysis. The researchers posited that the single-content nature of the participants being surveyed may have contributed to greater fitness to the seven-factor model of TPACK. An analysis of the items pertaining to assessment in the Lin et al. (2013) survey and those present in the Schmidt et al. (2009b) survey demonstrated shifts in focus from language that is teacher-centered in the Schmidt et al. (2009b) survey to a student-centered self-efficacy frame in the Lin et al. (2013) study. Additionally, domain realignments that may have contributed to greater clarity among the domains of TPACK in the Lin et al. (2013) survey (Table 2).

Table 2

Comparison Between Lin et al. and Schmidt et al. Assessment Items

Lin et al. (2013)	Domain	Schmidt et al. (2009b)	Domain
I am able to help my students monitor their own learning.	PK	I know how to assess student performance in a classroom.	PK
Without using technology, I can address the common misconceptions my students have about science.	PCK	I am familiar with common student understandings and misconceptions.	PK
I am able to facilitate my students to use (sic) technology to plan and monitor their learning.	TPK	I can assess student learning in multiple ways.	PK

Studies of the TPACK framework have been conducted with preservice students in specific courses or programs of study (Abbitt, 2011; Chai et al.,2010; Kelly, 2010; Kohler, Shin, & Mishra, 2011), with inservice teachers in a specific teaching environment (Archambault & Crippen, 2009), and with teachers from specific content areas (Doukakis et al., 2010; Lin et al., 2013). Although there have been multiple large-scale survey studies of the self-reported confidence of teacher TPACK, the domain of assessment has been represented minimally in surveys. Empirical studies that did include items on

assessment did not report data specifically on these items. Surveys about TPACK also did not include frequency items that would provide further evidence for how TPACK was being enacted in the classroom. The TAPS study built on the research into the TPACK framework through a survey with a pedagogical base in assessment. Survey items of teachers' confidence around assessment practices contributed to the understanding of the functioning of the seven domains to the TPACK framework. The inclusion of frequency of use items provided additional insight into what technologies are being used by teachers to assess student learning.

Summary

Research into how teachers use technology to assess student learning primarily was qualitative (Feldman & Capobianco, 2008; Irving et al., 2009; Johannesen, 2013). Large-scale surveys have been conducted in teacher assessment literacy (DeLuca & Klinger, 2010; Mertler & Campbell, 2005; Plake et al., 1993) and TPACK (Archambault & Crippen, 2009; Doukakis et al., 2010; Lin et al., 2013; Schmidt et al., 2009b). There were no large-scale studies into how teachers used technology to assess student learning and there were no TPACK studies that focused on the pedagogical domain of assessment.

With increased use of technology in schools and increased emphasis on assessment-based instruction, the TAPS study has the potential to bridge the gap between two high-profile bodies of knowledge. Additionally, researchers who studied the TPACK framework consistently issued the call for further investigation into the seven domains of TPACK. The TAPS study added to TPACK research through examining a pedagogical rather than content or technological domain of TPACK. Research on assessment literacy indicated a lack of confidence in applying large-scale assessment data to instructional

design and in assessing students in ways in which teachers have not been assessed previously (DeLuca & Klinger, 2010; Mertler & Campbell, 2005). Utilizing technology to assess student learning is a recent phenomenon, and the TAPS study provided additional insight into how teachers integrated experiences they had with assessment into their pedagogical practice.

CHAPTER III

METHODOLOGY

The purpose of this study was to describe how technology-using teachers understand and use technology to assess student learning. This chapter contains the details of the research design, participants, human subjects' considerations, research questions, instrumentation, pilot testing, data-collection procedures, and data analysis.

Research Design

This mixed-methods descriptive study built on prior research on teacher practices with technology for assessment, assessment literacy, and the technological pedagogical content knowledge (TPACK) framework (DeLuca & Klinger, 2010; Mishra & Koehler, 2006). A mixed-methods design was selected to address the complexity of the process of selecting, planning for, and using technology to assess student learning. The design of the study followed a concurrent embedded model, in which the quantitative and qualitative data overlapped (Creswell, 2009). Quantitative data were collected and analyzed in the study, with qualitative data providing detail and examples to augment the study.

Quantitative data were collected in a one-time survey developed using items from an assessment literacy measure (DeLuca & Klinger, 2010) and from a TPACK survey (Schmidt et al., 2009b) that were generated by the researcher. The survey was composed primarily of quantitative items in Likert-type, frequency, and confidence scale ratings. There were several open-ended questions included in the survey; additional qualitative data were collected from a smaller group of participants through semistructured interviews.

Within the concurrent embedded model, the embedding of qualitative data within the quantitative data collected provided a "broader perspective" (Creswell, 2009, p. 214)

about the beliefs and practices used by practicing teachers when employing technology for assessment of student learning. Although the survey provided background about participant knowledge and confidence in assessment literacy and TPACK, the survey alone did not provide sufficient depth about examples of the ways in which technology-using teachers think about and use technology to assess student learning. The semistructured interview utilized a protocol based on the TPACK construct (Harris, Grandgenett, & Hofer, 2012) to provide additional qualitative data about the process of how technology-using teachers designed, utilized, and applied results from assessments using technology.

The dependent variables identified in the survey were beliefs about technology and assessment, assessment practices using technology, and domains of knowledge within the TPACK framework: pedagogical, content, pedagogical content, technology, technology pedagogy, technology content, technological pedagogical content, and context. Assessment literacy was embedded within the pedagogy, content knowledge, and pedagogical content knowledge components of the TPACK framework. Independent variables in the form of demographic information about gender, age, professional role, content area, years of experience teaching, and grade level most recently taught were collected to provide background of participants.

Participants

In April of 2014, the researcher contacted several online groups and professional organization to request the opportunity to post an announcement about the survey and study information in online forums. In addition to posting the survey request and study information in online groups for the Computer Using Educators (CUE) and the International Society for Technology and Education (ISTE), these organizations included

the information in their monthly newsletters. The announcement of the opportunity to participate in the survey was posted in several LinkedIn groups connected to ISTE, CUE, and a group called “K-12 education technology” and “Technology in education.” Permission was granted to post the announcements by the group administrators prior to posting.

Within the initial communication, participants were notified that results of the surveys were kept confidential and were used as general measures of the participants’ assessment literacy and self-reported technology use for assessing student learning. Potential participants were invited to take the survey online during the administration window. Demographic items about the most recent role held by the participant and frequency of use of technology to assess student learning were used as a determinant for inclusion in the study data. Those who reported teaching in K-12 contexts as their most recent role and who used technology to assess student learning more frequently than “rare or never” were considered as participants in the study.

The Technology Assessment Practices Survey (TAPS) began online in May of 2014. The survey was available for participants to complete until the end of June 2014. During the administration period, 179 individuals attempted the survey. A total of 90 individuals completed all items on the survey. Responses from six individuals were removed from the analysis on the basis of responding that they “rarely or never” used technology to assess student learning.

There were 72 survey participants from the United States and 12 international participants. Utilizing online survey opportunities allowed for participation of international and nonlocal U.S. participants. Although many of the participants were from California, in part due to the CUE organization being a state organization, participants

reported residing in North Carolina, Oregon, Alabama, Tennessee, Florida, Kentucky, Georgia, New York, Illinois, Michigan, Indiana, Texas, South Carolina, Wyoming, Utah, Ohio, Kansas, New Jersey, Connecticut, Maryland, Missouri, Pennsylvania, Nevada, Puerto Rico, Qatar, Slovenia, Britain, Canada, Panama, and Chile. ISTE members were the largest group of participants represented, with 39 members and an additional 11 who had membership in both ISTE and CUE.

Participants represented a range of years teaching, from beginning teachers to those with more than 25 years in the classroom. Within the years teaching item, 20 participants had more than 25 years with 19 participants responding they had between 6 and 10 years experience. Only one participant reported having between 21 and 25 years teaching. Participants also indicated that the subject areas in which they most frequently used technology were varied. The most frequently selected subject areas were 19 reported using technology with multimedia/computers, followed by 19 focusing on English/language arts, 17 in mathematics, and 15 in science. Although there was representation of participants teaching all grades from Kindergarten through high school, there were more participants representing grades 4-6 and 10-12 than from K-3 and 7-9. More than half of participants indicated that they had not participated in a pilot program for standardized online testing. Those who had participated in either Smarter Balanced Assessment Consortium testing or state-developed tests. Participants indicated that the frequency of use of technology to assess student learning occurred daily or once or twice a week. Further details of the demographic data collected on participants can be found in Table 3. At the end of the survey, participants were given the opportunity to volunteer to participate in a 15-minute phone interview to provide insight into their practice. Nineteen participants responded to the request for interviews.

Table 3

Frequencies and Percentages of Survey Participant Demographics

Characteristic	*f*	%
Geographic Location		
United States	72	85.7
International	12	14.3
Gender		
Female	69	82.1
Male	15	17.9
Membership in Professional Organizations		
None	22	26.2
Computer Using Educators (CUE)	11	13.1
International Society for Technology in Education (ISTE)	39	46.4
CUE and ISTE	12	14.3
Years Teaching		
0-2	6	7.1
3-5	13	15.5
6-10	19	22.6
11-15	10	11.9
16-20	15	17.9
21-25	1	1.2
25+	20	23.8
Grade-Level Taught		
K-3	15	17.9
4-6	25	29.8
7-9	12	14.3
10-12	32	38.1
Subject in which technology is most used		
Art	1	1.2
Career	1	1.2
English/Language Arts	18	21.4
English as a Second Language	2	2.4
History	6	7.1
Mathematics	17	20.2
Multimedia/Computers	19	22.6
Physical Education	1	1.2
Science	15	17.9
Social Science	4	4.8

Continued on next page

Table 3 continued

Characteristic	*f*	%
Certification in Assessment		
Certificate	4	4.8
Major	2	2.4
MA	2	2.4
Doctorate	2	2.4
Certificate/MA/Doctorate	1	1.2
Certification in Technology		
Certificate	2	2.4
Major	2	2.4
MA	15	17.9
Doctorate	1	1.2
Certificate/MA/Doctorate	2	2.4
Educational Background: Assessment		
None	15	17.9
Professional Development (PD)	20	23.8
University	17	20.2
PD/University	32	38.1
Educational Background: Technology		
None	2	2.4
Self-Taught	9	10.7
Professional Development (PD)	5	6
University	12	14.3
Self/PD	21	25
Self/University	6	7.1
PD/University	21	25
Self/PD/University	8	9.5
Professional Development Experiences: Assessment		
None of those listed	32	38.1
Formative Assessment	2	2.4
Data-Driven Instruction	8	9.5
Backwards Planning	4	4.8
Formative/Data-Driven	16	19
Formative/Backwards Planning	6	7.1
Data-Driven/Backwards Planning	16	19
Formative/Backwards/Data-Driven	2	2.4
University Experiences: Assessment		
None	36	42.9
Embedded in other courses	11	13.1
Specific course(s) on assessment	19	22.6
Embedded and specific coursework	18	21.4

Continued on next page

Table 3 continued

Characteristic	*f*	%
Professional Development Experiences: Technology		
None of those listed	28	33.3
Various tools	28	33.3
Technological Pedagogical Content Knowledge (TPACK)	1	1.2
Suite of tools (such as GoogleDocs)	4	4.8
Various/TPACK	2	2.4
Various/Suite	13	15.5
Various/Suite/TPACK	8	9.5
University Experience: Technology		
None	37	44
Embedded in other courses	6	7.1
Specific course(s) on technology	25	29.8
Specific course(s) with TPACK	1	1.2
Embedded/specific courses	11	13.1
Embedded/specific/TPACK	4	4.8
Instructional Setting		
Face to Face	67	79.8
Online	2	2.4
Blended	15	17.9
Type of School(s)		
Public	60	71.4
Private	21	25
Charter	1	1.2
Public/Private	1	1.2
Public/Private/Charter	1	1.2
Participation in Pilot of Standardized Computer Testing		
None	50	59.5
PARCC	4	4.8
SBAC	13	15.5
State Created Test	14	16.7
SBAC/State	1	1.2
PARCC/State	1	1.2
PARCC/SBAC/State	1	1.2
Frequency of Use of Technology to Assess Student Learning		
1 to 2 times a grading period	16	19.0
1 to 2 times a month	8	9.5
1 to 2 times a week	31	36.9
Daily	29	34.5

Note: *n*=84

The researcher then emailed out a request to schedule an interview with each volunteer. Ten volunteers responded to this request. Of these 10, two interviews were not

scheduled due to time issues. Eight interviews were conducted and transcribed. One interview was not analyzed as it was a second-hand report by an administrator of observations of others' practices.

Interview participants represented different regions of the United States as well as different subject areas and grade levels. Table 4 provides demographic information about interview participants.

Table 4

Interview Participant Demographic Information

Participant	Gender	Location	Subject Area	Grade
1	Male	Texas	Algebra	9
2	Female	Georgia	English	12
3	Female	Wyoming	AP Biology	11-12
5	Female	California	English	8
6	Female	California	Language Arts	3
7	Female	California	Language Arts	1
8	Female	California	Special Education	6-8

Protection of Human Subjects

The American Psychological Association's (APA, 2010) guidelines for the protection of human subjects were followed during this study including institutional approval and informed consent. Guidelines were followed to protect participant confidentiality as well (p. 16). Institutional approval was obtained for the pilot study and the study from the Institutional Review Board of the University of San Francisco.

Potential participants were provided an invitation to participate as well as a description the study's purpose and background, procedures, and the risks and benefits through a brief email, post on a discussion board, or note in a newsletter. Participant completion of the online survey served as consent for the survey portion of the study

(Appendix A). Volunteers who elected to provide contact information on an external link upon completion of the survey were presented with information about the study and its purposes again and were informed that providing contact information for a follow-up interview served as consent to participate in the interview.

In both the survey and the interview introductions, it was made clear that participants could withdraw from the study at any point. There were no consequences for declining participation in this study. The survey link was open for several weeks in order to preserve anonymity and to allow potential participants the opportunity to consider participating.

Data were downloaded from the SurveyMonkey site onto a computer that was kept in a securely-locked location when not in use. Identifying features such as the Internet Protocol (IP) address collected by SurveyMonkey were stripped from the data file to ensure confidentiality. Interviews were recorded and transcribed, and then files were deleted to maintain security and confidentiality. All potentially identifiable data, such as names and locations, were replaced with pseudonyms. Utilizing SurveyMonkey to collect data provided security of data while collected. At the end of the survey period, the data were downloaded to a computer that remained in a secure, locked location not connected to the Internet when not in use. Data hosted on SurveyMonkey was deleted after the download to the secured computer.

Research Questions

Two questions and nine second-order questions guided the study:

1. How do self-identified technology-using teachers design, deliver, and use assessment technology?

a. What technologies do technology-using teachers use to assess student learning?(TK)
b. How do technology-using teachers develop assessments? (PK, PCK)
c. How do technology-using teachers deliver assessments using technology? (TPK, TPACK)
d. For what purposes do technology-using teachers use assessments?(PK, TPK)
e. What do technology-using teachers do with assessment results?(PK, TPACK)
f. What are the barriers to using technology to assess student learning?(TPACK, Context)

2. What is the assessment literacy of technology-using teachers?
   a. How confident are technology-using teachers in assessing student learning? (PCK, PK)
   b. What are the knowledge and beliefs about using technology of technology-using teachers?(TPK, TCK, TPACK)
   c. How has the technology used in assessment affected assessment practices, knowledge, and beliefs of technology using teachers?

Instrumentation

Within educational research, several surveys were intended to measure the assessment literacy of preservice and inservice teachers (Brown, 2004; DeLuca & Klinger, 2010; Mertler & Campbell, 2005; Plake, Impara, & Fager, 1993). Since the

publication of Koehler and Mishra's (2005) description of the TPACK framework, several surveys have been developed in an attempt to measure and validate the TPACK construct (Archambault & Crippen, 2009; Koehler & Mishra, 2005; Schmidt et al., 2009b) and teacher beliefs within the TPACK construct (Jamieson-Proctor, Finger, & Albion, 2010; Ozgun-Koca, 2009). There were, however, no surveys in either body of research that were designed to investigate the ways in which teachers use technology for assessment or how assessment was present in TPACK. To this end, the Teacher Assessment Practices Survey (TAPS) utilized in this study was a blend of items from an assessment literacy survey (DeLuca & Klinger, 2010) and a TPACK survey (Schmidt et al., 2009b). Permission to use items from these surveys had been granted by Dr. Schmidt and Dr. DeLuca.

The interview protocol used in this study was based on an existing protocol in use in the TPACK literature (Harris et al., 2012). Additional questions were added to this protocol to direct the interview data collection to a focus on the use of technology specifically for assessment of student learning. These additional items were added within the interview process to elicit elaboration on other items. The interview protocol and consent form can be found in Appendix C.

Development of the Teacher Technology Assessment Practices Survey (TAPS)

Both the assessment literacy (DeLuca & Klinger, 2010) and TPACK (Schmidt et al., 2009b) surveys were developed for use with preservice teachers. The assessment literacy survey was developed for use in Canada, whereas the TPACK survey was developed for use in the United States. An initial revision of the items for use with inservice teachers in the US was conducted early in the survey-development process. Items were revised to reflect differences in academic language usage between a Canadian and U.S. setting, for

instance replacing the term “marking” with the term “grading.” Items that were revised to fit an inservice, as opposed to preservice, setting had references to courses and future predictions of practice removed. Additional items applicable to both assessment literacy and TPACK practice were added to the item bank. Due to the modifications and additions, the survey items were reviewed by a survey development expert for face validity. Further revisions, including splitting single items into multiple items and rewording of existing items were completed in January 2013.

The development of the survey that merged 43 items from an assessment literacy survey (DeLuca & Klinger, 2010), 14 items from a TPACK survey (Schmidt et al., 2009b), and 21 items generated by the researcher based on assessment and technology literature (Earl, 2003; Wiliam, 2010). The survey contained a total of 79 fixed-response items, as well as eight questions about demographic variables and six open-ended response items. Demographic items included grade-level taught, years of teaching experience, gender, and educational experience with technology and assessment. The survey included both fixed-response and open-ended items in an attempt to collect quantitative and qualitative data around teacher use of technology for the purpose of assessment. A revision of the survey occurred in May of 2013 after a meeting with a TPACK expert from a Research 1 institution. The original survey items had been all confidence ratings. The TPACK meeting resulted in the division of items into confidence, Likert, and frequency rating scales. There were 20 fixed-response items where participants rated their confidence in assessment and TPACK constructs from 1 (*none*) to 5 (*very*). Item alignment with TPACK constructs is shown in Table 5.

Several of the items that originally were designed as confidence items were modified to frequency or agreement items based on expert review and input. There were 44 items

Table 5

Items in the TAPS Survey Aligned to Dependent Variables

Dependent Variable	Items
Technological Knowledge (TK)	8, 11, 18a, 18b
Pedagogical Knowledge (PK)	13, 15g-i, 15k, 15l, 16a, 16b-h, 16 j-l, 16o, 17a, 17b, 17d-j
Content Knowledge (CK)	10, 15e
Pedagogical Content Knowledge (PCK)	15a-d, 15f, 15j, 16i, 16n, 16p-u, 17k
Technological Pedagogical Knowledge (TPK)	9, 16m, 18c, 18d, 18e, 18f, 19c
Technological Content Knowledge (TCK)	18i, 19a, 19d
Technological Pedagogical Content Knowledge (TPACK)	12, 14, 18g, 18h
Context (C)	17c, 19b

that measure frequency of use of various types of technology and assessment practices. The frequency item scale ranges from 1 (*never*) to 5 (*daily*). There were 15 items that were intended to reveal beliefs about technology and assessment by using a Likert scale. Likert items ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). Further consultation with an educational measurement expert resulted in the addition of optional "comment" boxes after blocks of survey items. The purpose for including the comment box was to provide participants with the opportunity to provide qualitative data on the items if they desired to do so. The survey, in its entirety, is included as Appendix A.

The open-ended response items were designed to gather insight into participant interpretations of the terms technology and assessment as well as to delve into short descriptions of participant practice. Participants were asked to respond to four open-ended items asking participants to describe an instance when they have used technology to assess students were modified from one item on the TPACK survey (Schmidt et al., 2009b). After answering the open-ended items, participants were taken to a separate page

that contains instructions about completing the confidence-scale items and operational definitions for use in the remainder of the survey.

Items were grouped by type of measure and then by topic (e.g., general knowledge about assessment) within the survey. Items that measured confidence were clustered together, frequency items were clustered together, and Likert items were clustered together. Open-ended items originally were split into two sections with confidence, frequency, and Likert responses between them. After the pilot data were reviewed, the open-ended items were clustered together at the beginning of the survey in hopes of better response rates. The type of measure for each item within the survey is found in Table 6.

Table 6

Items in the TAPS Survey by Type of Measure

Type of Measure	Item Numbers
Demographic	1-7
Open-Ended	8-14
Confidence	18a-I, 15a-l
Frequency	16a-u
Likert	17a-k, 19a-d

Validity

In the Spring of 2013, permission was granted by the Institutional Review Board of the University of San Francisco for a pilot study of the survey. With this approval, checks for face validity were completed by the president of the local chapter of Computer Using Educators, a K-12 school district technology coordinator, and a faculty member from a local college of education. Feedback on the survey indicated that the items were clear and understandable. One item, about the use of technology to grade student work, was split

into two separate items, one about gradebooks, and one about learning, based on the feedback received. Two practicing teachers, one from an elementary setting and one from a secondary setting, were asked to time themselves in completing the survey. Both participants responded that completion of the survey took between 30 and 45 minutes.

Content validity reviews were completed in May of 2013. Reviewers were given the items, a description of the elements of the TPACK framework as used in this study, and instructions for review (Appendix B). They were asked to provide a code for each item and suggestions on revision or elimination of items.

Experts in TPACK were invited to review the survey through personal contacts with the researcher, an international LinkedIn TPACK group, and a posting in the TPACK Mendeley group. Three international TPACK researchers provided feedback via email on the survey items. One TPACK researcher provided written feedback and spent 2 hours meeting with the researcher to provide content feedback.

Experts in pedagogical content knowledge (PCK) and teacher assessment practices, educational assessment, and educational measurement were invited to provide comments on the validity of the instrument. An assessment expert from a large-scale testing company provided feedback. An expert on PCK and teacher assessment practices also gave comments. After making modifications based on the input of TPACK, assessment, and PCK experts, the survey was given to an expert in educational measurement for review. After recommended modifications were made to this draft, one of the authors of the original assessment literacy survey was given a final draft of the survey for input. He had no suggestions for additional changes.

Upon completion of the review and modification process, a pilot survey was distributed to educators in the researcher's networking groups for testing of the

instrument. All 39 participants began the pilot survey. The pilot was administered online, following the same protocol to be used in the study. Details are provided in the pilot study section of this dissertation.

Interview Protocol

To add depth and detail to the quantitative portion of this embedded mixed-methods study, eight follow-up interviews were conducted with volunteer participants. Although the TAPS included several open-ended questions, interviews with participants provided an opportunity to understand the thinking and planning process present in using technology for assessment. Participants were asked to describe a specific lesson in which they used technology to assess student learning. The use of the Harris et al. (2012) TPACK interview protocol as a basis for the interview was intended to investigate the thinking and practices of participants. Focusing the interview on the assessment led participants to reveal beliefs and practices around assessment, providing an opportunity to investigate assessment literacy. Participants were asked questions to provide context for the assessment presented as well as details about how they designed and administered the assessment. Participants were asked to comment on how technology effected their assessment practices, understandings, and beliefs. At the end of the interview, participants had the opportunity to provide any additional information they believed would be important to understanding their practices (Appendix C).

Pilot Test

Institutional approval was given in the Spring of 2013 to pilot test the TAPS survey. The purposes of the pilot study were to discover whether the items were written clearly, the average amount of time it took to complete the survey, and whether the open-ended items would elicit detailed information about how educators use technology to assess

student learning. The pilot was administered using SurveyMonkey, an online survey platform that provides data of actual time spent on each survey response in addition to statistical data for each item. According to the survey timer for the 26 surveys that were completed by participants, it took between 15 and 35 minutes to complete the survey. Many of the incomplete surveys were surveys in which the open-ended items at the end of the survey were left blank.

Incomplete survey timing information ranged from 3 minutes to over one hour. The limitation on interpreting the time spent from both complete and incomplete surveys using SurveyMonkey is that the time recorded is that the automatic timer records the duration of the survey being open, not necessarily active, on the participant's computer. Some participant times may be skewed due to interruptions.

Thirty-nine educators participated in the pilot study. Most participants were female and reported teaching in California. In addition to educators from across the US, three international participants reported teaching in Slovakia, Germany, and the UK.

Few pilot participants reported being a member of ISTE (3), IISME (2), or CUE (5). A majority of participants reported teaching in face-to-face settings (34) rather than in blended (4) or online (1) formats. Participants represented a range of years of teaching experience and grade levels taught. Data collected on formal learning experiences for technology and assessment indicated that learning about assessment occurred slightly more frequently in formal academic settings such as courses in school, and technology was more frequently presented in professional development settings as shown in Table 7.

A primary purpose of the pilot survey was to determine whether there was a natural skewness within confidence, frequency, and Likert-type item responses. Each confidence

Table 7

Pilot Participant Highest Level of Education in Technology and Assessment

Option	Assessment	Technology
None	8	4
Professional Development	6	12
Some content in a course	2	6
One or two courses	12	6
Minor	0	0
Certificate	1	2
Undergraduate Degree	1	2
Graduate Degree	6	4

item piloted received at least one *not at all* response and one *very confident* response. Similarly, Likert-type and frequency items resulted in the full range of responses. Although the sample size was small, only 26 completed the entire survey, the range of experiences and backgrounds of participants indicated that similar ranges of responses are possible in a larger implementation of the survey.

Based on the results of the pilot survey, the qualitative open-ended items at the end of the survey were reviewed for clarity and necessity. Instructions to participants were revised to indicate that it should take between 20 and 30 minutes to complete the survey. Items were rearranged, removed, or revised to increase the likelihood that participants would complete the survey. Pilot participants were invited to comment on each section of items.

Comments on the open-ended items resulted in a change afforded by the electronic nature of the administration of the survey. Responses to the items about how technology was used to assess student learning revealed that, for two of the participants, a

lack of knowledge or access to technology impeded their ability to answer the items. The researcher used an item with question logic to solve this dilemma. Item nine: "How frequently do you use technology to assess student learning? (*for classes that do not meet daily, please use "daily" to indicate use every time the class meets)" was added. Options for response on this item range from *rarely/not at all* to *daily*. Participants responding *rarely/not at all* were directed to item 14: "Briefly describe what would facilitate a greater use of technology in assessing student learning in your teaching. (access, technology tools, training, etc.)." Participants who make any other response were directed to items 10-13, which asked for details on an example of use in the classroom. As the study design primarily was quantitative with qualitative data being utilized to provide detail and depth, these revisions were necessary to increase the likelihood that participants complete the survey.

Procedures

Administration of the TAPS survey occurred online using SurveyMonkey between May 20, 2014 and July 15, 2014. Online self-administration was selected as the mode to facilitate participant response. SurveyMonkey was a familiar online polling service that allows fixed and open-ended responses to be gathered, tabulated, and reported in a timely fashion. The survey was open for a month and a half in order to allow respondents time to complete the survey. During the administration window, reminders were posted in online groups about the opportunity to participate in the survey. Data collection and analysis occurred at the end of the window.

Upon completing the online survey, respondents had the option to volunteer to participate in an interview about a time in which they used technology to assess student learning. To gain specific information about the elements of the TPACK framework and

assessment literacy of technology-using teachers, eight semistructured interviews were conducted via telephone.

Respondents volunteered to participate in an interview by clicking on a link to a page that was not connected to the survey data and answering a few demographic questions. Although there were 19 participants who indicated interest in participating in the interview process via the online form, only eight were able to schedule interviews and participate. All 19 were invited to participate in the interview process and were thanked for their willingness to participate. Invitations were in the form of an email requesting a date and time for the interview. The email included information about consent to participate in the interview process and a request for written confirmation of the date and time of the interview. Confirmation of the date and time of the interview served as consent to participate in the interview process.

Interviews were scheduled with those who replied to the invitation and were conducted over a month. At least one interview participant represented each of the grade ranges (Kindergarten to 3rd grade, 4th to 7th grade, and 8th to 12th grade). Interviewees primarily reported using technology to assess English Language Arts subjects; however, there were representatives from mathematics and science. One interview participant represented special-education settings.

These interviews were recorded and transcribed. Participants were offered the opportunity to review the transcription of the interview for validity (Creswell, 2009) and to ensure that the participants were comfortable with their responses. Participants were notified that the recordings of the interviews would be destroyed immediately after the transcription process was complete.

The use of a semistructured interview protocol allowed the conversation to focus on the elements of the planning and teaching process. Using this protocol ensured that all participants had the opportunity to provide information on the topics being studied.

Data Analysis

The data gathered in this study were analyzed by research question, using the technological pedagogical content knowledge (TPACK) framework as a lens for understanding responses. Using this framework provided insight into how assessment and technology are used and conceptualized in the work of teaching with technology (Koehler & Mishra, 2009). Analysis of qualitative data utilized the TPACK domains as a code bank. Assessment practices primarily were coded in either the pedagogical knowledge (PK) or pedagogical content knowledge (PCK) components based on general or content-related best practices in assessment (Earl, 2003; Wiliam, 2010). Practices were described through responses to frequency items as well as in qualitative data. Frequency items were most often coded as technological knowledge (TK), PK, or PCK. Beliefs about assessment, technology, and students as learners were coded under the component of context. Items related to beliefs were Likert-type responses. Confidence in assessment and technology practices were analyzed through confidence-rating items. Confidence items were coded in all of the component areas of TPACK. Quantitative data were analyzed to provide descriptions of practice in order to respond to a need for more research into the TPACK framework (Cox & Graham, 2009) and to provide insight for researchers, teacher educators, and educational stakeholders.

Data were collected from the SurveyMonkey electronic platform in an SPSS-compatible spreadsheet. SurveyMonkey provided an initial report on the quantitative data in the form of percentages and means. Descriptive data were analyzed for patterns and

trends within participant response demographics. The intent of the analysis was to describe how technology was being used to assess student learning. The use of the TPACK framework as a lens for looking at these data provided a structure for describing teacher practices. The study differed from other TPACK studies in that it had a focus on pedagogy, rather than a specific content area or academic setting, for the purpose of analysis. Due to this pedagogical focus, a chi-square procedure was used to investigate if there were any differences in confidence levels, frequency of technology use, and beliefs about technology within the participant population based on subjects taught, grade-level taught, membership in ISTE and CUE, and years teaching. Although other demographic variables were collected, the distribution of participants within those demographic variables were less than 10 in a given group.

Qualitative data initially were organized by participant demographics to obtain a range of multiple perspectives (Creswell, 2009). The primary purpose of the study was to understand how technology-using teachers used technology to assess student learning. An initial data coding was completed using the structure of the research questions. As another concern of the study was to contribute to the body of knowledge around the TPACK framework, a qualitative codebook describing the domains of the TPACK framework was used to code the data after an initial coding by research question. Data are presented by research question in chapter 4, and the secondary TPACK analysis is used to add to the description of the results in chapter 5.

Data were coded using a constant comparison, with periodic confirmatory analysis of a percentage of the collected data performed by an expert in the TPACK framework. The coding process utilized a coding software program, NVivo, as possible. Data were hand-coded using Excel spreadsheets. Coded data were utilized to develop descriptions of

processes and practices of various grade-level and subject-area technology-using teachers. TPACK codes were triangulated with research question data to provide insight into the data.

To ensure validity of the qualitative data, triangulation with general quantitative data and artifact data occurred. Qualitative data were presented in conjunction with quantitative date to create a rich and descriptive narrative, representing portraits of practice. An explicit clarification of the bias of the researcher as well as negative or contradictory evidence is presented in the limitations section of chapter 5 (Creswell, 2009). The qualitative data analyzed in this study were specific to the participants in the study and are not generalizable to a larger population.

Interrater reliability for the coding of the qualitative data was provided through the use of a second coder. A random sample of qualitative data and the qualitative codebook developed by the researcher were provided to a second coder. The second coder was a full professor at a local college of education. Her area of expertise is cognition and technology and her academic background is in qualitative research. She validated the coded themes of the primary researcher, with an initial interrater reliability of 80%. The second coder checked three of the eight interviews and 21 of the 84 survey open-ended response sets. Discrepancies in rating were discussed to arrive at consensus.

Research question one was intended to describe how teachers use technology to assess student learning. In order to answer this question, quantitative and qualitative components of the study were analyzed. Quantitative survey items regarding frequency of use of assessment practices and technologies were analyzed descriptively. Patterns of use for content area, grade-level taught, membership in ISTE and CUE, and years teaching are reported by research question and item in chapter 4. Open-ended items on the survey

asked participants to describe ways in which they use technology to assess student learning. Responses to these items were organized by the second-order research questions in order to generate descriptions of use. Interview data generated additional descriptions of practice in order to address this research question.

Research question two was intended to reveal aspects of participant assessment literacy, primarily in the pedagogical content knowledge component of the TPACK framework. Assessment literacy was embedded in confidence and Likert items about beliefs and practices in using assessment and technology. The open-ended items that prompted participants to describe how technology is used to assess student learning were coded for assessment literacy and aspects of the TPACK framework. Interview data provided insight into the process of using technology to assess student learning and into the effects of this use on teacher understandings of assessment and technology. Within the interview, specific questions were intended to align with domains in the TPACK framework as seen in Table 8.

Qualifications of the Researcher

The researcher was a doctoral student at the University of San Francisco. Her coursework focused on technology and educational assessment. She had presented introductions to the TPACK framework for teacher education faculty at local universities. She also had presented and been very active in the TPACK community at national and international conferences. She worked at a university assisting in designing, developing, and delivering student assessments following Common Core State Standards. Prior to entering the University of San Francisco, she was a school site and district technology coordinator, staff developer, and credentialed teacher for 14 years. She holds a Master's

Table 8

Sample Interview Items Aligned to TPACK Domains

Interview Item	TPACK Domain
Describe the student learning goals/objectives addressed in the lesson.	Content Knowledge
Describe your students (e.g., grade level, and specific learning needs/preferences).	Context
What educational technologies (digital) did you use?	Technological Knowledge
Briefly describe the activities in the lesson.	Pedagogical Knowledge
Describe how students were assessed in this lesson/project. (at all points where assessment was used in the lesson/project).	Pedagogical Content Knowledge
How and why do the particular technologies used to assess students in this lesson/project "fit" the content/process goals?	TPACK

degree in Anthropology and has experience in qualitative research methodology from her work in this program. She had been an active part of the Performance Assessment for California Teachers (PACT) at San Jose State University and had served as both a mentor and coordinator of the Beginning Teacher Support and Assessment program in the Milpitas Unified School District. The researcher's academic and work history supplied her with the qualifications to undertake this study.

Summary

The Technology Assessment Practices Survey study was developed based on research bases in assessment literacy and in the technological pedagogical content knowledge framework. The purpose for developing this mixed-method study was the need to better understand how technology-using teachers assess student learning with technology. Two primary research questions facilitated a description of the assessment literacy and use of technology by 84 technology-using teachers. Participants in the study represented a diverse population of self-identified technology-using teachers. Quantitative and qualitative data were analyzed to provide insight into the questions.

CHAPTER IV

RESULTS

The purpose of this mixed-methods descriptive study was to provide examples of and describe how technology-using teachers understand and use technology to assess student learning. Identified differences in technologies used, frequency of use, described practices, confidence levels in assessment and technology, and agreement with statements about assessment and technology were described based on years teaching, grade levels taught, affiliation with the Computer Using Educators (CUE) and the International Society for Technology in Education (ISTE), and subject area taught.

Survey data were collected through the use of an online instrument. Individuals from two professional organizations focused on technology and education were invited to participate in the survey. A total of 84 participants completed the entire survey. Participants who completed the survey were invited to participate in a brief telephone interview describing a lesson in which they used technology to assess student learning. There were eight participants in the interview process. One participant related observations of other teachers' practices rather than her own experiences as a teacher, this interview was excluded from the data reported in this chapter.

Results are presented in this chapter arranged by research question and second-order questions. Quantitative results for each question are presented in text and tables, followed by open-ended survey results and qualitative interview data.

Research Question 1
How Do Self-Identified Technology-Using Teachers Design, Deliver, and Use Assessment Technology?

The majority of items in the Technology Assessment Practices Survey were designed to elicit information about teacher practices in assessment, technology, and assessment using technology. The first research question in the study, therefore, is about these practices. Attempting to describe teacher practices is a complex undertaking. For the purposes of reporting results in a coherent fashion, the results of the first research question are presented as answers to second-order questions. Quantitative results are reported first with qualitative survey results following. Data from interviews that relate to the questions are presented last.

What Technologies Do Technology-Using Teachers Use to Assess Student Learning?

To understand how self-identified teachers use technology, participants were surveyed about whether they had used several types of technology tools. Results of this item were analyzed by overall response and by demographic variables. The majority of participants indicated that they had used between 2 and 6 of the 17 tools listed in the survey, as seen in Table 9.

Patterns in use of specific tools became readily apparent. A list of the tools and responses from participants is found in Table 10. Overall, apps, computer-adaptive testing, and document sharing were consistently among the tools most frequently utilized by participants, regardless of additional demographic features such as years teaching, subject taught, frequency of use, and professional affiliation.

Table 9

Number of Technology Tools Used by 84 Survey Participants

Number of Tools Used	*f*	%
1	6	7.1
2	10	11.9
3	10	11.9
4	16	19.0
5	10	11.9
6	8	9.5
7	2	2.4
8	8	9.5
9	5	6.0
10	6	7.1
12	3	3.6

Table 10

Use of Technology Tools by 84 Survey Participants

Technology Tool	*f*	%
Apps (mobile learning)	52	61.9
Document Sharing (i.e., Google Docs)	45	53.6
Computer-Adaptive Testing (diagnostic and self-paced assessments)	44	52.4
Student Response System (“Clickers”)	36	42.9
Discussion Boards	35	41.7
Textbook/Subscription Provided Electronic Tests/Quizzes	31	36.9
Email	29	34.5
Online Publishing (student-created webpages, products, etc.)	28	33.3
Blogs/E-Journals	27	32.1
Games	27	32.1
WebQuests	25	29.8
Electronic Portfolios	19	22.6
Chat	16	19.0
Virtual Simulations (virtual labs, engineering, building, etc.)	9	10.7
Text Messaging	7	8.3
Social Media (Twitter, Facebook, ePals, etc.)	6	7.1
Virtual Reality (i.e., SecondLife)	1	1.2

Analysis based on the demographic of grade levels taught resulted in the finding that 60 % of grades K to 3 and 44% of grades 4 to 6 teachers reported using games. Conversely, only 8.3% of grade 7 to 9 and 18.8% of grade 10 to 12 teachers reported using games as seen in Table 11. Participants' reported frequencies of use of technology to assess student learning, apps and document sharing were the most popular tools used by participants who report using technology 1 to 2 times a week or daily.

Table 11

Most Frequently Used Tools of 84 Participants Grade-Level Taught

	Grade-Level							
	K-3		4-6		7-9		10-12	
Tool	*f*	%	*f*	%	*f*	%	*f*	%
Apps	14	93.3	14	56.0	7	41.7	19	59.4
CAT	9	60.0	12	48.0	9	75.0	14	43.8
Document Sharing	5	33.3	11	44.0	5	41.7	24	75.0
Student Response	4	26.7	9	36.0	5	41.7	18	56.3
Games	9	60.0	11	44.0	1	8.3	6	18.8

CAT was reported as popular with participants who use technology to assess student learning 1 to 2 times a month or 1 to 2 times a grading period, as seen in Table 12.

Table 12

Most Frequently Used Tools of 84 Participants by Frequency of Assessment with Technology

	Grading Period		Monthly		Weekly		Daily	
Tool	*f*	%	*f*	%	*f*	%	*f*	%
CAT	8	50.0	7	87.5	16	51.6	13	44.8
Apps	7	43.8	2	25.0	21	67.7	22	75.9
Document Sharing	5	31.3	3	37.5	20	64.5	17	58.6
Student Response	5	31.3	1	12.5	16	51.6	14	48.3
Discussion Board	7	43.8	2	25.0	16	51.6	10	34.5

Another area in which responses for technology tools used differed based on the reported demographic of the participant was for subject taught. Apps and document sharing were the two most frequently reported tools with the largest number of participants overall as shown in Table 13, differences exist for other frequently used tools based on subject area taught.

Table 13

Most Frequently Used Tools of 69 Participants by Specific Subject Area

	English		Mathematics		Science		Multimedia	
Tool	*f*	%	*f*	%	*f*	%	*f*	%
Blogging	5	27.8	2	11.8	5	33.3	8	42.1
Games	7	38.9	3	17.6	8	53.3	5	26.3
Online Publishing	8	44.4	3	17.6	3	20.0	8	42.1
Text/Subscription Quiz	3	16.7	9	52.9	6	40.0	5	26.3

Survey participants had the opportunity to provide "other" responses to the item on types of technology used. There were eight entries in this optional open-ended item. All eight participants reported teaching grades 10 to 12. Subject areas in which they reported using the most technology varied but were primarily English. One participant reported using district or state data programs. Two participants reported using online quizzes with a learning management system. Student- or teacher-created products were technology tools reported by two participants. Individual participants cited online rubrics, SmartBoard games, research platforms, and interactive interview protocols as technology tools not listed in the fixed-response items of the survey. The responses from this item are listed by subject taught in Table 14.

In addition to items about general use of technology and assessment, participants were asked to describe a specific lesson in which they used technology to assess student

learning. One prompt was about the types of technology used within the assessment. Of the 84 participants who responded to the prompt, two responses were unusable due to their vague nature: “yes” and “many.” An additional response was not included

Table 14

“Other” Technology Tools Reported by 8 Grade 10-12 Teachers by Subject Taught

Subject	“Other” Technology Tool
All Subjects	Interactive Interview Process
English	SMART board games
English	Data Director - district provided data program
English	Noodle Tools research platform
English	Online quizzes with LMS, Online rubrics.
Mathematics	(OARS) Online Assessment Reporting System
Multimedia	Self-Developed Assessments in HTML5/Adobe Captivate
Multimedia	Student created programs

as the participant indicated confusion about the instructions for answering the item. The remaining 81 responses were coded into three interpretations of the term “technology.” The frequencies of responses for each interpretation are listed in Table 15.

Table 15

Frequency of Interpretations of the Term “Technology” by 81 Survey Participants

Interpretation	*f*	%
Physical Devices	20	24.6
Software or Apps	39	48.1
Physical Devices and Software or Apps	22	27.2

Interpretations of the term “technology” as physical device used in the assessment included the terms iPads, iPad minis, SmartBoards, Chromebooks, smartphones, iPhones, netbooks, desktop PCs, “clickers,” TI-Inspire, projectors, and “student-owned technology.” Other responses described “technology” as software or apps used in the assessment ranging from a single application, such as “scratch” to a list of many

applications used in the lesson (Socrative, Geddit, GoogleDrive, Backchannelchat, Curriculet, Screencasting, Surveys, GoogleaDay, Student blogs). “Technology” was represented as both physical devices and software or apps used in the assessment as well. These responses ranged from “iPad-Pocket Pals” to a very detailed description from a female, international, private-school multimedia teacher with between 16 and 20 years teaching:

> The students go through a whole process so there are many formative checks along the way that utilize technology. At the start, they use a website and embedded presentations to self pace their knowledge building. They use research skills to gather information on their topic. They use interview skills and record their notes with technology as well as make surveys online if needed. The students utilize spreadsheets to organise the data that they collected. They use design building skills to make a physical product or computer skills to design a product to make an impact to reduce the waste that they investigated. They use technology to document their process including taking photos, uploading to a blog, creating a written report, or making an online presentation. The teachers evaluate the different steps in the process, send online rubrics, and assign grades in an online grading system.

Interview participants were asked what technology they used in the lesson they were describing for the researcher. Most of the participants introduced the technology used in the assessment within a prompt to describe the assessment completed by students. Two participants required specific prompting (what technology did you use in the assessment?) to provide descriptions of the physical devices and software or apps utilized in the lesson described. Frequency of interpretations and distribution of specific prompting from the transcribed interviews are shown in Table 16.

A public-high-school mathematics teacher from Texas, described the technology he used as the TI-Inspire device in conjunction with Word, Excel, discussion boards, and Moodle (a learning management system, LMS). A public-high-school English teacher

from Georgia described the use of student smartphones, word processors, Quick Office, Dragon Dictation, the Desire2Learn LMS, and library databases as the technology used in her lesson.

Table 16

Frequency of Interpretations of "Technology" and Distribution of Specific Prompting of 7 Interview Participants

Description	*f*	Prompted
Physical Devices	0	0
Software or Apps	1	1
Physical and Software	6	1

A public-high-school Advanced Placement (AP) Biology teacher responded that she used online "quizlets" and Chromebooks both within the classroom and at home to access assessments. An eighth-grade English teacher and two third-grade English teachers provided information on both the devices and applications used, with a focus on how the applications allowed students to be assessed formatively in building basic skills. These three participants indicated the technology facilitated frequent assessment opportunities for students in classrooms. All three of these participants were public elementary-school multiple-subjects teachers who were focusing on developing language arts skills.

One of the third-grade English teachers described the technology used in the lesson as a combination of software and hardware thusly:

> So I found this great website called spellingcity.com, which allows me to input the spelling words, and then I have the option of assigning… assigning games or not assigning games or vocabulary words… Thursday evening they would take their spelling test online. So each child was getting a differentiated spelling assessment based on their spelling levels, that's less groups I had to manage. Less groups, I had to worry about on Friday when teachers would be going to be giving spelling tests. Just imagine giving eight multiple tests. At 10 minutes per test, that is a lot of time!... now about 1/3 of my students have access to a computer in the classroom at all times. As well as my grade level has a full cart of Chromebooks.

A special-education teacher for middle-grade students in a public school described the technology primarily in terms of how it facilitated student abilities to demonstrate learning in ways that traditional pencil-and-paper formats could not. The elementary- and special-education teachers' responses focused on the purposes of the technology rather than the specific devices and software or applications in their descriptions. They described using classroom computers, home computers, and online quiz applications to facilitate individualized learning for students.

How Do Technology-Using Teachers Develop Assessments?

Several items in the survey were designed to provide information on the assessment practices of participants. These items referred to assessment in a generalized sense. Participants were prompted to consider the subject area in which they most frequently used technology to assess student learning as a context for the items. A group of items was about the frequency with which participants developed types of assessments. A brief explanatory statement describing what was meant by each assessment type was included in each item. For instance, the item about alternative assessment was followed with "projects, problem-based learning, simulations, etc." in parenthesis. All item types were most frequently developed on a monthly basis, as seen in Table 17.

Table 17

Frequency of Development of Types of Assessments by 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Item Type	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Alternative	14	16.7	45	53.6	18	21.4	6	7.1	1	1.2
Constructed Response	10	11.9	39	46.4	28	33.3	5	6.0	2	2.4
Fixed Response	12	14.3	33	39.3	27	32.1	7	8.3	5	6.0
Rubric	18	21.4	44	52.4	19	26.6	2	2.4	1	1.2

Another item was included to provide information on the variety of types of assessment participants used. The responses for the item "How frequently do you - Use a variety of assessments (tests, projects, short responses, authentic/performance assessments) in your classroom?" Participant responses were divided evenly between monthly, weekly, and daily. Participants were asked to indicate how frequently they used standardized test items as models to create classroom assessments. The most frequently cited response for using standardized items to create assessments was monthly. Frequencies for responses on both items are presented in Table 18.

Table 18

Frequency of Use of a Variety of Item Types and Standardized Test Items as Models by 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Items	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Variety	5	6.0	28	33.3	27	32.1	21	25.0	3	3.6
As models	18	21.4	29	34.5	17	20.2	8	9.5	12	14.3

Results were analyzed further by years teaching, subject taught, grade-level taught, and professional-organization affiliation. Minor differences were observed for most of the independent variables; however, there was a distinct difference in responses by professional affiliation. Participants who did not indicate membership in ISTE or CUE were more likely to use standardized test items as models for instruction weekly or daily. Those who indicated affiliation with both organizations were most likely to report never using standardized test items as models as seen in Table 19.

Participants were asked to indicate the frequency with which they modified assessment items for students who might have linguistic or learning issues with assessments. Responses indicate that items are modified more frequently for special

Table 19

Frequency of Use of Standardized Test Items as Models for Creating Assessments by Professional Organization Affiliation for 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Professional Organization	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
No Affiliation	3	13.6	2	9.1	9	40.9	6	27.3	2	9.1
CUE	3	27.3	4	36.4	2	18.2	0	0.0	2	18.2
ISTE	10	25.6	20	51.3	4	10.3	2	5.1	3	7.7
ISTE and CUE	2	16.7	3	25.0	2	16.7	0	0.0	5	41.7

education students than for English Language Learners. Participant responses for the frequencies with which they modified items for English Language Learners and special education students are reported in Table 20.

Table 20

Frequency of Modification of Assessment Items for Student Characteristic by 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Student Characteristic	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
English Language Learner	27	32.1	24	28.6	16	19.0	3	3.6	17	20.2
Special Education	9	10.7	18	21.4	34	40.5	20	23.8	3	3.6

Analysis by demographic was completed for each student characteristic. Differences were found for the frequency with which participants modified items for English Language Learners by participant grade-level taught. Participants who reported teaching grades 4 to 6 and 7 to 9 reported modifying items less frequently for English Learners than those who reported teaching grades K to 3 or 10 to 12. Participants who reported teaching grades 7 to 9 were most likely to report never modifying items for English learners as shown in Table 21.

Table 21

Frequency of Modification of Assessment Items for English Language Learner by Grade-Level Taught for 84 Survey Participants

	Yearly		Weekly		Daily		Never	
Grade-Level Taught	*f*	%	*f*	%	*f*	%	*f*	%
K-3	2	13.2	5	33.3	3	3.6	1	6.7
4-6	8	32.0	9	36.0	4	16.0	4	16.0
7-9	5	41.7	2	16.7	0	0.0	5	41.7
10-12	9	10.7	34	40.5	20	23.8	3	3.6

Participants were asked how frequently they assess types of student learning in the subject area they selected as a focus for the survey. Both content knowledge and content skills were assessed with similar regularity as seen in Table 22.

Table 22

Frequency of Use of Assessment of Type of Student Learning for 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Type of Learning	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Content Knowledge	4	4.8	24	28.6	39	46.4	15	17.9	2	2.4
Content Skills	1	1.2	24	28.6	45	53.6	12	14.3	2	2.4

In addition to fixed-response items about the frequency of use of assessments and modifications of those assessments for different learners, participants were asked to describe a lesson in which they used technology to assess student learning. Several open-ended response items were included to guide the participants in describing the lesson. The first item was intended to provide insight into the planning or design process of participants. There were 84 responses to the question “What was the topic and learning objective (goal) of the lesson?” The responses were coded into 12 attributes. The most frequent forms of objectives described were the skill students were intended to

demonstrate or a more formal phrasing of the objective in a "students will be able to" structure. The attributes and frequency of those attributes are listed in Table 23.

Table 23

Frequency of Coded Objectives Used in a Described Lesson by 84 Survey Participants

Objective Type	*f*	%
Skill	21	25.0
Students Will Be Able to…	12	14.2
Topic	8	9.5
Unclear	8	9.5
Subject	7	8.3
Varies	8	9.5
Subject and Topic	6	7.1
Goal	4	4.8
Purpose of Assessment	4	4.8
Subject and Goal	3	3.6
"Improvement"	2	2.4
Confused about instruction	1	1.2

The wording of the open-ended answers to the item about objectives varied widely. Examples are provided of coded attributes and the text from selected responses in Table 24.

Table 24

Examples of Coded Objectives Used in a Described Lesson

Attribute	Objective
Skill	solving two-step equations.
Students Will Be Able to…	Demonstrate understanding of the physical layout…
Topic	Animal Adaptions
Unclear	The data warehouse manages both formative…
Subject	Physics
Varies	I assess and train individual students…
Subject and Topic	Algebra 1/Integrated Mathematics 1: Construction…
Goal	The goal was for students to master sixth grade…
Purpose of Assessment	I always used Socrative for bell ringers…
Subject and Goal	Web Design Class; goal: understanding/applying…
"Improvement"	to improve using…

Within the interviews, participants were asked to provide the goal, objective, or both for the specific lesson they were describing. One participant described the objective for the assignment in a students-will-be-able-to structure: "To be able to make predictions about genetic crosses, using Mendelian genetics, but multiple descriptors." One participant's description of the objectives was unclear within the description of the research project being done. Three participants listed objectives that had multiple goals, combining content knowledge and skills with technological skills.

An example of the combination of these three skills comes from an eighth-grade English teacher in a public school as follows:

> There were several different things. There was a writing standard where they needed to be able to create a paragraph on the computer and have an opening sentence and a closing sentence. And then within it I was checking for certain kinds of sentences and grammar. But it was mostly the writing, trying to get out paragraphs and answer a prompt… So I got to assess them based on their typing skills and their answering of the prompts.

The final two participants in the interview provided responses that would be coded as "varies." They described an ongoing use of technology for progress monitoring and individualization of student learning. A first-grade public-school teacher described her reasoning processes for selecting the technology as an answer to the objective (spelling) for the lesson.

> Two years ago I noticed, or maybe closer to three years ago, anyhow, I noticed that when I was giving the traditional pencil and paper test I could easily predict which child would be passing all of the spelling tests, which child would not be passing all of the spelling tests based on their home life…In October…So, in October I knew which route which kid would go. And I knew that this was a problem and I did not like it. So I turned to words their way, in order to get ideas for how to better differentiate spelling tests based on kids' levels.

A middle-grades special-education teacher also described objectives in an individualized, ongoing manner as follows:

> Well, we use computers to do their baseline and their end-of-the-year as well as several little mile markers through this particular program. So the students, so it was like the class stays ongoing, checking in with them and doing our assessments…within their learning goals and objectives, it was mainly reading comprehension and fluency. Although, of course, we always want our kids to know phonics, some of our kids will never be able to sound out words because there are just too many possible combinations, so we try to also teach them just rote memorization of words so they would be able to read fluently.

How Do Technology-Using Teachers Deliver Assessments Using Technology?

The second open-ended item in the section describing a lesson asked for a description of the assessment students completed. These responses were coded for assessment type. The most frequent types of assessment described in the responses were alternative, such as projects and complex tasks, and fixed-response, such as online quizzes or games. The codes aligned with the types of assessment items used in frequency items in the fixed-response portion of the survey. The coded data from the 84 responses is shown in Table 25.

Table 25

Frequency of Types of Assessments Used in a Described Lesson by 84 Survey Participants

Item Type	*f*	%
Alternative	29	34.5
Fixed-Response	28	33.3
Multiple Types	16	19.0
Unclear	8	9.5
Constructed-Response	1	1.2
Interactive Interview Process	1	1.2
Confused about instruction	1	1.2

The responses on this item varied in detail about use of technology and in specifics about the type of assessment itself. Some responses consisted of one or two words, whereas others were paragraphs. Examples of responses are shown in Table 26.

The descriptions of use of technology in the responses also varied. Some responses indicated technology used for gaining information and for assessment: “They were able to find answers to questions on the life cycles of various animals and then chose with a

Table 26

Examples of Types of Assessments Used in a Described Lesson by 84 Survey Participants

Item Type	Examples
Alternative	Students built a replica of a mission of choice in MineCraft...
Fixed-Response	I created a number of Kahoot quizzes (8-15 questions…
Multiple Types	Online multiple choice… Presentations...
Unclear	Students used computers to complete activities to reinforce…
Constructed-Response	Students were given a problem…online and submit using...
Interactive Interview	I do not use formal assessments...Interactive Interview…
Confused	Where were the instructions for this section?

group one classification of animals to do a PowerPoint presentation.” Other assessments used technology to gain information but then appeared to assess students offline: “they were assigned to use an interactive website that demonstrated how fossils are formed and then they had to recreate an art assignment that showed how fossils are formed.” Other responses were very detailed, outlining the entire process of assessment for the researcher. An open-ended survey response example from an elementary-grade, private-school multimedia-subjects teacher illustrates the type of response seen in paragraph form:

> The students go through a whole process so there are many formative checks along the way that utilize technology. At the start, they use a website and embeded presentations to self pace their knowledge building. They use research skills to gather information on their topic. They use interview skills and record their notes with technology as well as make surveys online if needed. The students utilize spreadsheets to organise the data that they collected. They use design building skills to make a physical product or computer skills to design a product to make an impact to reduce the waste that they investigated. They use technology to document their process including taking photos, uploading to a blog, or creating a written report, or making an online presentation. The teachers

> evaluate the different steps in the process and send online rubrics and assign grades in an online grading system.

Some responses only described peer assessments, "Each student showed their presentation to the class on the SmartBoard, and the class had to grade it using the classroom clickers." Other responses included both peer and teacher assessment such as "Wrote an essay and received teacher and peer comments as they revised; online response to non-fiction reading assignment" and "the students must receive feedback regarding their product from their peers as well as self reflect on their product/ solution. These are given in a written report or an online presentation. Teachers submit feedback and grades via an online grading system."

Interview participants also described how they delivered assessments using technology. Alternate assessment types, such as projects, were cited most frequently by the interview participants. The remaining participants described the use of online quizzes and games that fit a description of fixed-response assessments, as shown in Table 27.

Table 27

Frequency of Types of Assessments Used in a Described Lesson by 7 Interview Participants

Item Type	*f*	%
Alternative	4	57.1
Fixed-Response	3	42.9

An example of an alternative assessment described in the interviews from a high-school mathematics teacher was

> We used a TI Inspire CX model; the students all have a hand-held version of that. We also used, of course we used a word processor, Microsoft word, most of them used, and then, of course, some of them even used excel to input their tables with their inputs and outputs.

The use of technology-based, fixed-response assessments reported by a middle-grades special-education teacher was exemplified as

> So there are games online, and there are things like sortagories, where it gives them a blending and then it will have them build the word… they get points for everything that they do… they have goals of how many points they want to try to achieve, the skills continually get harder as they master them, there's vocab building, where there's a word… it says the word, it gives them a definition, there is a short story where they have to identify the right word and the right meaning… so there's a bunch of building, stepping stones to help the students throughout the program.

For What Purposes Do Technology-Using Teachers Use Assessments?

Several items on the survey were designed to elicit information about how technology-using teachers use the results of assessments. Responses indicated that a majority of participants used assessments to grade or promote students and provide feedback on a weekly basis. Most participants used assessments to guide student self-assessment monthly. Very few participants reported never using assessments to grade, guide self-assessment, or provide feedback as shown in Table 28.

Table 28

Frequency of Purpose for Assessment for 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Purpose	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Grade or Promote	9	10.7	25	29.6	31	36.9	16	19.0	3	3.6
Guide Self-Assessment	5	6.0	31	32.1	24	28.6	19	22.6	1	1.2
Provide Feedback	2	2.4	24	28.6	36	42.9	20	23.8	2	2.4

Two frequency items were included to investigate participant purposes for technology-based assessments. Participants indicated that they used technology-based assessments for students to demonstrate learning on a weekly basis. Participants indicated

they most frequently used technology-based assessments to guide student self-assessment on a monthly or weekly basis as shown in Table 29.

Table 29

Frequency of Purpose for Technology-Based Assessment for 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Purpose	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Demonstrate Learning	1	1.2	24	28.6	36	42.9	23	27.4	0	0.0
Self-Assessment	12	14.3	28	33.3	27	32.1	17	20.2	0	0.0

What Do Technology-Using Teachers Do with Assessment Results?

A series of items about the use of the results of assessments in general as well as in a described lesson were included in the survey. Participants were asked how frequently they used the results of different types of assessment to modify their instruction. Most participants indicated that they used alternative-, constructed-response, and fixed-response items to modify instruction on a weekly or monthly basis as shown in Table 30.

Table 30

Frequency of Use Assessment Results to Modify Instruction by Type of Assessment for 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Purpose	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Alternative	9	10.7	24	28.6	31	36.9	13	15.5	7	8.3
Constructed-Response	6	7.1	30	35.7	35	41.7	4	4.8	9	10.7
Fixed-Response	6	7.1	31	36.9	31	36.9	8	9.5	8	9.5

Participants were asked how frequently they used the results of nationally- developed, state- or locally-developed, and self-developed assessments to modify instruction. Nationally-developed assessment results were the least frequently used. State- and locally-developed assessment results were used more frequently, however results from self-developed assessments were the most frequently used, as shown in Table 31.

Table 31

Frequency of Use Assessment Results to Modify Instruction by Developer of Assessment for 84 Survey Participants

	Yearly		Monthly		Weekly		Daily		Never	
Purpose	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
National	21	25.0	21	25.0	16	19.0	3	3.6	23	27.4
Local or State	17	20.2	26	31.0	16	19.0	6	7.1	19	22.6
Own	4	4.8	24	28.6	36	42.9	18	21.4	2	2.4

After describing a lesson that used technology to assess student learning, a survey item about the use of assessment results was presented to participants. Participants were able to "select all that apply" or multiple answers in response to an item that asked, "How did you use the results of the assessment?" The results of this item were divided into categories as purposes, feedback, guiding student assessment, and instructional next steps. Unfortunately, many participants did not select options that fit into the categories of feedback, guiding student assessment, and instructional next steps.

The largest number of participants indicated that they used the results of the assessment from the lesson described to both assign a grade and determine mastery of student learning. The second most frequently selected response was for only assigning a grade, as shown in Table 32.

Table 32

Purpose for Use of Assessment Results of a Described Lesson for 84 Survey Participants

Purpose	*f*	%
Not reported	16	19.0
Provide a Grade	24	28.6
Determine Mastery	18	21.4
Grade and Mastery	26	31.0

Participant responses about uses of assessment results were analyzed using multiple demographics. These responses about the use of assessment results to provide a grade or determine mastery showed differences between groups of participants when disaggregated by grade-level taught.

Earlier-grades teaching participants (K to 3 and 4 to 6) most frequently reported using the results either to assign a grade or to determine mastery. Participants in the highest-grade levels most frequently reported using the results to both assign a grade and determine mastery as shown in Table 33.

Table 33

Purpose for Use of Assessment Results of a Described Lesson for 84 Survey Participants by Grade Taught

	Not Reported		Grade		Mastery		Grade and Mastery	
Grade	*f*	%	*f*	%	*f*	%	*f*	%
K-3	3	20.0	1	6.7	8	53.3	3	20.0
4-6	4	16.0	12	48.0	5	20.0	4	16.0
7-9	4	33.3	3	25.0	1	8.3	4	33.3
10-12	5	15.6	8	25.0	4	12.5	15	46.9

Within the item about use of assessment results from the described lesson, participants had the opportunity to indicate what types of feedback were provided to students. Participants who indicated that they provided feedback most frequently reported feedback both on quality of student work and that guided student learning. A majority of respondents did not select an option that described feedback, as shown in Table 34. After describing a specific lesson using technology, participants had the option of selecting responses about using results to guide student self- or peer assessment. A majority of participants did not select any options within this category. The most

frequently selected option was using the assessment to guide student self-assessment, as shown in Table 35.

Table 34

Purpose of Feedback in a Described Lesson for 84 Survey Participants

Feedback	*f*	%
Not reported	36	42.9
Quality of Work	13	15.5
Guide Student Learning	13	15.5
Quality and Guide	22	26.2

Table 35

Use of Assessment Results of a Described Lesson to Guide Student Assessments for 84 Survey Participants

Purpose	*f*	%
Not reported	44	52.4
Self-Assessment	21	25.0
Peer Assessment	5	6.0
Self- and Peer Assessment	14	16.7

Participants had the option of indicating how they used the results of the assessment to plan instructional next steps. Most participants did not select an option from this category. Participants who did select an option most frequently selected using results to plan instructional next steps for the class, groups of students, and individual students as shown in Table 36.

Interview participants were asked how they used the results of the lesson they described in the course of the interview. A public high-school mathematics teacher, public-elementary-school first-grade teacher, and public-middle-school special education teacher described how the use of technology helped them assess student progress toward mastery on an individual basis. They described how using the results of technology-based

Table 36

Instructional Next Steps for Students Based on Results of a Described Lesson for 84 Survey Participants

Next Steps for Students	*f*	%
Not reported	31	36.9
Class	12	14.3
Group	8	9.5
Individual	6	7.1
Class/Group	3	3.6
Class/Individual	6	7.1
Group/Individual	4	4.8
Class/Group/Individual	14	16.7

assessments enabled them to plan instruction for individuals and the class. Another commonality was the ability to guide student self-assessment by using technology.

A public high-school mathematics teacher described how using technology to assess student learning has influenced his planning process thusly:

> So technology has allowed me to give them a little independence of their own, kind of monitoring their own learning. And it's allowed me to give them more access to every problem, cause some students are afraid to speak up Hey, I need that problem… so, sometimes it goes well and sometimes I have had to go over every problem. So it's allowed that constant, I guess, constant, not remediation, evaluation of where we are at and through mobile homework checks there is no question when we get to a quiz that I know who is struggling on this topic, or this topic…

Frustration with curricular constraints put in place by state interpretations of the Common Core State Standard surfaced in the discussion of an assessment with a public-high-school English teacher.

> You know it (a research project) was supposed to span 2 semesters. But only part of two semesters. Like the end of first semester and the beginning of second semester. Mine went through the entire second semester. When I found out that we weren't allowed to teach any literature because we have only 30% of nonfiction in the fall with MacBeth because of the Common Core… I just… forget it… (exhale of breath)… this is supposed to be British Lit… So I just taught them… I made that all our objectives. I didn't break the rules, but I did it with research.

Progress monitoring at both the class and individual level and how that influenced instructional next steps was described by a public-high-school science teacher.

> The students completed this before coming to class, and using the data I looked to see what areas did they struggle, And then keyed in and focused on one to one, what their struggles were. And what I found was that it was kind of broad-based what they struggled with. The majority of the class had difficulties with certain kind of mathematical components. I just went over several different mathematical examples of how they would utilize that in a genetic study.

A public-middle-school English teacher described how she compared the results of the assessment with past years' work and used student input to evaluate the assignment. Her evaluation of the assessment focused on student engagement as an indicator of success.

> I compared it to what students did in book reports in prior years, when we didn't have a computer lab at our disposal. And I also had students give me… I had students answer a survey. Regarding… because they have been doing book reports all their life. They are in eighth grade. They have been doing them for years now. Asking them to compare the process of doing the book report this way, not only that, but also the process of listening. Because the students got to get up and present their PowerPoints as well. To the class. And overall it was a tremendous success. Kids loved it, they were more engaged, and listening to other people, They loved it.

A public-school third-grade teacher described using the results of a language-arts assessment with groups of students and with the whole class. She monitored progress in preparation for high-stakes testing using computers and spoke of how she used the results primarily to drive instructional next steps.

> Oh, I was able to go back, as this was before testing, so I was able to go back and meet with different groups of students, if they all had similar problems with it, or if I saw half the class not being able to answer the prompt… I would be like, ok, we have to work on this.

What Are the Barriers to Using Technology to Assess Student Learning?

One open-ended item was included to provide participants the opportunity to give input on what they needed to facilitate a greater use of technology for student assessment. The greatest need expressed by participants was for more training. Some entries are reported under multiple codes in Table 37 as participants sometimes listed several similar things they needed.

Barriers to implementing assessment using technology for interview participants most frequently surfaced in descriptions of the technology used in the described lesson. These descriptions focused on how the interview participant overcame barriers such as the attitudes of colleagues, a lack of technology, and concerns of parents.

Table 37

Needs in Order to Facilitate a Greater Use of Technology to Assess Learning by 84 Survey Participants

Need	*f*	%
Training	37	44.0
Tools	24	28.6
Access	18	21.4
Time	10	11.9
Leadership	4	4.8
Assessment Items	3	3.6
Variety of Assessment Options	3	3.6
Train Other Teachers	2	2.4

Note: Answers with multiple responses were coded multiple times

A public-high-school mathematics teacher described how colleagues with whom he taught had reservations about the use of technology tools in the classroom:

> Some of the teachers I teach with… no… all of the teachers I teach with are very hesitant to let students do things on the calculators. They feel that if you allow them to use the calculators, they aren't really gaining anything by it. And so, they really had their students do it by hand. I feel... I know that I had much more buy-in from the students because they were able to use their calculators; they were able to use their computers... Just because they are using a resource tool doesn't

> mean they aren't getting an education. We need to change the way we ask the question…. The TI (Texas Instruments) Inspire, it will do everything for them. Our algebra teachers are going bananas. They are like "they're not learning anything" because the calculator tells them. Well, that's fine that the calculator tells them. They are going to have that throughout their life. But why don't we ask questions about what does that data mean to you? Instead of just looking for the product, let's look at what the product means. And they (teachers) are not getting that. It is still trying to get them to that point.

Similarly, a public-middle-school special-education teacher expressed hope that teachers would be able to overcome attitudes about technology in order to recognize the affordances it provides:

> I think, honestly, the biggest thing is, I know that it is change, and that everybody is scared of change, and it does take time you know. You have to know how to use these tools, more than as just a spell checker, but until you know what it can really do for you as a teacher you are going to continue to hold back your students and continue to judge them on Friday's spelling test rather than judge them on their true abilities as a student. And in the future as a professional, it is our job to prepare them for real life. And real life is every aspect of technology.

A lack of computers in the classroom and in student homes inspired a public-high-school English teacher to investigate how a research paper project could be completed using smartphones.

> I was teaching a research process to senior English students, and everything encompassed technology. Everything. They used databases from the library to find their information, as sort of their first step; of course, they used word processors to write it. Everything was submitted through a Desire2Learn learning management system. They wrote nothing down; they were not allowed to write anything down.… Everything… yeah, everything had to be through, to save it, I encouraged them to use Google Drive, any of a number of things that are out there. I teach in a very poor area, 99% free and reduced lunch rate. But they all have smart phones. So when I realized that I showed them how to use their phones, they all you know text and talk, we used things like Dragon Dictation for the same project…, and they were able to create what was like a PowerPoint… I don't know... it was like Microsoft Office... oh, Quick Office. That's what they presented their final presentations with. Now, they were very plain white slides, but they were… they created everything on their smartphones. That is the whole research project…they did use laptops for accessing the online databases at school and they used the laptops, I taught them how to use Excel. We did some statistical

> analysis. I had them use surveys to create accounts on SurveyMonkey, which they also did on their phones. I mean, if you can't beat 'em, join 'em.

Later in the interview, she indicated frustration with the amount of time and resources that were being utilized in piloting online standardized tests.

> We have tons of computer labs, however, once April hits… the labs are used for testing and we test 22 of the last 30 days of school. And the 8 days that are not for testing days, those are make-up testing days. So we don't have access to the labs.

Students in the classroom of a public-high-school science teacher had access to technology tools but she expressed concern about the time students have to complete assignments.

> One of the things I found that was kind of limiting my ability to do this is the time for the students to be able to do this kind of intensive practice. What I am finding is that these kids who take these advanced classes are very busy. They have a job, they out for athletics, they have multiple AP courses and spending a concentrated amount of time outside of class that I was trying to get them to do was problematic. So one of the things that I am hoping to do is to do more of a flipped model so that they kind of do that kind of stuff in the classroom and then they get the lecture kind of stuff on their own. And would only be you know 45 to 50 minutes. So that would limit their time out of class that they have to spend on that class.

Two participants used a computer lab to complete the lesson. Neither one described classroom barriers to the use of technology to assess student learning. One of these participants, a public-elementary-school third-grade teacher, inferred that the lack of a computer at home was a barrier to student demonstration of learning.

> I noticed that some kids, the ones that struggled more, they don't have computers at home. So, the ones that I saw really achieving with their writing, I know they have computers at home. I'm sure they are on them all the time.

A public-elementary-school first-grade teacher explained how she overcame a lack of technology tools in the classroom.

> So, 2 or 3 years ago when I began this, about 50% of my students had a computer at home. And those students who didn't I always gave the option of staying after

> school to use a computer or to … go with me into the info lab…Or, I had a parent volunteer (my mother) she would come, and she would help, she would give spelling tests to the students who did not have access to a computer at home… now all of our students in our district have Google for Education accounts and so they have a wide range of Google activities and applications that's all to them for free so I don't think I would be able to do any of this if my students had not had those accounts or if I had the technology, not the technology in my hands, right now. If I had one or two computers of course I would make it work, but it's so much easier now that I have, a third of my class can be on a Chromebook at one time. Or I have a class cart I can grab easily and then everyone is online so that has been really nice as well.

She emphasized the importance of training students to be responsible users of technology as follows:

> I personally feel that before any teacher does anything online with their students they should be taking some sort of digital citizenship classes or courses or training on how to use technology respectfully and responsibly. At the beginning of the school year, I do a lot with common sense media, teaching my students how to be respectful online and how to be safe online. Because once they are online... there is a lot… it is very easy to click on this or click on that and before you know it, it is asking for your credit card and blood type and… whatnot… and you are everywhere. And so I make sure, before I do any of this, I make sure my students have a healthy fear and a healthy respect for the Internet and what is online…

She also described the need to bring parents on board when integrating technology thusly:

> I have also learned that it is very helpful to communicate and to have very clear communication with the parents. Why I am using technology as opposed to traditional pencil and paper, and share with my parents, and even show my parents the type of… how I go through the whole digital citizenship lessons and that whole unit before we even get on the computers, get our usernames or passwords, because some of my parents have been scared about allowing their child to just jump online and do all this stuff online. But once they see all the precautions that we take first and all the learning that happens first, they're more willing to allow their kid to be online, and the more trusting in me. So that has been really helpful.

Research Question 2
What Is the Assessment Literacy of Technology-Using Teachers?

Participants responded to confidence and Likert-scale items about assessment and the use of technology to assess student learning. These items were included in the survey to provide data on aspects of participant assessment literacy.

How Confident Are Technology-Using Teachers in Assessing Student Learning?

Instructional practices in assessing student learning were represented by seven confidence items. Most participants indicated confidence on all items. For items relating to assessment decisions over which the participant has control, such as assessing content knowledge or skills, the use of multiple assessments to determine mastery, determining the alignment between items and objectives, and identifying language skills in items more than 70% of participants indicated they were either confident or very confident. For items that were developed by other agencies, such as explaining how to assess students using the Common Core State Standards and making instructional sense of standardized reports, more than 25% of participants were somewhat confident, as shown in Table 38.

Table 38

Confidence for Instructional Use of 84 Survey Respondents

	Not at all		Slightly		Somewhat		Confident		Very	
Assessment Item	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Assess content knowledge	1	1.2	5	6.0	13	15.5	38	45.2	27	32.1
Assess content skills	1	1.2	4	4.8	10	11.9	38	45.2	31	36.9
Use multiple assessments	0	0.0	2	2.4	22	26.2	30	35.7	30	35.7
Assessment/objective alignment	2	2.4	6	7.1	14	16.7	37	44.0	25	29.8
Explain assessing CCSS	4	4.8	10	11.9	14	16.7	40	47.6	16	19.0
Identify language skills in assessment	1	1.2	8	9.5	14	16.7	38	45.2	23	27.4
Make instructional sense of standardized reports	2	2.4	4	4.8	28	33.3	31	36.9	19	22.6

Five confidence items focused on assessment knowledge through differentiating between types of assessments, understanding purposes of assessments, and use of data. More than 60% of participants indicated they were confident or very confident for all of the items with the exception of knowing the difference between norm-referenced and criterion-referenced assessment items. For the item on norm-referenced and criterion-referenced items, a majority of participants indicated they were slightly confident or confident, as shown in Table 39.

Table 39

Confidence in Assessment Knowledge for 84 Survey Respondents

	Not at all		Slightly		Somewhat		Confident		Very	
Assessment Item	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Difference: assessment and evaluation	1	1.2	12	14.3	16	19.0	33	39.3	22	26.2
Difference: diagnostic, summative, formative	1	1.2	4	4.8	16	19.0	29	34.5	34	40.5
Difference: data that can inform instruction and that cannot	1	1.2	8	9.5	17	20.2	31	36.9	27	32.1
Difference: norm- and criterion- referenced items	2	2.4	14	16.7	24	28.6	29	34.5	15	17.9
Explain purposes of assessments	1	1.2	2	2.4	15	17.9	37	44.0	29	34.5

Beliefs about assessment were the focus of three Likert items. Participants disagreed and disagreed strongly with the statement that students should receive grades on all assessments. More than 60% of participants agreed or agreed strongly with statements about how assessments can positively affect the classroom, as shown in Table 40. Likert items about contextual considerations for assessment development were included in the survey. Participants had clear stances on two of the three items, with more than 90% agreeing or strongly agreeing that vocabulary can interfere with assessment and over

75% disagreeing or strongly disagreeing that culturally-specific language does not need to be considered in assessments. Participant responses were more split on the item about making content of assessments easier for students with different learning needs. As seen in Table 41, most participant responses were split between agree, neutral, and disagree.

Table 40

Agreement with Statements about Assessment for 84 Survey Respondents

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
Statement	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Students should receive grades on all assessments	15	17.9	31	36.9	16	19.0	16	19.0	6	7.1
Assessments can increase learning for all students	2	2.4	6	7.1	17	20.2	32	38.1	27	32.1
Assessments allow students to demonstrate learning in multiple ways	0	0.0	5	6.0	15	17.9	35	41.7	29	34.5

Participant beliefs about feedback were investigated in three items. Most participants, 87.1% disagreed, or strongly disagreed with the statement that feedback is a waste of time because students do not read it. Responses to the items about qualities of feedback

Table 41

Agreement with Statements about Considerations in Assessment for Specific Learning Needs for 84 Survey Respondents

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
Considerations	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Vocabulary can interfere with student assessment	0	0.0	1	1.2	6	7.1	43	51.2	34	40.5
Culturally-specific language[a] does not need to be considered in assessments	35	41.7	29	34.5	8	9.5	9	10.7	3	3.6
It is appropriate to make content in assessments easier for students with learning or language difficulties	7	8.3	21	25.0	16	19.0	26	31.0	14	16.7

[a]Item included the qualifier: (idioms, slang, etc.)

received more positive responses, with 100% of participants strongly agreeing, agreeing, or being neutral on the importance of timely feedback, and nearly 98% responding similarly on the item about feedback needing to move learning forward as seen in Table 42.

Table 42

Agreement with Statements about Feedback for 84 Survey Respondents

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
Feedback	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Feedback is a waste of time	51	60.7	22	26.2	9	10.7	2	2.4	0	0.0
Timely feedback is important	0	0.0	0	0.0	5	6.0	26	31.0	53	63.0
Feedback should move learning forward	0	0.0	2	2.4	6	7.1	29	34.5	47	56.0

The survey included two Likert items about standardized assessments. More than 75% of participants were neutral, disagreed, or strongly disagreed with the statement that standardized tests are accurate measures of student achievement. Responses were more positive about the usefulness of state and local reports about student achievement, as shown in Table 43.

Table 43

Agreement with Statements about Standardized Assessments for 84 Survey Respondents

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
Standardized Assessments	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Standardized tests are accurate measures of student achievement	20	23.8	28	33.3	24	28.6	10	11.9	2	2.4
State and district reports about student achievement are useful	10	11.9	16	19.0	27	32.1	27	32.1	4	4.8

What Are the Knowledge and Beliefs About Using Technology of Technology-Using Teachers?

The survey contained six confidence items designed to investigate knowledge of how technology could be used to assess student learning. More than 60% of participants indicated they were confident or very confident on all six items, as shown in Table 44.

Table 44

Confidence in Knowledge of Use of Technology to Assess Student Learning for 84 Survey Respondents

	Not at all		Slightly		Somewhat		Confident		Very	
Knowledge	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Advantages	0	0.0	3	3.6	13	15.5	30	35.7	38	45.2
Limitations	0	0.0	2	2.4	20	23.8	33	39.3	29	34.5
Appropriateness	0	0.0	2	2.4	15	17.9	34	40.5	33	39.3
Differentiation	0	0.0	1	1.2	13	15.5	37	44.0	33	39.3
CCSS Assessment	5	6.0	8	9.5	20	23.8	32	38.1	19	22.6
Content-area professional	0	0.0	7	8.3	17	20.2	34	40.5	26	31.0

Four agreement items were included in the survey to probe for beliefs about using technology to assess student learning. More than 60% of participants disagreed or strongly disagreed that technology makes differentiation more difficult. Participants were more neutral on an item about technology making misconceptions more difficult to see. More than 70% of participants agreed or strongly agreed with the statement that technology made assessing content learning easier. Participant responses were more neutral about whether students make better-looking products with technology, as shown in Table 45.

Participants responded to several items about general technology knowledge and use. Most participants reported being confident or very confident, as shown in Table 46.

Table 45

Agreement with Statements about Technology and Assessment of 84 Survey Respondents

	Strongly Disagree		Disagree		Neutral		Agree		Strongly Agree	
Technology makes	*f*	%	*f*	%	*f*	%	*f*	%	*f*	%
Differentiation more difficult	29	34.5	36	42.9	12	14.3	4	4.8	3	3.6
Misconceptions more difficult to detect	14	16.7	29	34.5	30	35.7	11	13.1	0	0.0
Assessing content learning easier	0	0.0	6	7.1	16	19.0	44	52.4	18	21.4
Better-looking products	3	3.6	10	11.9	31	36.9	26	31.0	14	16.7

Table 46

Confidence in Technology for 84 Survey Respondents

	Not at All Confident		Slightly Confident		Somewhat Confident		Confident		Very Confident	
	f	%	*f*	%	*f*	%	*f*	%	*f*	%
Use a range of tech	0	0.0	1	1.2	12	14.3	25	29.8	46	54.0
Learning new tech	0	0.0	0	0.0	7	8.3	27	32.1	50	59.5
Keep up with edtech	2	2.4	4	4.8	21	25.0	23	27.4	34	40.5

How Has the Technology Used in Assessment Affected Assessment Practices, Knowledge, and Beliefs of Technology Using Teachers?

Interview participants were asked two follow-up questions after describing a lesson in which they used technology to assess student learning. The first question referenced the lesson described in the interview: “how do you feel the technology you used impacted your assessment of students or their work?” The second question was intended to allow participants to reflect on how technology has influenced their assessment practices in general: “how has technology changed your approach to or beliefs about assessment?” Participants were asked if they had anything to add at the end of the interview.

Responses to the three questions were open coded. Several themes emerged. The affordances of technology have influenced assessment practices through expanding participant’s use of a variety of assessment types, re-examination of assessment design

skills, and a shift toward student-centered assessment through personalization and differentiation. Knowledge and beliefs about technology and assessment centered on the use of technology as a tool, perceptions about students, and shifts in beliefs about the potential of assessment practices.

Expanding the Use of a Variety of Assessment Types

Two participants described how the use of technology has expanded their ideas on the types and variety of assessments that are possible. A public-elementary-school third-grade teacher described the use of technology to monitor student learning more efficiently.

> It has really shown me that there are a lot of different types of assessments out there. And they are more than just taking a test at a desk. There are different things that you can do to assess kids. Like, my gosh, trying to think of a couple of things that I have used, there's classroom dojo on the iPad, and I can give kids points for certain things. Like if I see they are understanding, or if they are raising their hand a lot. I can… there's a lot of things out there that are new to me. I really like… I'm opening up my eyes to a lot of new ways to assess kids instead of just giving them a test.

Within a discussion of different assessment types, such as clickers and online quizlets, a public-high-school biology teacher explained how a variety of assessment options could help her target instruction.

> I am trying to integrate more of those kind of models so that they use that formative assessment so that, and I use them as well, so that I can key in and focus on their weaknesses so they can springboard off of that for their summative assessments.

Re-Examination of Assessment Design Skills

A public-middle-school English teacher reflected on how technology has affected her design of assessments. She stated that:

> I think it has required me to be more, more descriptive in my rubrics for student assessment. But I think that is a good thing. Because anytime… the more detail I can give in a rubric The better results I get back from them. It's just like giving a student an assignment in years past. The more detail you can give them… the more successful they can be. If it is that kind of assignment. I guess if there are some that you want the student to go on their own and be creative with it, but it has helped me, I guess, to be more eloquent in what, in my definitions to them of what I am requiring.

Student-Centered Assessment Through Personalization and Differentiation

Several interview participants provided specific details on how the use of technology has facilitated student-centered assessment practices. Student self-assessment in a public-high-school mathematics class was described as "blended learning" by the teacher.

> I was blended learning before blended learning was cool. (laugh) I really like doing… what I do with Mathematics specifically, because it is a big problem and students get home and they don't know whether or not they got the problems right. So they don't even know whether or not they are on the right track. So what I do each day is, I give them a small set of homework problems they do them, but I will often post a video or I will put the answers or solutions online for them to go and check. And my students know their homework that night is not necessarily just to do the problems. Their homework is to check the answers and really dive in to what I did. The next day when they come to class, the way I have changed my assessment is, the first thing I do is I allow them to ask any questions. They already come to class knowing whether or not they knew what they were doing. There's no longer that period of "well, I didn't really understand the homework…" You know what you miss. So they come in, they ask their questions when they walk in the door they write down the number on the board that they need. And I go over any of those. And then I do a small, entrance ticket almost, usually 3-5 questions it is not quick assessment of, hey can you repeat this process, do you know the steps it took to do this mathematics?

He continues explaining how this blended learning approach has fostered self-assessment for students and progress monitoring for himself.

> Technology has allowed me to give them a little independence of their own, kind of monitoring their own learning. And it's allowed me to give them more access to every problem, because some students are afraid to speak up… "Hey, I need

> that problem…" so, sometimes it goes well and sometimes I have had to go over every problem. So it's allowed that constant, I guess, constant, not remediation, evaluation of where we are at and through mobile homework checks there is no question when we get to a quiz that I know who is struggling on this topic, or this topic and especially when we get to a test, I know where the problem areas are cause we've done all these checks and we've done this kind of process throughout.

Two interview participants cited the ability of technology to allow students to demonstrate learning in different ways. A public-elementary-school first-grade teacher reported that:

> Technology has shown me that…it has made me able to use different assessments to see if students are understanding the content. It's no longer a test or writing a paragraph or reading an English thing for certain words or comprehension instead its… kids have more choice for how they want to demonstrate their learning to me. And I think that is very valuable as a teacher because some excel in multiple choice tests I don't know… very few though… some do well in that, some like writing it, some students don't do well in either of those so now having this option of technology I have the students who in the past might have failed or not performed very well on an assessment or shown me on an assessment that they have very little knowledge about the task or the project are now able to excel and show their learning in multiple ways. They can build a website, they can do a PowerPoint, just the mere act of them typing a document and sharing it with me is phenomenal and they are more willing and more ready to write and create because it is now on the computer as opposed to pencil and paper. And during those small points, or when we use it I have everyone's attention and so that's great and they are going up and helping each other.

Similarly, a public-middle-school special-education teacher explained:

> It allows me to understand more of their abilities because the different barriers aren't there anymore. So, for example, especially because I am special ed, a lot of my students hate, and unfortunately they use that word, firmly. I hate that word, but they do hate writing. It is a chore for them. But when you put them in front of a computer, that can fix their grammar, that can give them spelling ideas, and they can use the internet to help them find a word that they are looking for it is spectacular. To see what is inside of these students' heads. And it is stuck inside of their heads because they can't find a way out. The technology shows the true

> ability of these students if we would stop judging them on the small criteria and look at the bigger picture.

Technology as an Assessment Tool

Most of the interview participants spoke of technology as a useful tool. The public-high-school mathematics teacher expressed concern over other teachers' resistance to using technology thusly:

> I love technology, it is a platform that is misunderstood. I think there's a lot of teachers who get into it and they think it is going to do everything for them. They just don't know that it's a tool. It's a tool just like the overhead projector used to be a tool, or even the chalkboard used to be a tool. It's a tool, but they don't get it. They're afraid of it, they don't know how to use it. And that's kind of where I'm at.

The public-high-school English teacher discussed technology as a tool in the form of advice for other users.

> I definitely think having a learning management system helps. Where ever you are. It depends on the features of the learning management system. But I definitely think having that learning management system helped. Having the smartphones in their hands helps. You can't ask hey who has a smartphone? But I can certainly make an observation, you know, looking to fulfill that requirement. Fortunately, our learning management system can be accessed through their BYOD. And accessed on their mobile device. So it is definitely something I plan to use in the fall… Use the LMS as an assessment tool both summatively and formatively.

Online district benchmarks and the tools through which they are administered was described by a public-elementary-school first-grade teacher as follows.

> Students take their benchmark tests, or they are called iReady diagnostics online three times a year. Every month they have a mini-test to monitor their progress. Then from there iReady assigns lessons based on the child's levels. It is supposed to help differentiate instruction…iReady seems to be more of what Children's Progress promised to be. That is, differentiated instruction. I am able to compare student data based on class average, based on grade level average, not just based on their differentiated levels. It's not perfect, it's not something like Khan Academy where I am able to physically go in and see exactly where the errors are.

The diagnostic potential of technological assessments of individual students in order to differentiate instruction was emphasized by a public-elementary-school third-grade teacher. She stated:

> I think it has really helped with.. like tests, testing and stuff. I still do a lot of assessments like chapter quizzes on paper and things. But when I want to get cumulative, I want to know their reading levels, their mathematics levels, then we do online assessments. So those are the biggest things we use them for. And I can see a lot of progress throughout the year, or decline, on these assessments. It's the STAR reading and STAR mathematics ones and they are really helpful in making small groups and assessing kids individually. They are wonderful…Because of our reading test and mathematics test on the computer I can differentiate for different levels of students. So I can make reading groups, I can make mathematics groups based on the score… not just on what I see them do, but what they can do on the computer as well. It really helps with showing me what they do know or what they need help with. Because then I get a printout of things that they need. Then I use that in the classroom as kind of a starter for a lot of things. Especially if we are starting something new.

The most emphatic response about the use of technology tools impacting assessment practices came from a public-middle-school special-education teacher.

> I can't live without it (technology). In my classroom I have a projector, a document camera, my own photocopier and printer So, as I am able to assess students through their own laptops that I am purchasing with my own classroom funds or DonorsChoose, or Adopt a Classroom, I am able to print off things for them to take home and show their parents, to close that communication gap. Students are emailing me their homework, so they're not losing papers in the midst. And I am able to use that to directly impact my lesson. They are getting the instruction that they need, when they need it without the uncertainty of what they actually know and what they are taking, they have taken. They are showing me their true selves and I am able to use that to directly change my lesson…We use computers to do their baseline and their end-of-the-year as well as several little mile markers through this particular program. So the students…so it was like the class stays ongoing, checking in with them and doing our assessments… the tools, number one, the most important one, is it is a direct reflection on my lesson. So, depending on how the students assess, will completely alter my lesson planning and the direction that I am heading. For instance, if I thought that the students

> completely understood the soft vowels, or short vowels… and then we did the fluency test and they didn't, then I would go back and reteach in a different way to help them to understand it as well as try to get them to memorize more of the words.

Perceptions About Students

Affordances and limitations of technology in assessing student learning often surfaced in relation to perceptions teachers had about students. The use of technology as engaging to students was described by a public-elementary-school first-grade teacher:

> And I did notice, and my parents noticed this as well…in attitudes between kids who were using the computer in the classroom to do this assignment and kids who were not and were getting the traditional paper and pencil lists. Their words were still differentiated, but the students using the computer and using the technology seemed more engaged and more excited about it and it seemed to be less of a fight. So I think, by parent word, I had, as the school year progressed and towards the end of the year, I had more parents willing to drop their child off at 7:30 in the morning, or let them stay 15 or 20 minutes after school to complete their spelling practice.

The public-high-school mathematics teacher described engagement for students in general and provided a specific example of engaging a special-education student through technology. He explained:

> I know that I had much more buy-in from the students because they were able to use their calculators, they were able to use their computers. …while my students still do a lot of work, I'm bringing in the technology component they were doing it more freely they took pride in it, and I will tell you, I teach… two of the sections I teach were collaborative sections, I have about 15 students with IEPs. Even the collaborative teacher came to me and mentioned that one of the students in particular, she took so much pride in her project, like that was all she would talk about. Somebody would be working on resource stuff, and she would come over and look at what I did on my calculator, look at the graph here. So, the technology component, I don't feel like it changed the objective at all, because my students still had to answer the probing questions, they still had to come up with the table for the real life application, but I feel like the students had more buy in. they were proud of what they were doing on the computer and it felt like something different. Because they were able to use all of this technology and they were kind of discussing in that discussion board and they were into it.

Using technology to extend learning at the pace of the student was a perception of a public-high-school biology teacher. She described the use of technology as meeting pacing needs as follows:

> I really think that, one, they really enjoyed it, because it was a different way to be exposed to the topic. Since this was an advanced placement class, they were familiar with genetics but not in a deeper level that I was pushing them towards. So I think that they felt that that was very engaging. And they, after we did the quick minilesson on how to use some of those mathematical tools, and I showed them quick ways to derive the solutions, then they were very quick to be able to answer those kinds of questions in the summative evaluation that we had several days later.

Although one participant primarily taught in a public-middle-school English class, she expressed concern about struggles faced by students using a technology-based assessment program in a high-school night class she taught. The participant described Plato as an online learning platform for high-school English curriculum.

> Because a lot of my (high-school) students in that class are English Learners in the class as well. Some of the language in high school English classes and Plato is so sophisticated that they, it is very hard for them to be successful and the whole point of Plato is that they are supposed to be able to do work on their own. But I find myself having to sit with them so often to explain what they are being asked, and to point out within the text where they might find examples to go with… that it seems counterproductive to me. So I think we are getting there as far as that type of resource for high school students, or students in general. But I think there is a lot of tweaking that needs to be done… by the time I get my students in my high school class, they are in English credit recovery…So they have already failed a class, they already think they are not capable to be successful, but they are trying. So I really do a lot of differentiation to try to help them be as successful as possible. That is my goal…I think Plato has a lot of great things, but there is a lot to be done technologically.

English learners also were mentioned by a public-elementary-school third-grade teacher as one group of students in her diverse classroom. Although both English learners

and RSP (special education) students are mentioned, the teacher expressed more concern about familiarity with technology rather than learning designation as impacting achievement as follows:

> They were third grade and in my classroom 'I did not have any RSP kids, but I had many students that were below grade level. Several of which were English language learners. The majority of my class was at a level 2 or 3…but then the other half of my class… was high achievers. There was a really big gap in my kids so I had to do a lot of differentiation for my lower kids with their writing and skills… And just by observing my students on the computers, I was trying to see their comfort levels, See if they had to keep looking at their fingers on the keys, or if they had a little more confidence in their typing skills. The kids that were typing one finger at a time… I noticed that the kids that were more advanced in their typing skills were able to write a lot more than students that had very few typing skills…I think the work from the students who were more comfortable was much better because they weren't fussing over what keys, they knew how to do spell check, they knew… so they weren't worried about all those little things like other kids.

Technology as a Shaper of Assessment Beliefs

Finally, two interview participants explicitly shared their feeling as to how technology has influenced their knowledge and beliefs about assessment. A public-elementary-school first-grade teacher described the potential of technology to allow for differentiation in this manner:

> I really think technology has really enhanced my education, my understanding of assessment. I really like that I am able to say this is what I need you to do, and then I will have several different students turn it in to me several different ways and I think technology really helps me do that.

A change of heart about data-driven instruction was credited to the use of technology to reveal student abilities for a public-middle-school special education teacher. She explained:

> I was not a fan of data-driven lessons. I wasn't a fan of it because I thought, me, as a bad test taker, I am not going to show you on a test what I can really do. And

> using the technology, giving the students an ability to show me what they know without the fumbling of a pencil or a paper… it's amazing how much more they can accomplish when I follow the data-driven assessment. I was not a fan of it what, 5 years ago, 6 years ago? I could not stand all the data we were going over… I thought, these kids aren't numbers, they are names… where are their names? And now their names are typed out for me with the students showing me their true abilities and it has completely changed my practices and beliefs.

Summary

The results of a mixed-methods study of technology-using teacher confidence, beliefs, and practices were presented in this chapter. Responses on survey items were similar for the 84 participants, who represented a range of experiences, subject areas taught, years teaching, grade-levels taught, and membership in professional organizations. Interviews were conducted with 8 participants, representing a range of grade-levels. The majority of interview participants described lessons taught in English language-arts settings. Two primary research questions guided the study and a summary for each question follows.

How Do Self-Identified Technology-Using Teachers Design, Deliver, and Use Assessment Technology?

Participants indicated that they used a range of technology tools to assess student learning both in and out of the classroom. The most commonly used tools were apps (mobile learning), document sharing, and computer-adaptive testing (CAT). Some variation in technology tools used existed for participants who reported teaching different grade-levels.

Participants indicated that "technology" was interpreted as physical devices, software, and a combination of both device and software. In open-ended and interview data, participants described using multiple technology tools within a single assessment or

lesson. Interview participants positioned technology tools as supporting differentiation, efficient assessment of learning, student engagement, and facilitating student demonstration of learning in "not paper-and-pencil" modes.

Assessments were reported as being developed most often on a monthly or weekly basis. A variety of assessment item types was reported as being used to develop assessments. Standardized test items were used as models for creating classroom assessments infrequently. Participants indicated that they more frequently modified assessments for special education students than for English language learners.

Assessment results were used weekly or daily to provide grades and feedback. Participants indicated that they used the results of assessments to modify instruction. The results of nationally-, state-, or locally-developed assessments were used infrequently, with some participants indicating that they never used the results of nationally-developed assessments to modify instruction.

Participants cited the need for more training in both assessment and technology as a barrier to using technology to assess student learning. A need for greater access, primarily interpreted as online access, and more technology tools for students were additional barriers to use. Interview participants added that colleague attitudes about and willingness to use technology also were potential barriers.

What Is the Assessment Literacy of Technology-Using Teachers?

Participants were confident in general assessment knowledge. Confidence levels decreased for utility of national standardized tests. Results indicate that participants rely more on classroom-based assessments than on national, state, or local assessments as measures of student achievement. Beliefs about the purposes of and quality practices in assessment aligned with best-

practice research. Participants agreed with items that showed a student-centered, growth-model of assessment.

Participants were confident in their knowledge of how to use technology to assess student learning. The one exception to this finding was the lower confidence of participants in knowing how Common Core Standards would be assessed using technology. Participants believed that technology could facilitate differentiation. Interview participants described the effect technology had on their understanding of students, assessment, and the feasibility of using frequent formative assessments.

CHAPTER V

SUMMARY, LIMITATIONS, DISCUSSION, AND IMPLICATIONS

This chapter presents a summary, limitations, and findings of the study reported by research questions. Findings are discussed using the lens of the technological pedagogical content knowledge (TPACK) framework. Implications for research and practice as well as conclusions are presented in this chapter.

Summary

During the 2013-2014 school year, online assessments of student achievement on the Common Core State Standards were piloted across the United States of America as a requirement of the Race to the Top Assessment (RTTA) program (U.S. Department of Education, 2010). In addition to shifting the administration of standardized assessments from pencil-and-paper to an electronic format, the traditional fixed-response tests were revised to include constructed response and performance assessment items. Policymakers, such as Tom Torlakson (2013) in California and the designers of the RTTA, hoped these new assessments would provide teachers with models for transforming "teaching, learning, and program improvement" (Whalen, 2011) through assessment using the affordances of technology. Although the computer-based assessments were intended to assist teachers in designing classroom assessments and using student data to inform instructional practice, teacher-reported data indicate that assessment (DeLuca, 2012; Wayman, Cho, Jimerson, & Spikes, 2007) and technology (Brush & Saye, 2009; Kramarski & Michalsky, 2010) were areas in which teachers lacked confidence and were most unprepared, apprehensive, or in need of development. There was a gap in the research literature of assessment and technology in how practicing

teachers used technology to assess student learning. This gap needed to be filled in order to provide professional developers, teacher educators, and educational researchers with models and descriptions of practice that could be used to guide inservice and preservice teacher learning. The purpose of this mixed-methods descriptive study was to provide examples of and describe how technology-using teachers understand and use technology to assess student learning.

Developing an understanding of teacher practices requires a framework for making sense of the data collected. As this study focused on teacher knowledge of assessment for student learning and educational technology, the technological pedagogical content knowledge (TPACK) framework was selected as a lens through which results could be interpreted. The TPACK framework was described in 2006 by Mishra and Koehler in order to describe the complex process of teaching using technology. They proposed that the introduction of technology to educational practice adds the domain of technology to Shulman's (1986, 1987) pedagogical content knowledge (PCK) framework. Shulman's (1986, 1987) work posited that teaching required pedagogical knowledge (PK), which encompassed knowledge about how to teach and how students learned; content knowledge (CK), which centered on the types of knowledge and skills of a given content area; and the overlap between these two types of knowledge, PCK in which the knowledge of teaching and learning interacted with content-area knowledge to create an interdependent way of thinking about teaching and learning in practice. Mishra and Koehler (2006) posited that the addition of technological knowledge (TK) of how to use technology created new intersections for the concept of teacher knowledge. These intersections were technological content knowledge (TCK) or how technology was

utilized in given content areas; technological pedagogical knowledge (TPK), or how technology modified the process of teaching and learning; and technological pedagogical content knowledge (TPACK), the way in which all of these domains interacted in planning, teaching, and assessing. Recent conceptualizations of the TPACK framework added an eighth construct, context that surrounds and is embedded within TPACK (Doering, Scharber, Miller, & Veletsianos, 2009; Doering, Veletsianos, Scharber, & Miller, 2009; Porras-Hernandez, & Salinas-Amescua, 2013). Context was conceived of as additional factors, such as considerations of access to technology, pressures of local and national policy on teaching, and knowledge of students as individuals. At the time of this dissertation, the TPACK community was beginning deeper dialogues about the definition of context in educational technology research. After data were collected and organized by research question, the TPACK framework was used to provide additional insight into teacher knowledge and practice.

This mixed-methods descriptive study built on prior research on teacher practices with technology for assessment, assessment literacy, and the technological pedagogical content knowledge (TPACK) framework (DeLuca & Klinger, 2010; Mishra & Koehler, 2006). A mixed-methods design was selected to address the complexity of the process of selecting, planning for, and using technology to assess student learning. The design of the study followed a concurrent embedded model, in which the quantitative and qualitative data overlapped (Creswell, 2009). Quantitative data were collected and analyzed in the study, with qualitative data providing detail and examples to augment the study.

Quantitative data were collected in a one-time survey developed using items from an assessment literacy measure (DeLuca & Klinger, 2010), a TPACK survey (Schmidt et al.,

2009b) and generated by the researcher. The survey was named the "Teacher Assessment Practices Survey" or TAPS. The survey was composed primarily of quantitative items in Likert-type, frequency, and confidence scale ratings. There were several open-ended questions included in the survey; additional qualitative data were collected from a smaller group of participants through semistructured interviews.

In April of 2014, the researcher reached out to several online groups and professional organization to request the opportunity to post an announcement about the survey and study information in online forums. In addition to posting the survey request and study information in online groups for the Computer Using Educators (CUE) and the International Society for Technology and Education (ISTE), these organizations included the information in their monthly newsletters. The announcement of the opportunity to participate in the survey was posted in several LinkedIn groups connected to ISTE, CUE, and a group called "K-12 education technology" and "Technology in education." Permission was granted to post the announcements by the group administrators prior to posting.

The Technology Assessment Practices Survey (TAPS) began online in May of 2014. The survey was available for participants to complete until the end of June 2014. During the administration period, 179 individuals attempted the survey. A total of 90 individuals completed all items on the survey. Responses from six individuals were removed from the analysis on the basis of responding that they "rarely or never" used technology to assess student learning.

Demographic information about years teaching, subject taught, location, membership in ISTE and CUE, gender, type of school, location, and background in assessment and

technology was gathered at the beginning of the survey. Open-ended items that guided participants to describe a lesson in which they used technology to assess student learning followed. Participants were then presented the frequency, confidence, and Likert items, grouped by topic such as assessment pedagogy.

Two questions and nine second-order questions guided the study:

1. How do self-identified technology-using teachers design, deliver, and use assessment technology?
    a. What technologies do technology-using teachers use to assess student learning? (TK)
    b. How do technology-using teachers develop assessments? (PK, PCK)
    c. How do technology-using teachers deliver assessments using technology? (TPK, TPACK)
    d. For what purposes do technology-using teachers use assessments? (PK, TPK)
    e. What do technology-using teachers do with assessment results? (PK, TPACK)
    f. What are the barriers to using technology to assess student learning? (TPACK, Context)
2. What is the assessment literacy of technology-using teachers?
    a. How confident are technology-using teachers in assessing student learning? (PCK, PK)

b. What are the knowledge and beliefs about using technology of technology-using teachers? (TPK, TCK, TPACK)

c. How has the technology used in assessment affected assessment practices, knowledge, and beliefs of technology using teachers?

Summary of Findings

Survey data were collected using frequency, confidence, and Likert items. These data provided insight into the assessment practices of technology-using teachers. Although the participants represented a range of experiences, subject areas taught, years teaching, grade levels taught, and membership in professional organizations, responses on items were more similar than different.

How Do Self-Identified Technology-Using Teachers Design, Deliver, and Use Assessment Technology?

Participants indicated that they used a range of technology tools to assess student learning both in and out of the classroom. The most commonly used tools were apps (mobile learning), document sharing, and computer-adaptive testing (CAT). Participants who reported teaching in primary grades (Kindergarten to fourth grade) also indicated the use of games as a popular technology tool for assessment. Secondary-grade participants (7th to 12th grade) indicated that the use of student-response systems also was popular.

Open-ended items in the survey were designed to reveal participant interpretations of the term "technology." In response to a request for a description of a lesson that had been implemented using technology to assess student learning, participants indicated that "technology" was interpreted as physical devices, software, and a combination of both device and software. In the open-ended and interview data collected, participants

described multiple technology tools being used within a single assessment or lesson. The majority of responses described using technology to deliver and assess student learning. A few responses were specific in how technology was used for instruction but vague in the description of how the technology was used for assessment. Interview participants positioned technology tools as supporting differentiation, efficient assessment of learning, student engagement, and facilitating student demonstration of learning in "not paper-and-pencil" modes. Data also indicated that participants used technology as a tool for helping guide student self-assessment.

The development of assessment items by the participant was described as occurring most often on a monthly or weekly basis. A variety of assessment item types was reported as being used to develop assessments. Standardized test items were used as models for creating classroom assessments once or twice a year, or once or twice a month. Participants indicated that they more frequently modified assessments for special education students than for English language learners. Interview and open-ended item responses most frequently cited alternative or fixed-response formats as those used in assessments using technology.

Assessments were delivered monthly or weekly by most participants. Results of assessments were used to provide grades and feedback that guided student learning. Participants indicated that they used the results of assessments to modify instruction with the same frequency with which assessments were delivered. The results of nationally-, state-, or locally-developed assessments were used less frequently, with some participants indicating that they never used the results of nationally-developed assessments to modify instruction. Participants reported low levels of confidence in the ability of standardized

assessments to reflect student achievement accurately but also reported finding the results of state and local assessments useful.

Assessments were used to provide grades or determine mastery by many participants. There were differences in the use of assessments by grade-level teachers. Kindergarten to third-grade teachers reported using the assessments most frequently to determine mastery. Fourth- to sixth-grade teachers most frequently indicated using assessments to provide a grade to students, and 7th- to 12th-grade teachers reported using assessments to both provide a grade and determine mastery of content.

An open-ended item in the survey was designed to allow participants to describe barriers to use of technology in assessing student learning. Participants overwhelmingly cited the need for more training in both assessment and technology in order to increase their own use of technology to assess. Participants described a need for greater access, primarily interpreted as online access, and more technology tools for students. Time also was described as needed to facilitate a greater use of technology for assessment. Interview participants echoed these results and added colleagues' attitudes about and willingness to use technology as additional barriers to the use of technology to assess student learning.

What Is the Assessment Literacy of Technology-Using Teachers?

Participants reported confidence in most of the items dealing with general assessment knowledge. The only item in which participants were less than confident was an item regarding being able to explain the difference between criterion- and norm-referenced assessments. Confidence levels also decreased for items that referenced nonteacher created assessments, such as national standardized tests. At the time of the survey, there was a transition to new national standards and new testing formats.

Agreement item responses indicated that participants believed that not all assessments should be graded, that vocabulary could interfere with the accuracy of an assessment item, and that culturally-specific idioms need to be considered when designing items. Participant responses were less clear on an item that posited that it is appropriate to make the content of an assessment easier for special education and English language learning students. The idea that feedback was a waste of time was rejected by the majority of participants. Several items related to the qualities of good feedback, such as timeliness and moving learning forward. Participants agreed or strongly agreed with these statements. A majority of participants was neutral or disagreed that national standardized tests were accurate representations of student achievement.

The effect of technology on assessment also was investigated in the study. Confidence levels on items focused on using technology to assess student learning were high. The one exception to this finding was the lower confidence of participants in knowing how Common Core Standards would be assessed using technology. Likert-item responses also indicated that participants believed that technology could facilitate differentiated and nondifferentiated assessments efficiently. Interview participants described the positive effect technology had on their understanding of students, assessment, and the feasibility of using frequent formative assessments.

Limitations

This study consisted of a voluntary self-administered online survey and a voluntary semistructured interview process. Participation in the study was limited by the purposeful selection of education technology organizations as sources of participants. These organizations had online presences and many members; however, not all teachers who use technology are members. Although participants in the study represented technology-using teachers, they may not represent all technology-using teachers. The voluntary nature of the study was a limitation for generalizability to the greater teaching population

as the motives of participants for completing the study was unknown. The sample was not a random sample of the general population due to the constraints of recruitment from professional organizations and the online mode of administration.

An additional limitation to this study was the researcher. The researcher believed that technology could be a powerful tool for student-centered instruction. She has been in education for over 15 years and has had extensive training in both technology and assessment. She attempted to acknowledge and monitor her biases in all aspects of data collection, analysis, and reporting in order to offset this limitation. Within the interview process, the researcher focused on asking questions about the work of the participant in such a way as to elicit, and not contribute, data on the participant's practice. A friendly, professional demeanor minimized potential interference of participant perception in the answers provided.

Time was a limitation of the study. The survey was administered at the end of the school year and may not have garnered as many participants as an earlier administration might have. The survey was intended to take no more than 30 minutes to increase the likelihood of completion. The percentage of participants who completed the survey indicated that the survey was longer than many would persevere to complete. Data on the amount of time spent on the survey by completers indicated that many were able to complete the survey in less than 20 minutes. Interviews were conducted for no more than 30 minutes. Limiting the amount of time spent on gathering data honored the busy lives of participants but limited the amount of data that could be collected.

The survey and interview measured one moment in time. The study was confined to the time in which it occurred and cannot be considered representative of beliefs and

practices of participants beyond the moment in which they were collected. The data collected were constrained by the willingness of the participants to volunteer for the interview. Participants selected what was shared, and the researcher accepted the information as presented. There was no opportunity to corroborate data or observe practice to establish whether what was stated by participants was enacted in practice.

The focus of the research on the TPACK framework potentially could have limited the analysis of data. Utilization of a pre-assigned codebook could have resulted in missed opportunities for alternative interpretations of data collected.

Two additional limitations of the study were participants' self-reporting of confidence and the online nature of the survey. Although the survey was designed to provide insight into participant knowledge and practices in using technology to assess student learning, corroboration in the form of observation or artifact analysis was not a part of the study. The participant responses needed to be taken at face value. The online nature of the survey was a potential limitation to the generalizability of the data as the link appeared to have been shared beyond the initial groups canvassed for the study. An attempt to exclude nontechnology-using-teacher data being included in the study was the use of an item about frequency of use of technology as a gatekeeper.

Discussion

The TPACK framework is a helpful lens to use in order to understand the work of self-identified technology-using teachers in designing, delivering, and using technology to assess student learning. Utilizing the framework as a means of organizing results will provide insights into types of knowledge and practice that could inform future research and teacher education. The results of the mixed-method Teacher Assessment Practices

Survey (TAPS) and interview data are presented in this context. A graphic representation of the TPACK framework is provided in Figure 4 below.

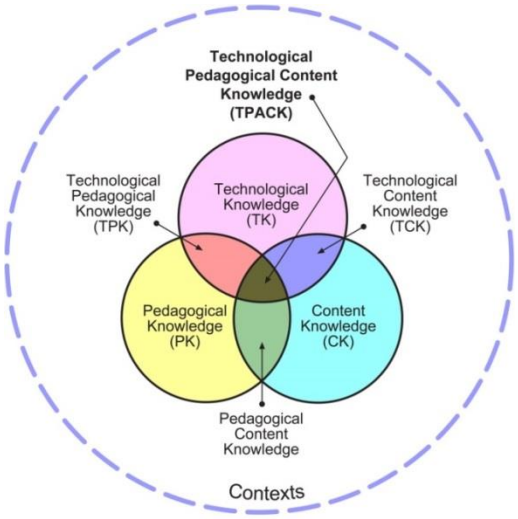

Figure 4. Graphic representation of the technological pedagogical content knowledge framework. © 2012 by tpack.org

Pedagogical Knowledge

Pedagogical knowledge (PK) is essential to teaching. Shulman (1987) described PK as inclusive of cognitive psychology, strategies for explaining content concepts, classroom management, and organization. In this study, PK was focused on the knowledge necessary to design, use, and interpret various types of assessments. Technology-using teachers responded with high levels of confidence in best practices in formative assessment (Abell & Siegel, 2011; Black & Wiliam, 1998a, 1998b; Brookhart, 2007; DeLuca & Klinger, 2010; Earl, 2003; Heritage, 2010; Popham, 2003; Stiggins, 2006; Wiliam, 2010). Responses on items about modifying assessments for cultural and language bias indicate that technology-using teachers also have high levels of understanding of the importance of considering these factors in assessment design (Abedi, 2004; Basterra, Trumbull, & Solano-Flores, 2011). Interpretation of participant

responses on the frequency with which they modified assessments were limited somewhat by a lack of data on whether the participant was a special education teacher or had English learners in the classroom described by responses.

Participants were less confident and had less positive beliefs about large-scale, nationally-developed assessments. The cultural climate around assessment and the transition to new standards and testing modalities may have contributed to this lack of confidence. Perceptions of policy can have consequences for teacher conceptions of value in large-scale assessments (Brown, 2004; Leighton, Gokiert, Cor, & Heffernan 2010) and the usefulness of data resulting from the assessments (Militello, Bass, Jackson, & Wang, 2013; Monopas-Huber, 2010; Wayman et al., 2012). There was a great deal of political scrutiny and potentially negative consequences for poor results on standardized assessments during the time in which the survey was administered. The dichotomy between participant trust in the assessments as accurate representations of student achievement and the utility of the data from the assessments for instruction was representative of the struggle teachers experienced in balancing classroom assessment and national initiatives.

The generally high level of confidence of participants contradicts earlier studies (DeLuca, 2012; Wayman et al., 2007) that indicated teachers were not confident in their assessment knowledge. After each section of items on the TAPS instrument, participants had the opportunity to provide comments. Within the section on general assessment knowledge, one participant stated that she would be more confident if she "brushed up on the terminology," indicating that the lack was not in knowledge but in language. A

revision of items or inclusion of a glossary could increase confidence in the construct being measured.

A majority of participants in this study were members of technology-focused professional organizations that host conferences focused on continuing to develop as professionals. The high level of confidence in PK of the participants may be an effect of that membership, although the organizations do not address assessment practices explicitly. This high level of PK may be a result of simply being part of an ongoing professional community of learners (Jones & Moreland, 2006) and having more than 5 years of teaching experience (Zhicheng & Burry-Stock, 2003). More than 75% of participants also reported having training in assessment in one form or another that increased the likelihood of having higher confidence in PK of assessment (Zhicheng & Burry-Stock, 2003).

Content Knowledge

Content knowledge (CK) is described as being deeper than the recall of facts; rather, teachers need to know the structures of knowledge and methodologies within the specific content area they are teaching (Shulman, 1986, p. 9). Although it was hoped that participant responses to survey items and interview questions would reveal thinking around learning progressions (Black, Wilson, & Yao, 2011; Heritage, 2010; Hess, 2011; Popham, 2009; Wilson, 2009) as indicators of CK, few responses were detailed enough to provide this information. Greater insight into participant CK was present in a confidence item about knowing misconceptions in a given content area. As with nearly all of the confidence items in the survey, participants indicated they were confident or very confident in identifying misconceptions. Most participants indicated they assessed

content-specific knowledge and skills on a monthly or weekly basis. Most of the participants had been teaching for more than 5 years, so a high level of self-reported confidence in CK is not surprising.

Participant content knowledge was more readily apparent in the analysis of an open-ended item requesting a goal or objective for a specific lesson using technology to assess student learning. The depth of student content knowledge required to achieve the goals set by participants varied. More detailed goals and objectives revealed both shallow and deep levels of complexity. Shallow levels of knowledge, such as understanding the parts of the digestive system and the order through which food passes or the steps to complete a mathematical procedure, were common in many objectives. Complex CK appeared in objectives that required multiple, linked content skills such as assessing both sentence-level and paragraph-level writing. Deeper levels of content knowledge, including historiographical thinking, were present in objectives such as designing a California Mission and its effect on the local culture and ecology. Learning progressions and greater depth of knowledge may have been revealed if participants had been asked to describe a lesson series or unit plan. The range of CK present in the objectives supplied in the survey indicates there may be some disconnect between self-reported confidence levels and enacted practice.

Pedagogical Content Knowledge

The description of the pedagogy, philosophy, and practical applications of teacher knowledge of assessment based in PCK is often called "assessment literacy" (DeLuca, 2012; Edwards, 2013; Mertler, 2009). Although assessment literacy is described in many different ways by various researchers (Abell & Siegel, 2011; Brookhart, 2011; DeLuca &

Klinger, 2010; Leighton et al., 2010; Mertler & Campbell, 2005; Park & Oliver, 2008; Popham, 2009; Stiggins, 1991), all of the definitions include several core components: a teacher's knowledge of what to assess (CK), how to assess and evaluate qualities of assessments (PK), how to interpret results in content areas, and how results influence instruction (PCK). PCK was present in many of the confidence and Likert items on the survey. Confidence levels were strong, and agreement with statements relative to PCK aligned with best practice research in assessment.

Areas in which confidence and agreement were low tended to involve knowledge of and perceived utility of national or state standardized assessments. Participant responses to items that address whether high-stakes assessments are accurate measures of student learning echo the problem identified by Bennett and Gitomer (2009) in which "accountability assessments typically reflect a shallow view of proficiency defined in terms of the skills needed to succeed on relatively short and, too often, quite artificial test items (i.e., with little direct connection to real world contexts)" (p. 46). Bennett and Gitomer (2009) described the potential of revised assessments, similar to those being developed by assessment consortia for the Common Core State Standards testing, to be more cognitively grounded and reflective of deeper learning. Responses on the TAPS instrument indicate that technology-using teachers in this sample do not yet share this understanding with assessment developers. Additionally, responses indicate that Torlakson's (2013) vision of standardized items being used as models for classroom assessment development has not yet been realized. Participants indicate they used these items infrequently, if at all, as models to design assessments.

A model of fixed-response and constructed-response items as primary modes of assessment is described in data gathered about what types of assessment items most participants most frequently created. A majority of participants indicated they most frequently (monthly, weekly, or daily) create these two types of assessment items. Alternative items, such as projects or problem-solving activities are created less frequently, often on an annual or monthly basis. The preponderance of fixed- and constructed-response assessments could be a reflection of how assessments are perceived by participants, or may reflect the more complex nature of alternative tasks. Additional research could provide insight into the types and purposes of assessments being developed by classroom teachers.

This same type of focus on traditional conceptualizations of assessment is present in the objectives described in the open-ended lesson description portion of the TAPS. Many participant responses to the description of topic or goal for the lesson indicate using fixed-response or short constructed-responses assessments. Because many participants report that they use assessments to provide students with grades and to guide self-assessment, the use of fixed-response and short constructed-response items makes instructional sense. Scoring of fixed-response and short constructed-response items is frequently easier and more quickly accomplished than the scoring of alternative assessments. Students, with a lower level of content knowledge than a teacher, would be better able to understand the results of fixed-response item scoring. Self-assessment in alternative assessment types, such as projects, would be more difficult for students to master without extensive experience.

Feedback about the quality of work and that is intended to guide learning is frequently cited as a regular practice in the assessment process reported by participants. Responses to items designed with research-based qualities of effective feedback (Earl, 2003; Hattie & Timperley, 2007; Heritage, 2010; Wiliam, 2010) also show that most participants have confidence in their knowledge in this area.

Results of fixed- and constructed-response items were used to modify instruction on a weekly or monthly basis by most participants. Alternative assessment results also were reported as being used frequently to modify instruction, including on a daily basis. It is unclear how participants interpreted the term "alternative" as project- and problem-based assessment on a daily basis would be unwieldy. It may be that participants view formative, informal, progress-monitoring assessments as alternative types, as these do not fit in the fixed- or constructed-response category. Additional research is needed to provide insight into how teachers conceptualize, design, and use the results of various types of assessment.

Research has shown that teachers more often use the results of classroom assessments to modify instruction rather than using the results of standardized tests (Brookhart, 2007; Earl, 2003; Hoover & Abrams, 2013; Leighton et al., 2010; Monopas-Huber, 2010). The TAPS study results support this research. Although participants report confidence in being able to make instructional sense of standardized reports, they do not use them more than on an infrequent basis to guide instructional decisions. Reported uncertainties about the design and delivery of high-stakes standardized test items may play a role in the infrequent use of items and results in instructional decisions. The high level of participant confidence in being able to use results is likely a result of the prevalence data-driven

decision-making professional development experiences (Mandinach, 2012; Monopas-Huber, 2010), which were cited explicitly by one interviewee who reported disliking data-driven decision-making prior to her experiences with technology. Her response and the responses of others about technology's effect on assessment are discussed further in the remaining domains of TPACK.

Technological Knowledge

Technological knowledge was present in the survey in the form of items about technologies used and confidence in using technology. Participants indicate that they are confident or very confident in knowing a range of technologies, keeping up with educational technology, and in learning new technologies. These findings are unsurprising as the participants sampled are self-reported technology users.

The term "technology" was investigated indirectly through an open-ended item about the technology used in a lesson. Cuban, Kirkpatrick, & Peck, 2001) described multiple ways in which the term could be interpreted, referring to physical devices and practices using devices as two options. Participant responses indicate that they would describe technology more as a tool rather than practice. This response also aligns with the common definition of technology within the TPACK literature (Kelly, 2010; Mishra & Koehler, 2006; Mishra, Koehler, & Henriksen, 2011; Schmidt et al., 2009a, 2009b Voogt, Fisser, Pareja Roblin, Tondeur, & van Braak, 2013).

Responses to the open-ended item on technology could inform knowledge about the level of technology adoption within school sites. The lack of technological adoption and diffusion into classrooms has been an area of concern (Cuban, 1986; Cuban et al., 2001; Mishra, Koehler, & Kereluik, 2009). Participants listed software and hardware as the

"technology" used in the lesson described, however relatively few, 15 of 84 participants, listed the hardware as "computers," "netbooks," or "Chromebooks." Often, participants listed software without listing the tool needed to utilize the software. This may represent the adoption of computers as an educational technology norm in the classroom, as the technology has become embedded enough in practice as to be unnecessary for the participant to mention.

Investigating how participants report using technological tools is important. Seventeen technology tools were presented to participants with the prompt to "select those you have used." Most participants indicated that they had used between 2 and 6 of the 17 tools. Apps and document sharing were used most often, as well as computer-adaptive testing. A comparison of these responses with open-ended responses about technology in a lesson raised the question of interpretation for the terms "apps" and CAT in the mind of the researcher. Several fixed-response apps were mentioned by participants as the technology being used. In an interview with a first-grade public-school teacher, she described an online app that would scaffold student learning of spelling as the technology she used. It is unclear whether she would have categorized this as an "app" or as "CAT" or both.

Complicating the issue, early-grade teachers also cited the use of games as technology used to assess student learning. The first-grade interview participant described the application as providing games to students based on pre-set words she assigned to each student. The games she described adapted to student responses as students progressed through learning the words. In this case, the game is functioning to some degree as CAT. Several apps cited by participants also function through the use of

CAT technology to some degree. It is unclear how the terms “apps,” “CAT,” and “games” are differentiated by participants.

Prior research in TK posits that confidence in using tools and a variety of use of tools are indicators of TK (Jamieson-Proctor, Finger, & Albion, 2010; Koehler, Shin, & Mishra, 2012; Schmidt et al., 2009b). Self-described technology-using teachers would be assumed to have high levels of TK. The results of the TAPS study support the findings of existing research and provide avenues for new research into the TK construct.

Technological Content Knowledge

Technological content knowledge (TCK) has been described as both understanding the constraints and affordances of using technology (Koehler & Mishra, 2008) and also as knowing how to use technology to represent content ideas and practices in a given subject area (Baran et al., 2011; Cox & Graham, 2009; Koehler & Mishra, 2009). The TAPS study provided insight into both of these descriptions through survey items and interview responses.

Participants expressed high levels of confidence in TCK on items referencing knowledge of the affordances and constraints of using technology to assess their subject areas. Participants indicated less confidence in knowing how professionals in their subject-area fields use technology. This lower confidence may reflect the nature of content knowledge as not only being specific to a given subject area but also being specific to the process of teaching (Ball, Thames, & Phelps, 2008; Shulman, 1986). Knowledge of how technology and content interact in educational settings may be different from the way these two bodies of knowledge interact in other professions. It

may reflect a lack of information for teachers about how other subject-area career paths utilize and integrate technology.

When disaggregated by subject area taught, differences in the types of technological tools used to assess student learning are apparent. English language-arts teachers more frequently use online publishing, whereas mathematics teachers tended to use adaptive testing more frequently. An examination of results reflects the emphasis on content-appropriate and content-aligned tools selected by subject area.

Using technology to represent subject-specific ideas or practices (Baran, Chuang, & Thompson, 2011; Cox & Graham, 2009; Mishra & Koehler, 2009) is present in open-ended survey responses about goals of a given lesson. One participant described having students use Minecraft to build representations of California missions, including the effect the missions had on the local area. This use of technology in the lesson shows what Puentedera (2009) would describe as redefinition. By using Minecraft, rather than sugar cubes or cardboard, students are able to examine more than the structure of the mission. Students are able to portray deeper understandings of the impact of the mission on local people and ecology through the scope and detail afforded by the technological tool.

The affordance of a technological tool in allowing students to explore a subject-area concept more deeply is present in an interview with a public high-school mathematics teacher about the experience of students using a high-technology graphing calculator. The technology tool, the TInspire, provided his students with color screens and the ability to graph multiple functions at one time. These screens, along with software designed to optimize use of the screens, allowed students to see the shifts in graphed equations when

a variable changed. This experience motivated students to "play with" the mathematics and technology.

Technological Pedagogical Knowledge

Technological pedagogical knowledge (TPK) represents the intersection between pedagogical knowledge and technological knowledge. TPK includes an understanding of how the use of technology can influence teaching and learning in the classroom (Koehler & Mishra, 2005, 2008; Mishra & Koehler, 2006). Several items in the TAPS survey reflect this component of the TPACK framework. Participants were asked how frequently they used technology to assess student learning: results indicate that technology is used monthly, weekly, and daily by most participants. Participants also indicated they used the results of assessments to provide feedback, guide student learning, modify instruction, and guide student self-assessment. These pedagogical practices are described as best practices in the pedagogy of assessment (Black & Wiliam, 1998a; Brookhart, 2007, 2011; Earl, 2003; Hattie & Timperley, 2007; Heritage, 2010; Wiliam, 2010). Participants also indicated that technology made assessment more efficient, which may have an effect on the frequency of assessment.

TPK practices in using assessments to determine grades or mastery learning varied by grade levels. Tools used to assess students and the frequency of using various types of assessments also varied by grade. Many participants cited technological substitutions for pencil-and-paper assessments such as student response systems and online quizzes. This would be a pedagogical practice existing at the beginning stage of technology adoption, substitution (Puentedera, 2009). Other responses primarily fell in the substitution and augmentation stages, with a few representing the redefinition processes described in the section above about TCK. Using technology as a substitute for pencil-and-paper modes of assessment facilitates an interactive experience for students with the knowledge or

skills to be learned. This interaction supports on-demand and just-in-time information that can be integrated into the students' existing knowledge, similar to how students learn through videogames (Gee, 2003) Pedagogy is tied to knowledge of teaching and learning including cognitive development (Ball et al., 2008; Grossman, 1990; Shulman, 1986), using the affordances of online quizzes and student response systems support cognitive development and illustrate TPK.

Interview-participant data support different iterations of pedagogical knowledge by grade levels taught. The same type of tool, an online "quizlet," or quiz-based game system is described for slightly different pedagogical purposes. For two elementary-school participants, the use of the tool was described as individualizing and personalizing instruction based on student learning. A middle-school special-education teacher cited the pedagogical affordance of technology allowing the students to demonstrate learning in differentiated ways. Two high-school interview participants described the use of the online "quizlets" as supporting self-paced instruction and self-assessment of learning.

One survey participant's phrasing of a description of the assessment students completed in a lesson provided insight into potential TPK overlap within assessment and instruction. The participant stated that students interacted with an online program to learn about fossils and then created an artwork depicting the fossilization process. The participant did not indicate that the artwork was created using digital technology, which could be interpreted as an analog assessment. This response shows that instructional practice may be intertwined with assessment in the mind of the participant. The delivery of information explicitly is technological; however, there is no indication that the assessment (artwork) was completed using technology. The delineation of instructional

pedagogy and assessment pedagogy using technology is an interesting avenue for future research into teacher knowledge and practice.

Research into teacher beliefs and knowledge as facilitative of the use of technology indicates that a predictor of technology adoption is the value of the technology to the process of teaching (Ertmer, 2005; Hughes, 2005; Johannesen, 2013). In this study, the researcher was interested in learning if there was an opposite effect, would technology use influence pedagogical practices or beliefs? Interview participants were asked how the use of technology effected their beliefs or practices of assessment. The middle-school special-education participant reported her initial negative response to data-driven instruction had changed as she utilized a technological tool that provided her with detailed information about what students learned. Other participants indicated that they were able to assess students more efficiently and effectively on a regular basis because of the use of the technological tools. There is a relationship between technological assessment and assessment practices and beliefs for the technology-using teachers who participated in the interview component of this study.

Participants listed quizzes, response system use, and online tools that measure fixed-responses as the purpose and technology used in the lesson. The tools used provide data about student progress toward instructional objectives, facilitating data-driven instructional decision making (Swan & Mazur, 2011). This pedagogical approach allows for more frequent formative assessments, which can benefit student learning (Black & Wiliam, 1998a, 1998b).

Most participant responses to open-ended items describing objectives and technology tools used for a specific lesson reflect dual approaches to assessment. Those who utilize

traditional approaches to assessment, such as quizzes and tests, select technological tools that would facilitate this use. Those who use more alternative assessments select tools that may not be purposely built for assessment, such as Minecraft and Googledocs. Alternative assessments are redefined (Puentedera, 2009) by the designer based on the affordances of the selected technological tool. After an analysis of responses, the researcher realized that additional survey items that investigated epistemological beliefs might have provided insight into the TPK practices and beliefs of participants.

Technological Pedagogical Content Knowledge

Examining the complex interaction between the bodies of knowledge that compose TPACK requires a holistic view of a teacher's practice. TAPS survey participants are confident or highly confident in aligning assessments to technologies appropriately, in using technology to differentiate, and in knowing the affordances and constraints for technology use in their subject areas. Taken with their confidence in other components of the TPACK framework, the researcher is confident in stating that the self-identified technology-using teachers who participated in the survey have TPACK. The only items on which participants were less than confident were those about new Common Core assessments and the delivery of these assessments online. As the Common Core is relatively new, this lower confidence level is not surprising.

Participant TPACK was evident in responses to Likert-scale items. Agreement with statements that technology makes assessment of student learning easier and facilitates differentiation reveals an understanding of affordances of technology at both pedagogical and content levels. An examination across open-ended items intended to reveal TPACK through describing a lesson that used technology to assess student learning also

demonstrated clear alignment between technology selected, content-related learning goals, and pedagogical practice.

TPACK is present at different levels of innovation in participant responses. Three interview participants indicated they assessed students using online quizzes or games, with fixed-response formats, to personalize learning, or to increase self-paced learning for students. This usage aligns to the substitution and augmentation levels of technology use proposed by Puentedera (2009) in which pre-existing pedagogical practices are moved to online formats with little change. The participants are using the technology to facilitate and efficiently use assessment information in student-level reports (Swan & Mazur, 2011) to assess student learning formatively (Brookhart, 2007; Earl, 2003; Heritage, 2010; Popham, 2003; Shepherd, 2008; Stiggins, 2006; Stiggins & Bridgeford, 1985; Wiliam, 2010). These uses of technology provide evidence of how participants are using the affordances of technology to be more efficient and specific rather than redefining how they design lessons and assessments (Bennett & Gitomer, 2009; Mishra et al., 2011; Parhizgar, 2012; Puentedera, 2009; Redecker & Johannesen, 2013; Shapiro & Gebhardt, 2012; Tsai & Chai, 2012; Webb, Gibson, & Forkosh-Baruch, 2013). It may be that the shift to a more technological approach to assessment begins with Puentedera's (2009) proposed substitution stage, transitioning familiar pedagogies into new tools. Perhaps the evolution of technological diffusion occurs as teachers become comfortable enough with the tool to begin experimenting. Although the use of technology as an agent of change in teacher practice has arisen in TPACK and other education technology literature (Cox & Graham, 2009; Hughes, 2005; Koehler & Mishra, 2008; Voogt et al., 2013), there is no specific epistemological stance to guide that change, such as

constructivism, explicit in the framework. There is much for educational researchers to explore in the realm of adoption and diffusion of educational technology and its relationship to pedagogical change.

The use of technology to assess student learning has some effect on participant TPACK and PCK. Due to the immediacy of being able to view student progress, an eighth-grade English teacher reported she needed to be more specific in her rubric design and needed to revisit her regular assessment practices. A third-grade English teacher described what researchers call the administration effect (Russell, 1999; Russell & Plati, 2002). The lesson she shared in an interview was couched in terms of "preparing students for the online assessments," and her goals were to familiarize students with the technological format as well as the process of writing to a prompt. She noticed that students who were less familiar with the technology produced lower-quality writing in comparison with their more tech-savvy peers. The third-grade teacher demonstrated an intuitive knowledge of unintended constraints of technology in her content- and pedagogical-knowledge of moving writing assessments online.

Context

Context is present in both the PCK and TPACK frameworks (Angeli & Valanides, 2009; Doering, Scharber et al., 2009; Grossman, 1990; Koehler & Mishra, 2008; Porras-Hernandez & Salinas-Amescua, 2013; Shulman, 1986, 1987). In this research, context includes considerations of learners and the broader context in which learning occurs. Porras-Hernandez and Salinas-Amescua (2013) framed context as scopes and actors. Results of the TAPS study are discussed using the scopes framework of macro, meso, and micro as described in Porras-Hernandez and Salinas-Amescua's (2013) article. Actors are

the people involved within the scopes of context, and will be referenced primarily as "participants" or "teachers."

Participant responses in the TAPS study reflect macro-level concerns, such as national or global considerations (Porras-Hernandez & Salinas-Amescua, 2013) for planning instruction with technology, when referring to Common Core pressures. Confidence in fixed-response items and agreement with Likert-scale items reveal insecurity with knowing how high-stakes Common Core testing will effect classrooms and classroom practices. There appears to be some negativity around national standardized testing perhaps in part as reactions to No Child Left Behind (NCLB) and RTTA national initiatives. Some responses regarding objectives and goals for lessons using technology to assess student learning illustrate a narrowing of curriculum, a legacy of NCLB standards (Bennett & Gitomer, 2009) and perceived pressures brought on by the testing format (Russell, 1999; Russell & Plati, 2002).

The meso level of context involves considerations of local and school factors (Porras-Hernandez & Salinas-Amescua, 2013). Within the TAPS study, participants cited a lack of technological resources at school and perceptions that this lack extended to student homes. When asked what would facilitate greater use of technology to assess student learning, two of the three most-frequently cited factors were technology tools and access. Interaction between meso and macro levels of context were present in the response of a high-school English teacher who expressed frustration with computer labs at school being colonized by high-stakes national testing for more than 30 of the 180 days of school in a year.

The third factor that participants indicated could improve the use of technology to assess student learning is training. In addition to the general response of "training," open-ended survey and interview responses listed training other teachers in the use of technology as facilitating more technology use, reflecting attention to meso-level contexts. A few participants implied that having colleagues who were trained in using technology to assess student learning would not only provide moral support but also it would provide students with more experiences and preparation for using technology in the classroom. An elementary-school interview participant added advocacy for the importance of informing and training parents in how technology is used in schools, which also represents meso-level concerns.

The need for training also represented micro-level concerns, with the teacher-as-actor, that directly influence classroom practices (Porras-Hernandez & Salinas-Amescua, 2013). Participants described the need for further training for themselves and one requested training "specifically for my subject area" that would justify the use of the TPACK framework in designing trainings (Mishra et al., 2009). Other participants specifically mentioned training in assessment and in technology tools. Most participants were members of professional organizations that focus on sharing best practices in technology in education, so this desire for training is predictable.

Concerns at the micro level of context also focused on the student-as-actor. Confidence was high for most participants on items that dealt with differentiation based on student types (English learners, special education) and in general. A middle-school special-education teacher emphatically endorsed the use of technology in allowing individual students to demonstrate learning. She issued a plea that overlapped a meso-

level concern, encouraging all teachers to use technology in order to provide students with much-needed individualized support. She viewed the technology as facilitating teachers seeing students as individuals in the classroom. Unfortunately, the demographic information of student types taught by participants was not included in the survey. It is unclear to what extent the student populations taught by participants influenced answers about frequency and confidence in meeting the needs of special populations of students-as-actors.

Another interview participant, a high-school English teacher, discussed meso- to micro-level concerns. She cited the socioeconomic level of the area in which she teaches (99% free-and-reduced-lunch status) as a barrier to using technology. She addressed the potential issue her perceptions about lack of access to technology in the home surfaced by observing what technology students brought to class (smartphones) and designing the project around these devices. Her description also addressed the sociopolitical delicacy teachers need in working with students; she stated that teachers could not ask what technology students have as it would make students self-conscious. This interview illustrated the high-level attention to micro-level contexts teachers provide when designing assessments using technology.

An advanced placement (AP) biology teacher expressed concern for students-as-actors at the micro level. She described using technology to "flip" her classroom so that students can better balance their workload and lifestyle pressures. She lamented the stress under which students are put and indicated that moving more of her direct instruction online would lighten their perceived workloads.

Digital citizenship and literacy were micro-level contextual concerns for an elementary-school participant. A regular part of her curriculum was guiding students in developing digital citizenship prior to using technology in her classroom. She also connected the meso and micro levels through mentioning that it is essential to communicate with parents about technology and digital literacy used in the classroom.

All interview participants emphasized the micro-level contextual benefit of how technology engages students in learning. A high-school mathematics teacher shared anecdotal evidence that the use of the technology engaged a student who normally did not enjoy mathematics so much that she continued to do mathematics work in a support class, rather than doing other work.

The TAPS study provides insight into the role of context in TPACK at the macro, meso, and micro levels (Porras-Hernandez & Salinas-Amescua, 2013). Teachers consider context when planning lessons and are often navigating pressures within and between these levels. The focus on context is relatively new in TPACK research (Doering, Scharber et al., 2009; Mishra et al., 2009; Porras-Hernandez & Salinas-Amescua, 2013); however, it is an essential part of the planning, teaching, and assessing of student learning.

Implications for Research

There has been a call for the development of instruments measuring TPACK (Abbitt, 2011; Voogt et al., 2013). The TAPS study introduced a focus on assessment practices to the collection of instruments intended to measure TPACK. The survey component of the study was long, resulting in many potential participants not completing the survey. One avenue for future research would be to narrow the scope of the survey or split the survey

to investigate more deeply elements such as the connection of epistemological beliefs and TPACK. Additional areas for further investigation based on survey items would be whether technology helps reveal student misconceptions about a subject, whether student-types (e.g., special education, language learner, gifted, etc.) taught in a classroom change participant responses, and what differences are perceived between the terms "games," "apps," and "CATs."

Shortening the survey may allow for its use with a broader audience. The participants in this survey were selected purposefully to reveal the TPACK of technology-using teachers. A larger, more diverse sample population would allow for factor analyses to be completed on the survey that would add to the knowledge of the components of TPACK (Angeli & Valanides, 2009; Cox & Graham, 2009; Voogt et al., 2013).

Further qualitative research including inservice teacher practice and voice may add dimension to the TPACK framework, much of the existing research is grounded in preservice practice (Abbitt, 2011; Voogt et al., 2013). Further examinations of TPACK in practice with technology-using teachers at various stages of integration would inform the framework of how TPACK is reflected in naturalistic practice. This type of research would also provide insight into the processes of technology adoption, diffusion, and how technology tools become classroom norms.

Areas for qualitative investigation within TPACK include connections between epistemology and practice, perceptions of how student learning can be assessed with technology, and how technology tools are described. The descriptions of tools and development of technology-supported pedagogies could be investigated with an ethnographic lens to capture cultural changes in educational settings. Deepening the

examination of how technology is used to assess student learning in case studies would also inform the interplay between how teachers develop expertise in both assessment and technology as they progress forward in adapting or adopting new pedagogies.

TAPS participant responses often varied based on grade levels and subjects taught. Qualitative research across subject areas and grade levels would provide insight into pedagogical and subject-specific practices reflecting TPACK. Observing the design and delivery of assessments using technology within various contexts would reveal TPACK thinking as well as assessment literacy in a more authentic manner than is possible in a survey. A specific pedagogical practice to investigate in this research may be how teachers design and develop formative, informal, progress-monitoring assessments.

An investigation into the TPK thinking about instruction and assessment could provide greater insights into the process of assessment development. TAPS participants indicated that teachers favor classroom-based assessments over standardized assessment data. The interplay between technological and pedagogical assessment practice would be worth exploring more deeply in future studies of TPACK.

Research comparing teachers with other professionals who rely on strong content knowledge is another avenue for potential investigation, extending the PCK research of Ball et al. (2008). Knowledge of how technology and content interact in educational settings may be different from the way these two bodies of knowledge interact in other professions.

More research is needed into how teachers consider context as they use TPACK to design assessments. Considerations about how macro, meso, and micro levels and actors in the classroom effect instruction and assessment are relatively unexplored in

educational research (Doering, Scharber et al., 2009; Porras-Hernandez & Salinas-Amescua, 2013). Descriptive research into student and classroom contexts would also provide understanding of how TPACK transforms the learning environment and process for both teachers and students.

Action research around educational technology adoption and diffusion at the meso and micro level of districts, schools, and classrooms could inform administrators and policy makers at various levels of the challenges and methods for successfully implementing change. Organizations such as ISTE and CUE provide a rich source of potential participants in action research. Technology-using teachers who are putting TPACK in action on a regular basis are an authentic and open group who want to share the successes they have had in designing innovative and interesting learning experiences for students. Partnering with these organizations or other exemplary technology-using districts, schools, and teachers to research best practices and change would provide insights that intervention-based research cannot.

Implications for Practice

Research has shown that increasing formative assessment practices in the classroom can effect student achievement positively (Black & Wiliam, 1998a) and that teachers spend much of their time assessing students (Stiggins, 1995). Effective professional development and teacher-education programs utilize real-life examples of practices to inform teacher learning. TAPS participant experiences could provide insight into the value of technology (Ertmer, 2005; Hughes, 2005) in making assessment more efficient and providing finer-grained information about what students are learning. The experiences reported on within this study could be a starting point for authentic learning

community discussions centered on how technology can facilitate just-in-time and alternative assessment of student learning. Embedding the practices provided within this study into preservice teacher education coursework, including modeling the use of technology in assessing student learning, could shape the practical use of assessments for beginning teachers.

Although participants indicated experiences in having been trained in assessment and technology in the past, they still expressed a desire for further training with a subject-specific focus (Koehler & Mishra, 2009; Voogt et al., 2013). Utilizing the TPACK framework as a design template would increase the value and usability of technology trainings for teachers. Designing teacher learning experiences that consider the affordances and constraints of given technology tools within subject area PCK could lead to greater adoption of technology as well as more informed assessment-based decision making in the classroom.

Increasing the adoption and diffusion of technology to assess student learning can support differentiation, personalization, and efficiency in assessing student learning. Study results could be utilized as examples of these high-impact practices in trainings. Conversations around how technology can contribute to more engaging, challenging curriculum for individual students can lead to changes in practice.

None of these innovations can occur, however, without access to the technological devices and reliable infrastructure for getting online. Policymakers, community members, and administrators need to work together to ensure that every child has access to the tools, inside the classroom and out, that will support their learning. In order to have effective, successful integration of technology for learning stakeholders must address the

digital divide. Bridging the divide includes outreach to parents about media literacy as well as embedding media and technology literacy skills into Kindergarten through 12th-grade classrooms. Creating innovative goals for 21st-century learning without supplying the tools, information, and support for implementation is a recipe for failure.

Technology-using teachers are not using release assessment items as models for developing classroom assessments. An apparent lack of clarity on the utility and design of these assessment items combined with a need for informed, supported time to examine, discuss, and develop items is essential for the vision of policymakers to become reality. Participants in the study clamored for more learning experiences in both assessment and technology, even though high levels of confidence in both areas. Providing ongoing, accessible training or supports for facilitating the use of items as models for classroom assessments may advance the hopes of policymakers (Torlakson, 2013) that these items have utility beyond a high-stakes measure.

The distrust of the national assessments as valid measures of student learning, paired with the high level of confidence in assessment literacy items also indicates a greater need for transparency in the development, construction, and scoring of the assessments. Greater transparency at the state and national level could support teachers, parents, and community members being more informed of the affordances and constraints of technology-based assessments. A technology-using participant in the study expressed frustration with the instructional time colonized by testing. Greater transparency could allow teachers and parents to see how the assessments can support student learning, rather than seeing the assessments as taking time away from instruction.

Conclusions

Assessment (DeLuca, 2012; Wayman et al., 2007) and technology (Brush & Saye, 2009; Kramarski & Michalsky, 2010) are two areas in which teachers have reported feeling unprepared in the past. The TAPS study shows that technology-using teachers who belong to professional-education organizations have higher levels of confidence in both assessment and technology. Quantitative and qualitative data collected in the study also provide insight into the ways in which technology-using teachers think about, design, implement, and use the results of assessments in the classroom. Technology-using teachers exemplify TPACK, including attention to context at the macro, meso, and micro levels (Abbitt, 2011; Doering, Scharber et al., 2009; Koehler & Mishra, 2009; Koehler & Mishra, 2006; Porras-Hernandez & Salinas-Amescua, 2013; Voogt et al., 2013). Future qualitative and quantitative research is needed into how preservice and inservice teachers use technology to assess student learning. Stakeholders in national, state, and local educational institutions need to consider how they are supporting the successful use of technology to assess student learning.

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APPENDIX A

TAPS SURVEY AND CONSENT FORM

Technological Assessment Practices Survey

The Technology Using Teachers Assessment Practices Survey

Researcher: Lara Ervin, doctoral student at the University of San Francisco leervin@dons.usfca.edu

Thank you for taking the time to participate in this study.

Confidentiality: This survey is completely confidential, please respond candidly. Please do not use your name or the name of your school in your responses.

CONSENT FOR RESEARCH PARTICIPATION

Purpose and Background
Lara Ervin, MA is conducting a confidential and anonymous study of how teachers use technology to assess student learning. This study is toward completion of my doctoral studies in the School of Education. Your involvement will help inform inservice and preservice teachers about the ways in which technology can be used to assess student learning, which will help them develop as technology-using teachers.

Procedures
The procedures for the study will take place online and by telephone. By agreeing to participate in this study, you are asked to fulfill the following research components:

1. Complete an online survey that will take approximately 15-30 minutes. The survey is composed of multiple choice, statement rating, and a few short answer questions.
2. A few participants may volunteer for telephone interviews to provide details and insight into how teachers use technology to assess student learning. Candidates who have piloted online Common Core Tests will be invited to share their impressions of the tests. These interviews will take 30-45 minutes and will be completely confidential.

If you would like to volunteer for the interview portion of the study, you will have the opportunity to click a link to an external source and provide an email address at the end of the survey. A telephone interview will be arranged at your convenience.

Risks and/or Discomforts
It is unlikely that completing the module will make you feel uncomfortable, but you may stop the survey and/or interview at any time. Participation in this research will not result in a loss of your confidentiality, and every attempt will be made to keep your individual responses confidential. Your identity will not be used in any reports or publications resulting from the study.

Benefits
There is no direct benefit to you for participating in this study; however, you may find completion of the survey and/or interview a reflective experience that guides your professional development.

Costs
There will be no cost to you for participating in this study.

Payment/Reimbursement
No monetary reimbursement will be given to your for participating in the study.

Questions If you have questions or comments about the study, first contact the researcher, Lara Ervin by emailing leervin@dons.usfca.edu. If for some reason you do not wish to do so, you may contact the IRBPHS, which is concerned with the protection of volunteers in research studies. You may reach the IRBPHS office by calling (415) 422-6091 or by writing to the IRBPHS, School of Education Building, University of San Francisco, 2130 Fulton Street, San Francisco, CA 94117-1080.

Consent
Participation in this research is voluntary.

Thank you,
Lara Ervin, MA

Technological Assessment Practices Survey

Doctoral Student, University of San Francisco

Technological Assessment Practices Survey

Please answer the following questions to help the researcher understand your context.

*1. What is your gender?

- Female
- Male

*2. The state/nation in which I have most recently taught is:

*3. In which of the following professional organizations have you been a member? (select all that apply)

- CUE (Computer Using Educators)
- IISME (Industry Initiatives in Science and Math Education)
- ISTE (International Society for Technology in Education)
- none of these

Other (please specify)

*4. How many years of teaching have you completed?

- 0-2
- 3-5
- 6-10
- 11-15
- 16-20
- 21-24
- 25+

*5. I teach (or most recently have taught) primarily

- Face to Face
- Blended (online and face to face)
- Online

Other (please specify)

Technological Assessment Practices Survey

6. In what setting have you most recently taught?

- [ ] Public School
- [ ] Private School
- [ ] Charter School

*7. The grade or level in which I currently (or most recently) taught is:

- ○ Early Childhood Education
- ○ K-3
- ○ 4-6
- ○ 7-9
- ○ 10-12

Other (please specify)

*8. The subject area in which I use the most technology in my teaching is: (please answer all items in this survey with this subject area in mind)

- ○ Art
- ○ Career/Technical/Vocational Education
- ○ English/ Language Arts
- ○ English as a Second Language
- ○ History
- ○ Other Social Science (Sociology, Psychology, etc.)
- ○ Mathematics
- ○ Multimedia/Technology
- ○ Music
- ○ Physical Education/Dance/HealthScience
- ○ Science
- ○ Theater Arts
- ○ World Language

Other (please specify)

Technological Assessment Practices Survey

9. What is your educational background in educational technology? (Please select all that apply)

- [ ] None
- [ ] Self-taught educational technology user
- [ ] Professional Development on Various Technology Tools
- [ ] Professional Development on Technological Pedagogical Content Knowledge (TPACK)
- [ ] Professional Development on a Suite of Tools (Google Docs, Intel Teach, etc.)
- [ ] Technology was embedded in university coursework on other topics in education
- [ ] University courses on technology in education
- [ ] University courses on technology in education (with TPACK)
- [ ] Certificate in educational technology
- [ ] Minor in educational technology
- [ ] Major in educational technology
- [ ] Masters in educational technology
- [ ] Doctorate in educational technology

Other (please specify)

10. What is your educational background in assessment or educational measurement? (Please select all that apply)

- [ ] None
- [ ] Professional Development in Data-Driven Instruction
- [ ] Professional Development in Formative Assessment
- [ ] Professional Development in Backwards Planning
- [ ] Assessment was embedded in a university education course (such as methods)
- [ ] University coursework in educational assessment
- [ ] Certificate in assessment or educational measurement
- [ ] Minor in assessment or educational measurement
- [ ] Major in assessment or educational measurement
- [ ] Masters in assessment or educational measurement
- [ ] Doctorate in assessment or educational measurement

Other (please specify)

Technological Assessment Practices Survey

The researcher would like to understand how you have used technology to assess a topic you teach.

Please use the following definitions:

Technology refers to computerized, digital, online, or electronic tools, including software and hardware.

Assessment refers to vehicles for collecting data on student learning, understanding, or achievement. Assessment refers to a range of activities, including but not limited to formal testing, checks for understanding, performance assessment, progress monitoring, diagnostic, formative, and summative activities.

* 11. Which of the following technology tools have you used to assess student learning?

- ☐ Apps (mobile learning)
- ☐ Computer Adaptive Testing (diagnostic and self-paced assessments based on student responses to questions)
- ☐ Blogs/E-Journals
- ☐ Chats
- ☐ Discussion Boards
- ☐ Document Sharing (i.e. Google Docs)
- ☐ Electronic Portfolios
- ☐ Email
- ☐ Games
- ☐ Online Publishing (student-created webpages, products, etc.)
- ☐ Social Media (Twitter, Facebook, ePals, etc.)
- ☐ Student Response System (“Clickers”)
- ☐ Textbook/Subscription Provided Electronic Tests/Quizzes
- ☐ Text Messaging
- ☐ Virtual Reality (i.e., SecondLife)
- ☐ Virtual Simulations (virtual labs, engineering, building, etc.) Student-Created Media (videos, podcasts, etc.)
- ☐ WebQuests

Other (please specify)

Technological Assessment Practices Survey

12. How frequently do you use technology to assess student learning? (*for classes that do not meet daily, please use "daily" to indicate use every time the class meets).

- Daily
- 1-2 times a week
- 1-2 times a month
- Several times a grading period
- Rarely/Never

Technological Assessment Practices Survey

Please take a few minutes to describe an instance in which you used technology to assess student learning in a lesson you taught.

* 13. What was the topic and learning objective (goal) of the lesson?

* 14. What technology was used in the assessment?

* 15. Please describe the assessment students completed:

* 16. How did you use the results of the assessment? (select all that apply)

- [ ] Assigned a grade
- [ ] Determined mastery of a standard
- [ ] Guided student self-assessment
- [ ] Guided student peer-assessment
- [ ] Planned instructional "next steps" for a whole class (reteach, move forward, etc.)
- [ ] Planned instructional "next steps" for a group of students (reteach, move forward, etc.)
- [ ] Planned instructional "next steps" for individual students (reteach, move forward, etc.)
- [ ] Provided feedback on the quality of the work (good work, needs improvement, etc.)
- [ ] Provided feedback to guide student learning (posed questions, specific observations, specific suggestions)

Other (please specify)

* 17. Briefly describe what would facilitate a greater use of technology in assessing student learning in your teaching. (access, technology tools, training, etc.)

Technological Assessment Practices Survey

18. Which of the following did you pilot test in the 2013-2014 school year?

- [ ] PARCC test
- [ ] Smarter Balanced (SBAC) test
- [ ] State test delivered online
- [ ] None of the above

Technological Assessment Practices Survey

The researcher is interested in how you think about and use assessment in your teaching.

Please use this definition for assessment as you answer the following items:

Assessment refers to methods for collecting data on student learning, understanding, or achievement. Assessment refers to a range of activities, including but not limited to formal testing, checks for understanding, performance assessment, progress monitoring, diagnostic, formative, and summative activities.

At the end of each section is a "comment" box for you to use to provide further input or clarification if you wish.

*19. For the content area you have most recently taught (multiple subject teachers, please select the content in which you use the most technology)how confident do you feel in your ability to

*Non-Common Core participants, please answer for your nation/province standards for Common Core State Standard questions

	Not at all confident	Slightly confident	Somewhat confident	Confident	Very confident
Explain how an assessment is aligned with a learning objective.	○	○	○	○	○
Explain how a teacher would assess your content-specific Common Core State Standards.	○	○	○	○	○
Assess student knowledge in your content area (e.g., periodic chart, mathematical formulae, artists of the renaissance).	○	○	○	○	○
Assess student skills in your content area (e.g., interpreting primary sources in history, numeracy, decoding vocabulary).	○	○	○	○	○
Identify the language skills (vocabulary and content-specific forms) students need to be able to complete an assessment.	○	○	○	○	○
Use multiple assessments to make a judgment about a student's mastery of a topic or skill.	○	○	○	○	○
Understand the difference between diagnostic, formative and summative assessments.	○	○	○	○	○
Understand the difference	○	○	○	○	○

Technological Assessment Practices Survey

between norm-referenced and criterion-referenced test questions/items.					
Distinguish between assessment data that can inform instructional decisions and that which cannot.					
Make instructional sense of the data from standardized test reports.					
Explain the difference between assessment and evaluation.					
Explain the underlying purposes of assessment (i.e., student growth, accountability, etc.)					

(Optional) Comments:

Technological Assessment Practices Survey

* 20. How frequently do you

	Never	Once or Twice a Year	Once or Twice a Month	Once or Twice a Week	Daily
Develop rubrics that guide student learning.	○	○	○	○	○
Develop constructed-response items for assessments (short essay, short answer, etc.).	○	○	○	○	○
Develop alternative-response items for assessments (projects, problem-based learning, simulations, etc.).	○	○	○	○	○
Develop fixed-response items for assessments (multiple-choice, true/false, matching, etc.).	○	○	○	○	○
Use standardized test questions as models to design classroom assessments.	○	○	○	○	○
Use a variety of assessments (tests, projects, short responses, authentic/performance assessments) in your classroom.	○	○	○	○	○
Assess student knowledge in your content area (e.g., periodic chart, mathematical formulae, artists of the renaissance).	○	○	○	○	○
Assess student skills in your content area (e.g., interpreting primary sources in history, numeracy, decoding vocabulary).	○	○	○	○	○
Create opportunities for students to use technology to demonstrate content-specific knowledge, skills or understanding.	○	○	○	○	○
Modify assessments for students with special needs.	○	○	○	○	○
Modify assessments for English Language Learners.	○	○	○	○	○
Guide students in assessing their own learning.	○	○	○	○	○

Technological Assessment Practices Survey

Use technology to help students assess themselves.	○	○	○	○	○
Provide feedback on assessments that guides student learning.	○	○	○	○	○
Use assessments to grade or promote students.	○	○	○	○	○
Use the results of a fixed-response (multiple choice, matching, etc.) question to modify instruction.	○	○	○	○	○
Use alternative assessment data to modify instruction.	○	○	○	○	○
Use the results of a constructed-response (multiple choice, matching, etc.) question to modify instruction.	○	○	○	○	○
Use the results of your own assessments to plan instruction.	○	○	○	○	○
Use the results of local standardized assessments to plan instruction.	○	○	○	○	○
Use the results of national standardized assessments to plan instruction.	○	○	○	○	○

(Optional) Comments:

Technological Assessment Practices Survey

* 21. For the following statements, please indicate your level of agreement.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Students should receive grades for all assessments.	○	○	○	○	○
The vocabulary used in a question can interfere with a student's ability to demonstrate understanding or skill.	○	○	○	○	○
Culturally-specific language (idioms, slang, etc.) doesn't need to be considered when designing assessments.	○	○	○	○	○
It is appropriate to make the content of an assessment easier for students with language or learning difficulties.	○	○	○	○	○
Assessments allow students to demonstrate knowledge or skill in multiple ways.	○	○	○	○	○
Assessments can increase learning for all students.	○	○	○	○	○
Feedback on an assessment should be focused on moving learning forward.	○	○	○	○	○
Feedback is a waste of time, students don't read it.	○	○	○	○	○
It is important to give feedback to students in a timely manner.	○	○	○	○	○
Standardized tests are accurate measures of student achievement.	○	○	○	○	○
State and district reports about student achievement are useful in planning instruction.	○	○	○	○	○

(Optional) Comments:

Technological Assessment Practices Survey

The researcher is interested in how you use technology to assess student learning.

Please use the following definition for technology:

Technology refers to computerized, digital, online, or electronic tools, including software and hardware.

At the end of each section is a "comment" box for you to use to provide further input or clarification if you wish.

* 22. When it comes to technology, how confident are you in your ability to

	Not at all confident	Slightly confident	Somewhat confident	Confident	Very confident
Learn new technologies.	○	○	○	○	○
Use a range of technologies.	○	○	○	○	○
Keep up with how new technologies are being used in education.	○	○	○	○	○
Understand the advantages of technology for use in assessment.	○	○	○	○	○
Understand the limitations or constraints of technology for use in assessment.	○	○	○	○	○
Understand how technology can support differentiation of assessments	○	○	○	○	○
Ensure that the technology you select for use in assessments is appropriate to the content and skills being assessed (i.e., using a word processing program to assess writing, an audio recorder to assess speech, etc.)	○	○	○	○	○
Know how technology will be used to assess student learning of Common Core State Standards.	○	○	○	○	○
Know how technology is used by professionals in your content area.	○	○	○	○	○

(Optional) Comments:

Technological Assessment Practices Survey

* 23. For the following statements, please indicate your level of agreement.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Technology helps assess student learning of content area concepts better.	○	○	○	○	○
Technology makes it more difficult to address the diverse needs of students in learning.	○	○	○	○	○
Students create better-looking products with technology than with other traditional media.	○	○	○	○	○
Technology makes student misconceptions about your content area concepts more difficult to detect.	○	○	○	○	○

(Optional) Comments:

Technological Assessment Practices Survey

Thank you so much for taking the time to participate in this survey. Your input is extremely valuable. If you are interested in participating in a follow up interview, the results of this study, or in participating in the online workshop currently under development, please Click here to be taken to an external site to provide your email and selection of follow-up options. This will ensure the confidentiality of your responses to the survey you have just completed. If you have any questions or wish to give further input, please email leervin@dons.usfca.edu.

APPENDIX B

EXPERT REVIEW OF TTAPS FORM

Expert Review of the Technology-Using Teacher Assessment Practices Survey (TUTAPS) and Interview Questions

Instructions

Thank you for agreeing to participate in my expert review of the items on the TUTAPS, and follow-up interview questions that I am developing. Below is a description of the research project, the construct definitions, and then matrix for each of the items on the survey. Please begin by familiarizing yourself with this background information and the construct definitions, and then review the specific instructions for completing the content validation.

I. Research project:

The purpose of the study is to describe how technology-using teachers understand and use technology to assess student learning. Within this purpose, the assessment literacy of technology-using teachers needs to be investigated in order to provide insight into the use of technology to assess learning. Assessment literacy will be described as the ability to develop, interpret, critically analyze and use data from various assessments in the process of teaching. The data gathered in this study will be analyzed using the technological, pedagogical content knowledge (TPACK) framework in order to understand how assessment and technology fit into the work of teaching with technology, and to add to the body of research (Mishra & Koehler, 2009). I will be sampling voluntary teachers from three different professional organizations: the International Society for Technology in Education (ISTE), Computer Using Educators (CUE) and Industry Initiatives in Science and Math Education (IISME). The survey and follow up interviews will provide the data to be analyzed using the TPACK framework.

Three questions will guide the study:

1. How do technology-using teachers use technology to assess student learning?
2. What are technology-using teachers' perceptions of their own assessment literacy?
3. How do technology-using teachers' beliefs and practices around assessment with technology align with the technological pedagogical content knowledge framework?

II. Construct definitions: *(please feel free to contact me with any questions or suggestions to clarify these constructs)*

Contexts (C). An understanding of how context shapes the thinking and actions behind teacher use of technology. Doering et al. described the factors of classroom culture,

school and district policy, and student characteristics as being important considerations in the use of the types of knowledge inherent in the framework (2009, 336.). Context has also been interpreted as the availability and access to technology (tpack.org) and how this access affords or constrains the use of TPACK in the classroom.

Content knowledge (CK). Content knowledge is described as being deeper than the recall of facts; rather, teachers need to know the structure of the specific content area in which they are teaching (Shulman, 1986. 9). This structure includes ways in which the content areas are organized and conceptualized, how new content is added to the body of knowledge, controversies and unresolved
questions, and an understanding of essential knowledge of the content area.

Pedagogical knowledge (PK). Pedagogical knowledge(PK) describes the knowledge teachers have about how to teach, including strategies for explaining content concepts, classroom management and organization (Shulman, 1987). Quality assessment practices utilize specific pedagogies for designing, developing, validating, analyzing, and interpreting various types of assessments.

Pedagogical Content Knowledge (PCK).Pedagogical content knowledge is the intersection between content knowledge and pedagogical knowledge, but is distinct from its component parts. Pedagogical content knowledge is conceptualized as the knowledge of not only what to teach and general strategies, but in knowing the how a teaching and learning occur within a given content area (Shulman, 1987). In order to assess student learning accurately, teachers need to know content, learning progressions within a given content, and how that content is assessed accurately using various methods of assessment (Deluca & Klinger, 2010, Mertler, 2009).

Technological knowledge (TK). Technological Knowledge (TK) refers to the ability to explore, learn about, and use technology. Technology is constantly changing and teachers need to have a certain amount of knowledge about hardware and software in order to trouble-shoot and investigate new technologies (Mishra & Koehler, 2006). Technological knowledge is focused on adaptability, creativity and the ability to recognize the uses technology can have in schools (Koehler & Mishra, 2008).

Technological content knowledge (TCK).Technological content knowledge (TCK) describes a knowledge of what and how given technologies shape or are used within a content area (Mishra & Koehler, 2006). TCK also involves an understanding of how the technology is both “an influence and constraint” within a content area (Koehler & Mishra, 2008; 16). Koehler and Mishra explain that TCK also involves how technology supports and shapes representations within a content area (2008). The development of

assessment items may use technology as a metaphor or may involve students understanding of how technology affects the content area. Teachers must also understand the role of technology within the content area in order to generate contextually appropriate assessments.

Technological pedagogical knowledge (TPK).Technological Pedagogical Knowledge (TPK) refers to knowledge around how to use technology for instruction, classroom management, instructional design (general) and assessment. TPK also includes an understanding of how the use of technology can influence teaching and learning in the classroom (Koehler & Mishra, 2008; Mishra & Koehler, 2005, 2006). The repurposing of a technology for use in a pedagogically appropriate manner in the classroom requires a solid knowledge of pedagogy and a creative approach to technology. TPK functions in teacher decision-making about technologies to use for learning and the format of assessments.

Technological pedagogical content knowledge (TPCK or TPACK).Koehler and Mishra state that:
TPACK is the basis for effective teaching with technology and requires an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (2008; 17-18). TPACK represents the integration of TK, CK, PK and Context into a complex concept of teaching practice.

III. The Survey and Interview Items.

I have provided a matrix for the items on the survey and one for interview questions. Please review the items and use the following guide to complete the matrix. There are spaces for you to comment on any items that need revision.

A. Clarity: In this section we would like to know how comprehensible each item is for teachers in general. Please rate how understandable each of the following items is by using the scale below.

0-Not at all	*2-Somewhat*	*4-Very Understandable*
1-Slightly	*3-Understandable*	

B. Item responses: In this section I would like your help to anticipate which items will produce an adequate range of responses. Please indicate whether you think the question will result in a range of responses for each item given our target respondents. (yes/no)

C. Relevance: In this section I would like your input on how the items align with the TPACK constructs. Please assign initials for the construct you think the item best measures in the given box:
C- Context
CK- Content Knowledge
PK-Pedagogical Knowledge
PCK-Pedagogical Content Knowledge
TK-Technological Knowledge
TCK-Technological Content Knowledge
TPK-Technological Pedagogical Knowledge
TPACK- Technological Pedagogical Content Knowledge

TUTAPS Survey Items				
A Clarity (0-4)	B Range of Responses (Y/N)	C Construct Relevance (C,CK,PK, PCK,TK, TCK,TPK, TPACK)	Item	Suggestions (if any)
			How do you define the word "technology?" (open ended)	
			How do you define the word "assessment?" (open ended)	
			Please describe a specific episode where you combined content, technology and assessment approaches to better understand student learning of a topic you teach. Please include in your description what content you taught, what technology you used, and what approach(es) you implemented. (open ended)	
The following items use teacher self-rating on confidence/comfort levels. Prompt Stem: How comfortable are you with using: 1-Not At All; 2-Minimally; 3-Somewhat; 4-Confident; 5-Very				
			Explaining how a teacher would assess your content-specific state standards (as outlined in your state's curriculum frameworks)	
			Understanding how standardized test items are developed.	
			Using released test questions as models to design classroom assessments that will help students learn.	
			Using released test questions as models to design classroom assessments that will help students pass tests.	
			Using released test questions to plan instruction.	
			Distinguishing between assessing and grading.	
			Using a gradebook software program.	
			Knowing how the Common Core or state standards can be assessed	

			using technology.	
			Understanding the level of detailed information about students provided by electronically delivered testing.	
			Understanding the level of detailed information about students provided by computer adaptive testing.	
			Analyzing externally prepared assessments (release questions, textbook support materials) for accessibility for special needs students.	
			Modifying assessments for students with special needs.	
			Understanding how technology can support differentiated assessments for students with special needs.	
			Analyzing externally prepared assessments (release questions, textbook support materials) for accessibility for language learners.	
			Modifying assessments for English Language Learners.	
			Understanding how technology can support differentiated assessments for English Language Learners.	
			Writing assessments that consider literacy and language levels/abilities of students, to minimize the chances of measuring reading or literacy instead of the content/skills you want to measure.	
			Ensuring that the technology selected for use in assessment is appropriate to the content being assessed.	
			Ensuring that the technology selected for use in assessment is appropriate to the skills being assessed.	
			Using assessments for summative evaluation (i.e., assessment primarily for grading).	
			Using assessments for formative	

			evaluation (i.e., assessment primarily for improvement of learning).	
			Using assessments for diagnostic evaluation.	
			Understanding the underlying purposes of assessment (i.e., student growth, accountability, comparability, etc.).	
			Designing and using rubrics in the classroom.	
			Developing fixed-response items for assessments (e.g., multiple-choice, matching, etc.).	
			Using the results of a fixed-response (multiple choice, matching, etc.) question to modify instruction.	
			Interpreting the results of a fixed-response question to determine next steps for individual students.	
			Analyzing fixed-response items for quality.	
			Using technology to deliver fixed response assessments.	
			Using technology to evaluate student learning through fixed response assessments.	
			Using technology to develop fixed response assessments.	
			Developing constructed-response items for assessments (e.g., essay response, short answer, etc.).	
			Assessing constructed-response (short answer, essay, etc.) items on tests or assignments.	
			Using the results of a constructed-response (multiple choice, matching, etc.) question to modify instruction.	
			Interpreting the results of a constructed-response question to determine next steps for individual students.	
			Analyzing constructed-response items for quality (i.e., created by	

			another teacher, from a textbook or online).	
			Using technology to deliver constructed response assessments.	
			Using technology to evaluate student work on constructed response assessments.	
			Using technology to develop constructed response assessments.	
			Developing alternative assessments (e.g., performance assessments, presentations, simulations, problem or project based learning, etc.) to assess student learning.	
			Assessing student knowledge/understanding using alternate forms (e.g., performance assessments, presentations, simulations, problem or project based learning, etc.).	
			Using alternative assessment data to modify instruction.	
			Interpreting the results of alternative assessments to determine next steps for individual students.	
			Analyzing alternative assessments for quality (i.e., created by another teacher, from a textbook or online).	
			Using technology to deliver alternative assessments.	
			Using technology to evaluate student work on alternative assessments.	
			Using technology to develop alternative assessments.	
			Providing a rationale for using various assessment practices.	
			Using common misconceptions about topics in your content area to develop questions in which “wrong” or “alternate” responses inform you of partial understandings or misconceptions your students have.	
			Assessing student skills in a content	

			area (e.g., interpreting primary sources in history, numeracy, decoding vocabulary).	
			Using technology tools that are in use by professionals in the content area taught. (e.g., drafting software used by architects, composition tools used by musicians)	
			Selecting technologies that enhance teaching.	
			Selecting technologies that enhance learning.	
			Selecting technologies that enhance how student learning is assessed.	
			Creating opportunities for students to use technology to demonstrate content-specific skills.	
			Creating opportunities for students to use technology to demonstrate content-specific knowledge or understanding.	
			Guiding students in learning to assess themselves.	
			Using technology to help students assess themselves.	
			Using technology to help students assess one another.	
			Learning new technologies.	
			Using a range of technologies.	
			Keeping up with new technologies.	
			Understanding how to maximize the technology at my site.	
			Understanding the limitations or constraints of technology for use in assessment.	

Technology Assessment Interview Questions				
A Clarity (0-4)	B Range of Responses (Y/N)	C Construct Relevance (C,CK,PK, PCK,TK, TCK,TPK, TPACK)	Item	Suggestions (if any)
			Describe the content and/or process topic(s) for the lesson.	
			Describe the student learning goals/objectives addressed in the lesson.	
			Describe your students (e.g. grade level, and specific learning needs/preferences).	
			Walk me through the lesson/project as it unfolded in the classroom.	
			What educational technologies (digital) did you use and how did you and/or your students use them?	
			Describe any contextual information (e.g. access to a computer lab, materials, and resources available; particular departmental/school-wide initiatives) that influenced the design or implementation of the lesson/project.	
			Describe how students were assessed in this lesson/project. (at all points where assessment was used in the lesson/project).	
			How and why do the particular technologies used in this lesson/project “fit” the content/process goals?	
			How and why do the particular technologies used in this lesson/project “fit” the instructional strategies you used?	
			How did you use the information from assessments in the lesson/project?	

			How do you feel technology has effected your assessment of students or their work?	
			Please describe how using technology to assess students has influenced your teaching practice.	
			Please describe how using technology to assess students has influenced your understanding or beliefs about assessment.	

Next, please think about all the items as a whole for a moment. I hope this survey scale fairly represents the entire construct (TPACK and Assessment Literacy) without ignoring important features of the construct. Please indicate any aspects or characteristics that you feel are important parts of this construct which are not represented or are inadequately represented by this survey scale.

1._____
_____
_____

2._____
_____
_____

3._____
_____
_____

APPENDIX C

TTAPS INTERVIEW PROTOCOL

TTAPS Interview Consent Form

Provided in an online form through a link from SurveyMonkey upon completion of the TTAPS survey.

The Technology Using Teachers Assessment Practices Survey

Researcher: Lara Ervin, doctoral student at the University of San Francisco
leervin@dons.usfca.edu

Thank you for taking the time to participate in this study. The interview is composed of several short answer questions. It should take between 30-45 minutes to complete.

The purpose of the study: The researcher is attempting to capture the ways in which technology using teachers are using technology to assess students. You will be asked questions about how you assess students, how you use technology and how you use technology to assess student learning in your teaching.
Confidentiality: This interview is completely confidential, please respond candidly. Please do not use your name or the name of your school in your responses.

Your participation in the interview is completely voluntary. Provision of an email address at which the researcher can contact you to schedule an interview serves as consent to participate in the interview portion of the study.

Right to Withdraw: You may opt out of the interview at any time by simply telling the interviewer to stop. Withdrawing will have no adverse consequences.

IRB Approval:
This study has been reviewed and approved by The University of San Francisco's Institutional Review Board (IRB). The IRB has determined that this study meets the ethical obligations required by federal law and University policies. If you have questions or concerns regarding this study, please contact the Investigator.

TTAPS Interview Protocol

Introduction: Thank you for agreeing to participate in an interview about your use of technology in assessing student learning. Your time is valuable and I appreciate your

willingness to participate in this 15-20 minute conversation. Your responses will be kept confidential and you have the right to decline to answer any questions you wish and to end the interview at any time. Do you have any questions before we begin?

For this interview, please think of a specific lesson in which you used technology to assess student learning. The questions that follow will refer to that lesson.

1. Describe the content and/or process topic(s) for the lesson.
2. Describe the student learning goals/objectives addressed in the lesson.
3. Describe your students (e.g. grade level, and specific learning needs/preferences).
4. Briefly describe the activities in the lesson.
5. What educational technologies (digital) did you use?
6. How did you and/or your students use them?
7. Describe any contextual information (e.g. access to a computer lab, materials, and resources available; particular departmental/school-wide initiatives) that influenced the design or implementation of the lesson/project.
8. Describe how students were assessed in this lesson/project. (at all points where assessment was used in the lesson/project).
9. How and why do the particular technologies used to assess students in this lesson/project "fit" the content/process goals?
10. How did you use the information from assessments?
11. How do you feel the technology you used impacted your assessment of students or their work?
12. Why do you choose to use digital tools for assessment?
13. Has using these technology tools changed your approach toward assessment? Why or why not?

This concludes the formal interview. If you have any questions or would like to share any ideas or opinions about technology and assessment not covered in the protocol questions, please feel free to do so now.

Thank you again for your participation.

APPENDIX D:

TAPS QUALITATIVE CODEBOOK

Technology Assessment Practices Survey (TAPS) Study Qualitative Codebook

Data collected within the open-ended items on the survey and in voluntary interviews will be coded using the following codes:

Code	Term
C	Context
CK	Content Knowledge
PK	Pedagogical Knowledge
TK	Technological Knowledge
PCK	Pedagogical Content Knowledge
TCK	Technological Content Knowledge
TPK	Technological Pedagogical Knowledge
TPACK	Technological Pedagogical Content Knowledge
1G	First Generation Technology Assessment
2G	Second Generation Technology Assessment
3G	Third Generation Technology Assessment

In a review of the qualitative data provided in the pilot survey, potential codes in the areas of access, digital divides, and respondent attitudes about both assessment and technology are present. These are areas in which secondary (post-doctoral) analysis may be of interest.

Codes

Term	Description
C	Culture, Climate, Student Characteristics, School Characteristics including access to technology
CK	Expertise in the content being taught. Includes prioritization of topics, common misunderstandings or misinterpretations about the content, key skills or knowledge students must have to master the content, and learning progressions within topics.
PK	Understanding how learning occurs in general, specific strategies for facilitating learning. Includes methods of instruction, knowledge of assessment practices and theory, and structures of teaching.
TK	Ability to use and learn about technology in general. Includes comfort with technology, using technology with students, hardware and software trouble-shooting, and understanding of the affordances and constraints of a given technology tool.
PCK	Interaction between content and pedagogy. Includes how specific pedagogical approaches are appropriate for a given content topic or skill, decisions made about teaching or re-teaching strategies from student learning, and assessment approaches that are appropriate for a content topic or skill.
TCK	Understanding of how specific technologies are used in a content area by professionals, teachers and students.

TPK	Use of a given technology tool as a mode of instruction or assessment. Demonstrates an understanding of how the technology facilitates learning in general.
TPACK	Technology is couched in the pedagogy and content of the lesson. All three elements are integrated with choices about technology being dependent upon the content and pedagogical approach being taken.
1G	Pedagogical approaches and content are hosted in a technology tool, but are exactly the same as a pencil-and-paper form.
2G	Pedagogical approaches and content are augmented by being hosted in a technology tool. Some affordances of the technology may be utilized however implementation is more similar to pencil-and-paper than to a transformative experience. *Examples of 2G are electronic tests or quizzes with visuals, dictionaries, video clips, etc. that augment the items/products but do not significantly transform the assessment.*
3G	Pedagogical approaches and content are transformed by the use of a technological tool. Affordances of the technology are utilized to develop approaches to instruction and assessment that would not be possible in a pencil-and-paper format. The technology is integral to the experience. *Coders should ask "Would this be possible in paper-and-pencil formats?" to determine fit for 3G. If the product would not be possible in paper-and-pencil, it is a 3G code.*

Examples from Pilot Survey

Term	Examples
C	My school only has 35 computers and 750 students. I would love to do more with assessments with technology, but there just aren't the opportunities to do so all the time. … I am aware that we ought to be able to tailor technology to address diverse student needs, but I have not yet seen it done. I can use Khan academy and do so students who need a second look at place value can do that, while students who are above grade level and want to learn more about complex fractions can do that. But the student who needs human interaction, the student who cannot type, the student who loses focus quickly... I have not seen technology meet their needs yet….
CK	Make sure students are able to use and apply concepts in art creation and criticism as accurately as possible. …I would LOVE a test that showed by benchmark where the student understanding broke down... addition error, or not knowing the difference between area and perimeter, for example.
PK	(Assessment is…) Assessment is ongoing throughout instruction. (Assessment is…) I think of assessment as evaluating the success of teaching

	methods. (Assessment is…) Diagnostic, formative, summative processes to gather data about student learning/progress/understanding which is then analyzed to improve instruction. … I can explain the difference between assessment and evaluation, I think, but I believe they are words used differently that functionally should be used together. Psychobabble is the word used in the psychotherapy world for such differences. I can use an evaluation to inform me about a student's progress, to drive instruction and to give student feedback, just as I can use an assessment to do the same. You left out the word "test". I guess that one is so politically incorrect you just did not bother with it!
TK	(Technology is…) Computer, Smart Board, Smart Phone, IPad, Notebook,IPod. (Technology is…) Quick, exciting, many resources available at a touch, but very uneven in consistently doing what it is supposed to do when I need it as part of a lesson. Loading time, malfunctions, etc. ought not to be an issue, but with the small window of time that I use for direct instruction, I have not found it to be my best friend.
PCK	My answers for all of the above statements would really have to be "as often as necessary for the particular unit." Some units involve constant, near daily monitoring and assessment and others don't. I only use a rubric for annual band performance task, the bulk of assessment is done formatively during rehearsals. The alternative/fixed response models are generally student created small group composition/arrangements for general music. I do more rubrics, constructed-response items, and alternative-response items in Science rather than in math. My tests and quizzes are always a combination of textbook questions I have chosen from a list, and my own questions (usually essay). I also utilize responses from discussion groups and projects to assess learning. Since History, specifically, is at least somewhat subjective (as to motivations and positive/negative outcomes), a great deal of my time is spent on over-arching concepts and trends, and the students' thoughts and opinions on various events.
TCK	Our district does use Smart Music to help assess and help students self-assess but we do not use that software until the second year of band. …I would love to have access to the lab on a daily basis for researching topics, creating power points, writing assignments, and teaching students how to use different programs.
TPK	(Technology is…) the use of and creation of digital media as learning tools

	(Technology is…) I think of a widening of possibilities for creation and problem solving. Assessments can be great, but they must be done correctly. The same with using technology. It can be great, but some students have never used technology, so rather than assessing their understanding, you are assessing how well they use a computer.
TPACK	Learners Navigate four scenarios of ticket processing utilizing a mockup of the ETP system. Learners are first presented with the scenarios and they can choose which scenarios to complete in what order. Since incorrect data causes significant problems for state residents, learners are allowed only one mistake in all four scenarios. If learners make 2 mistakes, they are told what mistakes they have made, what skills they should brush up on and what remediations they may consider. They are returned to the beginning and must complete all 4 scenarios again. Every button they click on is tracked through 'backend' reporting software to our LMS, but learners are only provided with feedback after 2 errors in processing or upon successful completion. In math I provide laptops for students to use in small groups(independent of me) to explore and demonstrate mastery of skills. Khan academy, Everyday math and one other math program are the ones I have tried, so students can challenge themselves. It has been very informative to me, but of limited success in showing me or them their math skills... the tech component requires a teacher's full time support. They can't navigate through to completion. In Science and Social Studies we use the smart board and kids learn/take quzzes with brain pop, brain pop junior, discovery education, etc. Also they write in cursive on smart board so they can see their handwriting using full arm movements.
1G	Students drew blood from a virtual patient, mix it in three different test tubes, one filled with A antibodies, one with B antibodies, and one with Rh antibodies. The three test tubes will either clot or not clot and students will be able to identify the blood using those visual representations and the guide provided. Then students will transfuse blood into the patient that will be safe. Example: Patient has blood type A+ and student gives them B- blood. Result: Patient screams and student gets a message about the blood being incompatible with the patient and they are instructed to try again…I had students use the results from this game and a hands-on lab to write a constructed response to demonstrate their understanding of bloodtyping. *(assessment is pencil-and-paper)* Students create an infographic or digital poster to discourage other students from plagiarizing… The best poster is displayed on the library website (or in the library itself if hand crafted). The results showed me which students still needed help understanding plagiarism.
2G	We used a program called Reading Eggs that helped us assess our students by

	using games that the students play on the computer. Once the students are done playing the games, the program gives us a print out telling us which standards the students are strong in and which standards the students need help in…We used the results to differentiate our lesson plans during centers so that each student would be able to receive addition help in the specific areas. Make an animation that explains multidigit multiplication using visuals.
3G	… I also do a stock report and a real estate project using data from the computer. Students are taught how to complete spreadsheets, research companies and organize the information into a report, compare real estate in different regions, compute interest rates based on the current market, compute money exchange rates in different countries, and percent of change. These are culminating projects in my mathematics class which incorporates all of the skills I have taught. Grades are based on completeness of each section and accurate calculations. There are two major groups of results from the assessment: click-track data and completion data. The completion data is used to verify to supervisors that the learner has obtained the requisite skills in the use of the ETP program. The click-tracking data is used to verify the completeness and correctness of the completion data, but more importantly for me, the click-tracking data allows me to see average path through the online module. Are learners using the supporting resources? are the learners all following the same exact path (indicating a systemic cheating problem)? Are one or two screens causing learners to make mistakes more than others (and the screen may need to be revised?) Click-tracking data is also used to calculate return on investment for my agency. The higher the use of the module, the greater the monetary savings (Level 3 and Level 4 Kirkpatrcik)

APPENDIX E:

TAPS Item and TPACK Alignment

Items 1-7 are demographic items.

TK 8. Which of the following technology tools have you used to assess student learning?

TPK 9. How frequently do you use technology to assess student learning? (*for classes that do not meet daily, please use "daily" to indicate use every time the class meets).

Please take a few minutes to describe an instance in which you used technology to assess student learning in a lesson you taught.

CK 10. What was the topic and learning objective (goal) of the lesson?

TK 11. What technology was used in the assessment?

TPACK 12. Please describe the assessment students completed:

PK 13. How did you use the results of the assessment? (select all that apply)

TPK 14. Briefly describe what would facilitate a greater use of technology in assessing student learning in your teaching. (access, technology tools, training, etc.)

15. For the content area you have most recently taught (multiple subject teachers, please select the content in which you use the most technology)how confident do you feel in your ability to

*Non-Common Core participants, please answer for your nation/province standards for Common Core State Standard questions

PCK a. Explain how an assessment is aligned with a learning objective.

PCK b. Explain how a teacher would assess your content-specific Common Core State Standards.

PCK c. Assess student knowledge in your content area (e.g., periodic chart, mathematical formulae, artists of the renaissance).

PCK d. Assess student skills in your content area (e.g., interpreting primary sources in history, numeracy, decoding vocabulary).

CK e. Identify the language skills (vocabulary and content-specific forms) students need to be able to complete an assessment.

PCK f. Use multiple assessments to make a judgment about a student's mastery of a topic or skill.

PK	g.	Understand the difference between diagnostic, formative and summative assessments.
PK	h.	Understand the difference between norm-referenced and criterion-referenced test questions/items.
PK	i.	Distinguish between assessment data that can inform instructional decisions and that which cannot.
PCK	j.	Make instructional sense of the data from standardized test reports.
PK	k.	Explain the difference between assessment and evaluation.
PK	l.	Explain the underlying purposes of assessment (i.e., student growth, accountability, etc.)

16. How frequently do you

PK	a.	Develop rubrics that guide student learning.
PCK	b.	Develop constructed-response items for assessments (short essay, short answer, etc.).
PCK	c.	Develop alternative-response items for assessments (projects, problem-based learning, simulations, etc.).
PCK	d.	Develop fixed-response items for assessments (multiple-choice, true/false, matching, etc.).
PCK	e.	Use standardized test questions as models to design classroom assessments.
PCK	f.	Use a variety of assessments (tests, projects, short responses, authentic/performance assessments) in your classroom.
PCK	g.	Assess student knowledge in your content area (e.g., periodic chart, mathematical formulae, artists of the renaissance).
PCK	h.	Assess student skills in your content area (e.g., interpreting primary sources in history, numeracy, decoding vocabulary).

TCK	i.	Create opportunities for students to use technology to demonstrate content-specific knowledge, skills or understanding.
PK	j.	Modify assessments for students with special needs.
PK	k.	Modify assessments for English Language Learners.
PK	l.	Guide students in assessing their own learning.
TPK	m.	Use technology to help students assess themselves.
PCK	n.	Provide feedback on assessments that guides student learning.
PK	o.	Use assessments to grade or promote students.
PCK	p.	Use the results of a fixed-response (multiple choice, matching, etc.) question to modify instruction.
PCK	q.	Use alternative assessment data to modify instruction.
PCK	r.	Use the results of a constructed-response (multiple choice, matching, etc.) question to modify instruction.
PCK	s.	Use the results of your own assessments to plan instruction.
PCK	t.	Use the results of local standardized assessments to plan instruction.
PCK	u.	Use the results of national standardized assessments to plan instruction.

17. For the following statements, please indicate your level of agreement.

PK	a.	Students should receive grades for all assessments.
PK	b.	The vocabulary used in a question can interfere with a student's ability to demonstrate understanding or skill.
PK	c.	Culturally-specific language (idioms, slang, etc.) doesn't need to be considered when designing assessments.
PK	d.	It is appropriate to make the content of an assessment easier for students with language or

learning difficulties.

PK	e.	Assessments allow students to demonstrate knowledge or skill in multiple ways.
PK	f.	Assessments can increase learning for all students.
PK	g.	Feedback on an assessment should be focused on moving learning forward.
PK	h.	Feedback is a waste of time, students don't read it.
PK	i.	It is important to give feedback to students in a timely manner.
PK	j.	Standardized tests are accurate measures of student achievement.
PCK	k.	State and district reports about student achievement are useful in planning instruction.

18. When it comes to technology, how confident are you in your ability to

TK	a.	Learn new technologies.
TK	b.	Use a range of technologies.
TPK	c.	Keep up with how new technologies are being used in education.
TPK	d.	Understand the advantages of technology for use in assessment.
TPK	e.	Understand the limitations or constraints of technology for use in assessment.
TPK	f.	Understand how technology can support differentiation of assessments
TPACK	g.	Ensure that the technology you select for use in assessments is appropriate to the content and skills being assessed (i.e., using a word processing program to assess writing, an audio recorder assess speech, etc.)
TPACK	h.	Know how technology will be used to assess student learning of Common Core State Standards
TCK	i.	Know how technology is used by professionals in your content area.

19. For the following statements, please indicate your level of agreement.

TCK	a.	Technology helps assess student learning of content area concepts better.
TPK	b.	Technology makes it more difficult to address the diverse needs of students in learning.
TPK	c.	Students create better-looking products with technology than with other traditional media.
TCK	d.	Technology makes student misconceptions about your content area concepts more difficult to detect.

APPENDIX F

INTERVIEW TRANSCRIPTIONS

Participant 1 Interview

June 20, 2014

8am PST

Gender: M

Role: High School Algebra Class

Notify the participant that responses are confidential etc.

I: Do you have any questions before we begin?

P: I do not.

I: For this interview if you would please think of a specific lesson in which you used technology to assess student learning and specifically speak to the…answer the questions with that lesson in mind. In what role were you (grade level and setting) in what role were you using technology to assess student learning?

P: It was a 9th grade Algebra I class in a public school.

I: Fabulous. And can you please tell me the content and/or process topic(s) for the lesson?

P: The content was really a kind of cumulative wrap up of linear graphing. Linear graphing with comparing functions within graphing.

I: Okay, great. Can you describe the… what your goals were for your students… in the lesson?

2:02 P: (. Linear graphing with comparing functions within graphing.) The goals for the students were to be able to independently kind of discover the connection between certain graphs and the way that like… if we add 4 at the end…. How that acts differently than if we, you know, subtract 3 within the parent function. So it was to see how… it didn't matter what the parent function was, if I add 4 at the end, it goes up by four on the the Y-axis, but every single paired function (Pair or parent?). So it was basically (unintelligible) self-discovery and noticing that the different parent functions, even though they look different, all react the same.

I: wonderful

P: so then by knowing that, they can predict the way that the graph should look just by looking at them, rather than by having to rely on graphing them by hand, or using a graphing calculator, they kind of predict.

I: Wonderful. And, um, let's see, what technology did you use?

P: We used a TI Inspire CX model; the students all have a hand-held version of that. We also used, of course we used a word processor, Microsoft word, most of them used, and then, of course, some of

them even used excel to input their tables with their inputs and outputs. Now, within this, though, I will tell you I really am a firm believer in the blended classroom. I really run a kind of an online classroom as an extension to my regular classroom. So all of this was done outside the classroom. We had a separate 3:43 class kind of going on within the class. And we were actually teaching into the concepts. But outside the classroom, they were able to interact with me in our discussion board, through Moodle rooms, which is what we use, so they were able to interact with me through the discussion board and that's where any resources were posted. Within my Moodle rooms discussion board.

I: Awesome, and so what were some of the activities that students were doing inside the Moodle rooms, you mentioned discussion boards, were there any specific activities around the discovering of the graphs that they were completing?

4:22 P: It was all a series of activities that they had to complete. For example, we took them through each of… let's say an exponential graph and we showed them what the exponential graph would look like. And they had to graph them by hand and graph it in their inspire and make sure they were the same. Then they had to graph one with a shift in it. So they were really, we took them though each one in discovering absolute value, exponential, linear, even a square root function. So then, at the end, we had one where they had to compare each one of the paired functions, adding 4. So they could see that each one of them still moved the same. And so, through this, the whole activity was there were different leading questions and there were some real world applications in it too. We would give them you had one block and then the next set you would have eight blocks and the next set you would have 27 blocks, and they had to realize that that was an exponential function. So they would have to make a table, and then graph their table to see what kind of paired function it was. (5:38) So there were several leading questions within each paired function that the students had to do. This was a complete project so the students were completing their project by answering their questions and really diving into… by completing these graphs they get to do this, like I said, on their calculator and by hand, and a lot of them typed up and even put in Microsoft excel, in tables. Now in this, it was kind of interesting how the kids kind of they almost kind of grouped up. In the discussion board, they kind of paired together and certain ones of them would respond to different ones. And it kind of spurred a lot of conversation because this was a self-discovery. It was not something we were really doing in class they were truly kind of digging in and discovering this themselves.

6:33 I: Awesome, so, was there a specific prompt, or was it fairly open-ended?

P: It was open-ended on the discussion board, absolutely. The discussion board was there simply as a place for them to meet and talk.

I: Great. So do all of your students have laptops or internet access at home, because you are talking about it being a lot of out of class what are the, kind of, contextual components to how your students were able to access the technology?

7:06 P: I am in a very fortunate public school that is pretty affluent. I mean, we have, I would estimate that 90% of our students have internet access at home.

I: ok.

P: Any of the students that don't have internet access, they know I come in early and I have a little office hours there. They can come by still and kind of check it early. I try to get there about an hour before school just to work on things if they don't have computer access at home. But I would say it is a very rare situation to where we have a student who doesn't have internet access and/or computer access constantly.

I: Wonderful, so, what kind of assessments did you use during the project?

7:55 P: Now, granted, of course their projects had to be turned in They typed it up, they would even take screenshots of their Inspire and kind of put it into their word document so it looked really neat. They had Excel in there. But I graded this with a rubric. And I was looking for the specific things, making sure their graphs were correct. And making sure, of course, that they were able to discover, you know, just the connection and correlation between the different parent functions. That you know, well I guess, one of them looked like a V and one looked like a U when we still shifted up four those graphs shifted up four. And so, just noticing that similarity.

I: Awesome, and a lot of the questions I have on my list, you are answering within other questions. How do you feel the technology that you use impacted your assessment of students or their work?

9:00 P: I will say, and this is where I differ, let me give you a little bit more of a background on where I am at. I teach in a PLC, and so I have two other teachers in a professional learning community. I have two other teachers that also teach the same content as me. And we developed this project together. Well, in the state of Alabama we just went to using quality core assessments. Developed by ECT. Well, ECT allows students to use a calculator as high as the TI Inspire CX model. Some of the teachers I teach with… no… all of the teachers I teach with are very hesitant to let students do things on the calculators. They feel that if you allow them to use the calculators, they aren't really gaining anything by it. And so, they really had their students do it by hand. I feel, I know that I had much more buy-in from the students because they were able to use their calculators; they were able to use their computers. They were able to make this project more towards 21st Century rather than having to do all of these graphs by hand. Because this is a lot to do by hand.

10:18 I: Yeah

P: And yes, while my students still do a lot of work, I'm bringing in the technology component they were doing it more freely they took pride in it, and I will tell you, I teach… two of the sections I teach were collaborative sections, I have about 15 students with IEPs. Even the collaborative teacher came to me and mentioned that one of the students in particular, she took so much pride in her project, like that was all she would talk about. Somebody would be working on resource stuff, and she would come over and look at what I did on my calculator, look at the graph here. So, the technology component, I don't feel like it changed the objective at all, because my students still had to answer the probing questions, they still had to come up with the table for the real life application, but I feel like the students had more buy in. they were proud of what they were doing on the computer and it felt like something different.

Because they were able to use all of this technology and they were kind of discussing in that discussion board and they were into it.

I: Awesome. And did you monitor the discussion board and get involved in that, or (or absolutely) did the students answer each other's questions mostly?

11:43 P: Well, no, well, absolutely, I would say that I was more of a participant than a leader in the discussion board. And just like anything else, I had to ask at the beginning how's it going? That type of thing, because of course students are going to be like, waiting until the last minute to do it. But really and truly, by the time we got going with this, and down the road with this, they were discussing freely. I was monitoring, I was reading every one of them, I would comment on it, Hey, You might want to think about this… but I did not take a lead role in the discussion board, I let it free. I let them take ownership of that.

12:30 I: Awesome. Has using technology changed your approach to assessing students at all?

P: Yes.

I: How so?

P: Like I said… I was blended learning before blended learning was cool. (Laugh) I really like doing… what I do with Math specifically, because it is a big problem and students get home and they don't know whether or not they got the problems right. So they don't even know whether or not they are on the right track. So what I do each day is, I give them a small set of homework problems they do them, but I will often post a video or I will put the answers or solutions online for them to go and check. And my students know their homework that night is not necessarily just to do the problems. Their homework is to check the answers and really dive in to what I did. The next day when they come to class, the way I have changed my assessment is, the first thing I do is I allow them to ask any questions. They already come to class knowing whether or not they knew what they were doing. There's no longer that period of "well, I didn't really understand the homework…" You know what you miss. So they come in, they ask their questions when they walk in the door they write down the number on the board that they need. And I go over any of those. And then I do a small, entrance ticket almost, usually 3-5 questions it is not quick assessment of, hey can you repeat this process, do you know the steps it took to do this math? So technology has allowed me to give them a little independence of their own, kind of monitoring their own learning. And it's allowed me to give them more access to every problem, because some students are afraid to speak up Hey, I need that problem… so, sometimes it goes well, and sometimes I have had to go over every problem. So it's allowed that constant, I guess, constant, not remediation, evaluation of where we are at and through mobile homework checks there is no question when we get to a quiz that I know who is struggling on this topic, or this topic (14:51) and especially when we get to a test, I know where the problem areas are cause we've done all these checks and we've done this kind of process throughout.

I: Excellent, well that concludes the formal interview. Invite to share any other ideas or opinions that weren't covered in the interview.

15:16 P: Not really, I am going to the international conference next week in Atlanta, will you be there?

I: Not this year, I hope to submit my findings from this study to present next year.

Some chatter, about ISTE and his wife doing her dissertation… he volunteered to help out because he saw her struggle.

P: I love technology; it is a platform that is misunderstood. I think there's a lot of teachers who get into it and they think it is going to do everything for them. They just don't know that it's a tool. It's a tool just like the overhead projector used to be a tool, or even the chalkboard used to be a tool. It's a tool, but they don't get it. They're afraid of it; they don't know how to use it. And that's kind of where I'm at.

P: I will tell you, my whole goal for this, where I want my classroom to develop into is, I was talking with another teacher on the phone one morning on the way to work, he was in standstill traffic, and I was like, why are you in standstill traffic? I was on Twitter, and within 2 minutes I took a snapshot of the wreck and sent him a picture of the wreck. And I was like, hey, in about ½ a mile, here is the wreck you are going to see. But students have got that kind of access literally available for them. Why can't we post a topic and say, "hey, go out there and see what kind of information you can find on this, the information is out there, making them learners. Basically, making them use what they have I don't know how we change, especially in the k-12 setting, to that. If we try to find ways to make that happen.

17:52 P: I have a master's in IT, and an EDs in instructional leadership. Finishing his EdS, then moving toward an instructional coach and designer. We are asking the wrong questions.

18:44 just because they are using a resource tool doesn't mean they aren't getting an education. We need to change the way we ask the question…. The TI Inspire, it will do everything for them. Our algebra teachers are going bananas. They are like "they're not learning anything" because the calculator tells them. Well, that's fine that the calculator tells them. They are going to have that throughout their life. But why don't we ask questions about what does that data mean to you? Instead of just looking for the product, let's look at what the product means. And they (teachers) are not getting that. It is still trying to get them to that point, so.

I: Do you find that your students, with the calculators, that they play with the data more?

19:47 P: Oh, absolutely. And I will give you a prime example of that. When we did inequalities, the new TX Inspire it will even graph and shade your graph for you. So, it will shade half your graph green, and then when you put another line in it will shade that line red. And so, when we were doing stuff like that, they would kind of shift it to see how small they could get their overlap section. They would kind of play with the data and just see. Improve their skill on that and see how big they can get their graph. So, yeah, I feel like they would kind of play and explore on their own a bit.

20:33: And I will tell you, the funny part about it, I taught my students some of the tips and tricks of how to factor, how to do trinomials in your calculator. But what was funny was they (other algebra teachers) would come to me and say, they're doing this in the calculator, and it blew their mind, because they didn't know, they accused another teacher that tutors some of the students of teaching them to

“cheat.” And that wasn’t the case. The case was the students were going home and looking online. Hey, how do I factor using the TI Inspire? And there are tutorials out there. And they’re not getting that. Instead of trying to play ahead of the game, they want to sit back and do what we have always done.

Algebra teachers I work with are frustrated that the calculator does everything for the students, but why aren’t we asking what the data means, instead of freaking out about the students not doing the calculations?

Participant 2 Interview Transcription

Female, High School English Teacher

I: Interview protocol reviewed with participant.

I: For this particular interview, please think of a specific lesson in which you used technology to assess student learning and answer the questions using that particular lesson in mind. In what situation have you used technology to assess student learning?

P2: Regarding a lesson plan?

I: Yes, or a lesson that you have taught, yes.

P2: I was teaching a research process to senior English students and everything encompassed technology. Everything. They used databases from the library to find their information, as sort of their first step; of course, they used word processors to write it. Everything was submitted through a Desire2Learn learning management system. They wrote nothing down; they were not allowed to write anything down. (Ok)… Everything… yeah, everything had to be through… to save it, I encouraged them to use Google drive any of a number of things that are out there. I teach in a very poor area, 99% free and reduced lunch rate. But they all have smart phones. So when I realized that I showed them how to use their phones, they all you know text and talk, we used things like Dragon Dictation for the same project. We used... oh, we used… oh, I can't remember… what is it called… something office… and they were able to create what was like a PowerPoint… I don't know... it was like Microsoft Office... oh, Quick Office. That's what they presented their final presentations with. Now, they were very plain white slides, but they were… they created everything on their smartphones. That is the whole research project.

I: Wow, that is pretty impressive. All on the smartphone.

P2: Right, they did use laptops for accessing the online databases at school and they used the laptops, I taught them how to use Excel. We did some statistical analysis. I had them use surveys to create accounts on SurveyMonkey, which they also did on their phones. I mean, if you can't beat 'em, join 'em. (Laugh)

I: (laugh) Well, it sounds like an absolutely amazing project. How did you assess students at the end, and kind of along the way… what kind of assessments did you do while they were doing their research projects?

P2: I followed... I followed strictly our curriculum, what we call the academic knowledge and skills, so it was... um... I made rubrics and... I should say, this is my first year back into teaching after I was gone for six years. Five years, sorry, to get my PhD… so me coming back into a classroom that was totally foreign and was not like this five years ago. A lot of it has to do with where I was too. I used rubrics, and I would just use what I learned in grad school in instructional design because it had the objectives in there. And I presented these rubrics to the students beforehand, saying do you want to get a one, which is not so great, this is all you have to do. But you are not meeting the school objectives and if you don't meet the

school objectives, or the county, rather, the district objectives, then you don't get the little pat at the end. We're dealing with seniors here, 12th graders, so… I really encourage using rubrics and using rubrics, not with how the teacher thinks they should go, but using your curriculum to help set up your objectives in there. So they know what they are shooting for.

I: Excellent. And did you do any, throughout the lesson, any progress monitoring or formative assessment,

P2: Yes.

I: using technology?

P2: Um, using technology… No. I went old school on that one. And printed out a list... I guess you can say I used Excel… to make a checklist. I just learned that Desire2Learn, our learning management system, has a checklist in it… I could have used that, but I didn't know it existed. To answer your question, no, I made a checklist and posted it on the wall. Said you should be here at this date, here at this date.

I: Excellent, well, what I'm seeing in my research thus far, is that teachers are using the technology for the summative assessment, but not as frequently, you know it just doesn't occur to us as teachers, having myself been a teacher before leaving to go do my doctorate, it just, it is just easier to assess in the moment without using technology sometimes.

P2: Right. But something that I was not aware of, I just learned it last week, is that a lot of learning management systems are incorporating that idea. So I really had a face palm moment when I saw that checklist in our LMS. So, now I know.

I: So, Desire2Learn, you also have a discussion board or chat feature?

P2: Yes.

I: Did you use that at all?

P2: Not with this group. Not with this group. I did with my juniors. We used the discussion board. And I … you know… I don't know if it was a motivation thing, but the juniors… they were just not excited about it. But they weren't excited about anything.

I: Excellent. How did you use the information from the assessment?

P2: You mean the research project that they did?

I: Yes.

P2: Um... how did I use the information…? I guess I don't understand this question.

I: So was this an end of the year project, or did it shape instruction…?

P2: Oh, right, you know it was supposed to span 2 semesters. But only part of two semesters. Like the end of first semester and the beginning of second semester. Mine went through the entire second semester. When I found out that, we weren't allowed to teach *any literature* because we have only 30% of nonfiction in the fall with Macbeth because of the Common Core… I just, forget it (exhale of breath) this is supposed to be British Lit… So I just taught them… I made that all our objectives. I didn't break the rules, but I did it with research.

I: Can I ask what state you are in?

P2: I'm in Georgia. And Georgia has actually pulled out of the Common Core, but my school system, which is the largest school system in the state, has decided to keep it… so we are not, you are interested in the assessments, we are not doing any of the assessments associated with the Common Core. None of them. (Further off-interview conversations about CCSS).

I: Ok, has using technology tools changed any of your approach to assessment or thoughts about what you might like to do in the future with technology and assessments?

P2: Yes. Yes.

I: How so?

P2: Well, um, I definitely think having a learning management system helps. Wherever you are. It depends on the features of the learning management system. But I definitely think having that learning management system helped. Having the smartphones in their hands helps. You can't ask hey who has a smartphone? But I can certainly make an observation, you know, looking to fulfill that requirement. Fortunately, our learning management system can be accessed through their BYOD. And accessed on their mobile device. So it is definitely something I plan to use in the fall. Using the LMS as an assessment tool. Both summative and formative.

I: Did your students… if your students didn't have a smartphone what kind of resources did you have for them in the classroom to be able to… or did everyone have a … have one?

P2: Well, in the case of my seniors, everyone had one. In the case of my juniors, not everyone had one. Some of them had parents who said you're not allowed to use them at school. .. or some of them had the old flip phones. So not everyone, when you got down to my juniors, not everyone had access and I don't know what the difference is…in the year by year. And my classroom is actually in a trailer outside of school because we are overpopulated in our area. So I did not have access to a lot of the things that the teachers who were inside had access to. For example, I couldn't check out laptops. So that limited my abilities, really.

I: Ok, so was there, is there a computer lab you could go to though... or ….?

P2: We have tons of computer labs, however, once April hits… the labs are used for testing and we test 22 of the last 30 days of school. And the 8 days that are not for testing, testing days, those are make-up testing days. So we don't have access to the labs.

I: This has been a very enlightening interview… thanks… etc.

Interview 3 Transcription

Intro with information for the participant about deleting the recording and such.

I: In what subject area and what topic was the lesson taught?

P: This is an AP Biology classroom and I use them as a blended classroom. This particular lesson was online.

I: Oh, the whole lesson was completely online?

P: Uh Huh,

I: Oh, fabulous, and what was the learning goal of the lesson?

P: To be able to make predictions about genetic crosses, using Mendelian genetics but multiple descriptors.

I: Ok, and what grade level were the students?

P: Juniors and seniors in high school.

I: juniors and seniors in high school, excellent. Could you describe, please, the activities that took place in this lesson?

P: First, they had a reading that they had to do online to give them some background information. And then I had some, how should I say, interactive quizlets. I guess you would call it, where they would go through some animation and then after the animations were done then the students had to answer some questions.

I: Ok, great. And was there a specific technological tool that you used or was it kind of an amalgamation?

P: It was a web-based… and it was a partner with the textbook that I use.

I: excellent, and how did the students tend to use these tools?

P: I guess I don't understand the question…

I: How did they access the tools, were they in a computer lab…?

P: Oh, ok. In our school, our juniors and seniors were given Chromebooks if they wanted to borrow our Chromebooks. And since it was web-based, they could do it with their Chromebooks.

I: Ok, excellent. Can you give me a little context about your school? Maybe anything that might have influenced your design or implementation of the project?

P: Um, ah, let's see. The AP biology curriculum was revamped a couple years ago. And with that revamp of the curriculum, I was looking for a source or a textbook that would integrate the new curriculum

easily and effectively. And this particular textbook also had an online component. And so that is why I went with it.

I: Ok. And how were students assessed in this particular lesson or project?

P: There's a couple of different levels of assessments. First, after the animation sequence, they took these quizzes and they could not move on to the next animation until they had proficiency on those quizzes. And then they also took something called prep-view quizzes. And the way this works is I will ask questions and it will scaffold the questions to higher cognitive levels until they reach a particular, how should I say, proficiency. And I set the proficiency, whether it is a high proficiency or a goal proficiency based on the importance of that particular topic.

I: Excellent, and how did you end up using the information from the assessments that were given?

P: The students completed this before coming to class, and using the data I looked to see what areas did they struggle, and then keyed in and focused on at 1:1 what their struggles were. And what I found was that it was kind of broad based what they struggled with. The majority of the class had difficulties with certain kind of mathematical components. I just went over several different mathematical examples of how they would utilize that in a genetic study.

I: How do you think the students…? How do you think the use of the technology impacted your assessment of the students or their work?

P: I really think that, one; they really enjoyed it, because it was a different way to be exposed to the topic. Since this was an advanced placement class, they were familiar with genetics but not in a deeper level that I was pushing them towards. So I think that they felt that that was very engaging. And they, after we did the quick mini-lesson on how to use some of those mathematical tools, and I showed them quick ways to derive the solutions, then they were very quick to be able to answer those kinds of questions in the summative evaluation that we had several days later.

I: Excellent. Has using these technology tools changed your approach to assessment?

P: It has, it has. I am trying to integrate more of those kind of models so that they use that formative assessment so that, and I use them as well, so that I can key in and focus on their weaknesses so they can springboard off of that for their summative assessments.

I: Those are the last of the formal questions I have, so if you have any questions or further ideas that you would like to share…?

P: One of the things I found that was kind of limiting my ability to do this is the time for the students to be able to do this kind of intensive practice. What I am finding is that these kids who take these advanced classes are very busy. They have a job, they out for athletics, they have multiple AP courses and spending a concentrated amount of time outside of class that I was trying to get them to do was problematic. So one of the things that I am hoping to do is to do more of a flipped model so that they kind of do that kind of stuff in the classroom and then they get the lecture kind of stuff on their own.

And would only be you know 45-50 minutes. So that would limit their time out of class that they have to spend on that class.

I: Awesome. And are you thinking of creating your own kinds of stuff…

P: Yes.

I: Ok, so screencasting and…

P: Yep.

I: Excellent. That is great to do.

P: Yes, now that we have access to technology that allows us to do that faster than what we used to be able to do just three years ago…makes it more successful.

I: Thanks participant and closes out conversation.

Participant 5: Transcription

I: Overview of the details and recording information. Asking first question: could you please describe the content or topic for the lesson in which you used technology?

P: The topic was a PowerPoint book report. Students were given a task along with a rubric and my goal was to get them familiar with using Google for research ability, using copy and paste, and being comfortable with PowerPoint.

I: Great. So could you describe what the students did in this project?

P: Sure, they set up a PowerPoint book report, it had to be at least 10 pages, and I gave them requirements as to what would be on each page. For instance, page 1 was the title of the novel, author, and graphic about the novel and their name. I wanted them to be comfortable copying and pasting graphics from the internet on to their PowerPoints. I feel like anything that's visual and anything that's hands on is such a better learning tool for them. So I wanted them to do that. Anyway, each page had a requirement. One page was setting, one page characters, one page prompt, conflict, solution, quotes, point of view, etc. etc.

I: Great. And what is the background... grade level of the students… sorry I should have asked this first… and little background to the school, without using any school names, what kinds of… is it a very diverse population…

P: Ok, great. It was 8th grade. An 8th grade English class. It was not a terribly diverse school. It was approximately 85% English Learner, probably 10% Asian, and 5% Caucasian.

I: ok, great, so they were doing all of this work on the internet using Google Search and PowerPoint, was most of this occurring in class, or out of class…?

P: Most of this occurred in class because most of the students did not have computers at their disposal. So it was an ongoing project that we did during the semester. Well, it didn't take the whole semester, it would be every other Friday, and that would be our computer day. They were supposed to be reading along at the same time.

I: Ok, and did they do this in a lab, or do it with…

P: We did it in a computer lab. And one of the things on the rubric was a peer review as well, so they could have the opportunity to critique peers and get good ideas from their peers.

I: So that leads to this question, how were you assessing students during the creation of this project?

P: Mostly by walking the room and monitoring what they were doing. Mostly by answering questions for them about how to do some of the technical work that they weren't familiar with. I really, really… my students would call me the Google queen because I constantly Google. I love Google; I love Wikipedia, even though I think you need to check your facts on Wikipedia. But I love having that technology

available to me. And I wanted them to get comfortable with it. Oh, you have a question? Google it! Google it, google it. And that was kind of my catchphrase… I know… Google it…. Yes

I: Excellent. And how did you assess students overall in the project?

P: I had a rubric for what they had to do per page. They knew that the more detail they gave me the better their grade would be. They knew that if they did something creative like, did extra work with fonts, background colors, and background designs that would be worth extra points. And that was listed on the rubric.

I: Excellent. Let me see… you are answering a lot of my questions within the questions… How did you use the information from the assessment in your further teaching?

P: I compared it to what students did in book reports in prior years, when we didn't have a computer lab at our disposal. And I also had students give me… I had students answer a survey. Regarding… because they have been doing book reports all their life. They are in 8th grade. They have been doing them for years now. Asking them to compare the process of doing the book report this way, not only that, but also the process of listening. Because the students got to get up and present their PowerPoints as well. To the class. And overall, it was a tremendous success. Kids loved it, they were more engaged, and listening to other people, they loved it.

I: Excellent, how do you feel technology has effected your assessments of students or of their work, kind of in general question.

P: How do I feel it has affected their work?

I: Your…

P: My assessment of their work?

I: Your assessment of student learning. Not just in this project, but in general.

P: That's kind of a wide open question. I would say… that one way that technology has effected that is that we live in such an immediate gratification world right now. And I can tell how adept my students are at technology, technologically, just based on how quickly they are able to answer when I ask them, or how quickly they are able to perform on a computer. I always find in the lab that sometimes my students teach me something on the computer. That is a bonus day for me, because I'm all about learning as well as teaching. Boy howdy, have I answered you?

I: yes. So, has using technology affected your understandings or beliefs about assessment at all?

P: Has using technology affected my understanding of what?

I: Of assessment. (Pause) Like, do you do anything differently when you are assessing students…?

P: Yeah, I am thinking. (Pause). I think it has required me to be more, more descriptive in my rubrics for student assessment. But I think that is a good thing. Because anytime… the more detail I can give in a

rubric the better results I get back from them. It's just like giving a student an assignment in years past. The more detail you can give them… the more successful they can be. If it is that kind of assignment. I guess if there are some that you want the student to go on their own and be creative with it, but it has helped me, I guess, to be more eloquent in what, in my definitions to them of what I am requiring.

I: So, of course we ask the most difficult questions last. So that was my last formal question. Is there anything you would like to say about technology and/or assessment, or do you have any questions about the study?

P: Um, no. I will say that I have enjoyed reading your surveys and hearing about everything that you are doing. I think what you are doing is fabulous. So, yeah you!

I: Great

P: So, I love it when I have a class that has iPads available. I teach a multitude of things. I am primarily doing long term subbing during the day, so my middle school job last year was a long-term sub job from January to almost May. Which was fabulous. I loved it. But I'm also teaching high school English at night at () high school. Which is just a great job. And we are doing a lot of technology with that, because, are you familiar with Plato?

I: I am very familiar with Plato.

P: Ok, well then good. Because a lot of my students in that class are English Learner in the class as well. Some of the language in high school English classes and Plato is so sophisticated that they, it is very hard for them to be successful and the whole point of Plato is that they are supposed to be able to do work on their own. But I find myself having to sit with them so often to explain what they are being asked, and to point out within the text where they might find examples to go with… that it seems counterproductive to me. So I think we are getting there as far as that type of resource for high school students, or students in general. But I think there is a lot of tweaking that needs to be done. That is why I say I think what you are doing is fabulous. The ideas are great… but as I said, you want… by the time I get my students in my high school class, they are in English credit recovery.

I: Right

P: So they have already failed a class, they already think they are not capable to be successful, but they are trying. So I really do a lot of differentiation to try to help them be as successful as possible. That is my goal. So, as I said, I think Plato has a lot of great things, but there is a lot to be done technologically. One of my biggest… one of the things that I strive for in my teaching with the use of technology is the extra use of graphics whenever possible. A picture tells a thousand words, and that is just so true. And we have so much graphic capability… If I need an image, I just go to Google and there it is. Basically, anything that I want I can get, including a lot of fun clipart things that help get the idea across to students. So, and especially when you are dealing with English Learner students they really need... they need graphics, they need to see the picture to understand what is happening.

I: So, do you think it is that the technology needs more support for language learners? Not necessarily, it's more about the academic language components.

P: I think so, yeah. You've managed to state much more precisely, what I was trying to spit out there. Thank you.

I: Yeah, that's a component of what I would like to do post-doctorally…. Is looking at pulling that in…

Interview 6:

I: Overview of the project and information about how the recording will be transcribed and deleted.

I: So, for the questions I am going to ask you, for the most part, if you could think of a specific unit or lesson in which you used technology to assess student learning, and answer the questions with that one lesson in mind, that would be perfect.

P: Okay

I: Okay, so for that lesson, what was the content or topic that you were teaching to the students?

P: Language Arts.

I: Language Arts, excellent. What were the student learning goals or objectives that were addressed in the lesson?

P: There were several different things. There was a writing standard where they needed to be able to create a paragraph on the computer and have an opening sentence and a closing sentence. And then within it I was checking for certain kinds of sentences and grammar. But it was mostly the writing, trying to get out paragraphs and answer a prompt.

I: Awesome. And then could you please describe your students, what grade level this was… were there any specific learning needs or preferences present in the classroom?

P: They were 3rd grade and in my classroom 'I did not have any RSP kids, but I had many students that were below grade level. Several of which were English language learners. The majority of my class was at a level two or 3. (I: Okay) but then the other half of my class, it was like half-and-half; the other half was high achievers. There was a really big gap in my kids so I had to do a lot of differentiation for my lower kids with their writing and skills… having different expectations for what they could put out versus my higher kids who could write almost an essay.

I: Excellent. And how did you use technology within this lesson?

P: It was all… they got a prompt when we were practicing for our common core testing. So they got a prompt and we were practicing answering prompts. So we had time in the computer lab where they got to practice their writing on the computer. So I got to assess them based on their typing skills and their answering of the prompts.

I: Ok, excellent. So, did you often get to use the computer lab, or was it a kind of novel activity?

P: It was kind of a novel activity. But we actually got Chromebooks at our site this year, so I am hoping that we are going to be able to work more and more.

I: awesome. And how were students assessed in the lesson or project? What formative or summative assessment took place during the assignment, this lesson?

P: It was very, just, very formative. I wanted to make sure they had something that answered the prompt. You know grammar is correct. We were working on starting and ending sentences. Having a body in between. Of going over... we do step up to writing, so they had their idea sentence, they have descriptions about it, yep, definitely going over those. It was very, very informal. I just wanted to make sure the kids felt comfortable on the computer before testing.

I: Okay, did you use any specific programs?

P: Any programs?

I: Yeah, like was it word, or…

P: Word. Generic word… typing.

I: Awesome. And then how did you use the information from the assessments that you did in your teaching?

P: Oh, I was able to go back, as this was before testing, so I was able to go back and meet with different groups of students, if they all had similar problems with it, or if I saw half the class not being able to answer the prompt… I would be like, ok, we have to work on this.

I: awesome, and how did you see that? Was it through the technology or … what were you doing to gather that assessment information?

P: I printed out all of their stuff, so I was able to read everything. And just by observing my students too on the computers, I was trying to see their comfort levels, See if they had to keep looking at their fingers on the keys, or if they had a little more confidence in their typing skills. The kids that were typing one finger at a time…

I: I have definitely experienced that.

P: Actually, I noticed that the kids that were more advanced in their typing skills, they were able to write a lot more than students that had very few typing skills. So, that was good.

I: So, do you think that was because of time, or maybe comfort level? Why do you think that might have happened?

P: I think it was comfort level. Because I noticed that some kids, the ones that struggled more, they don't have computers at home. So, the ones that I saw really achieving with their writing, I know they have computers at home. I'm sure they are on them all the time, not just iPads.

I: Did you notice, by any chance, did you notice any difference in the quality of the work between the students who you felt were more comfortable or who were less…

P: I definitely, I think the work from the students who were more comfortable was much better because they weren't fussing over what keys, they knew how to do spell check, they knew… so they weren't worried about all those little things like other kids. And one kid was formatting… and (phone cut out)…

I: Awesome, awesome. Great. So I have three more questions and these are more in general, not specific to this lesson or this project.

P: Ok.

I: The first one is… how do you feel technology has affected your assessment of students or their work?

P: I think it has really helped with... like tests, testing and stuff. I still do a lot of assessments like chapter quizzes on paper and things. But when I want to get cumulative, I want to know their reading levels, their math levels, then we do online assessments. So those are the biggest things we use them for. And I can see a lot of progress throughout the year, or decline, on these assessments. It's the STAR reading and STAR math ones and they are really helpful in making small groups and assessing kids individually. They are wonderful.

I: And how has technology, how has using technology to assess students affected your teaching practice? The things you do in the classroom.

P: Because of our reading test and math test on the computer, I can differentiate for different levels of students. So I can make reading groups, I can make math groups based on the score… not just on what I see them do, but what they can do on the computer as well. It really helps with showing me what they do know or what they need help with. Because then I get a printout of things that they need. Then I use that in the classroom as kind of a starter for a lot of things. Especially if we are starting something new.

I: And so, the final question… how has using technology to assess students affected your understanding or beliefs about assessment? Has there been any impact?

P: It has really shown me that there are a lot of different types of assessments out there. And they are more than just taking a test at a desk. There is different things that you can do to assess kids. Like, my gosh, trying to think of a couple of things that I have used, there's classroom dojo on the iPad, and I can give kids points for certain things. Like if I see they are understanding, or if they are raising their hand a lot. I can… there's a lot of things out there that are new to me. I really like… I'm opening up my eyes to a lot of new ways to assess kids instead of just giving them a test. I am more than happy to take any feedback on what I should do with that.

I: Awesome, well I am hoping that this study that I am doing will provide more information for researchers, but also for teachers, on what is being done out there.

P: I am actually starting my master's degree program in educational technology soon.

I: oh great… (conversation about MA in technology at Fullerton)

Participant 7

I: overview of project, thank participant, disclosure about recording.

I: What I am researching is how teachers are using technology to assess student learning. So if you could think of a particular lesson or unit in which you used technology to assess student learning and answer the following questions with that lesson or unit in mind,

I: What was the content or topic that you used technology to assess student learning within?

P: I have used technology in a couple of different ways to assess, and so could I talk about both, or are you looking for one particular…?

I: Well, at the end I am going to ask about general use, for these questions it is more thinking of a specific activity just so I can get that sort of…

P: Ok, I can do that. I used it for spelling. When I taught first grade. And I began to use a website called spellingcity.com. Two years ago I noticed, or maybe closer to three years ago, anyhow, I noticed that when I was giving the traditional pencil and paper test I could easily predict which child would be passing all of the spelling tests, which child would not be passing all of the spelling tests based on their home life. (I: Ok) In October. (I: Wow) So, in October I knew which route which kid would go. And I knew that this was a problem and I did not like it. So I turned to words their way, in order to get ideas for how to better differentiate spelling tests based on kids levels. And realized that I would have to manage seven odd spelling groups and I… that's a lot for something like spelling. Or, I felt that that was a lot when I was doing differentiation with guided reading and with math and with writing and all the other stuff. So I found this great website called spellingcity.com, which allows me to input the spelling words, and then I have the option of assigning… assigning games or not assigning games or vocabulary words. Or paragraph or sentence writing with those spelling words to the students. And instead of kids doing traditional spelling packets and rote memorization they would be playing games online or writing sentences, or doing a wide variety of activities with their group's words and what was really cool about this is, Thursday evening they would take their spelling test online. So each child was getting a differentiated spelling assessment based on their spelling levels, that's less groups I had to manage. Less groups, I had to worry about on Friday when teachers would be going to be giving spelling tests. Just imagine giving eight multiple tests. At 10 minutes per test, that is a lot of time! (I; yeah) and so, it was all done. And then, because it was all done online, Spellingcity would report back the results to me and I can easily go back and see what kids did well, what kids I would need to go back and reteach the spelling patterns to or sit with, and then adjust their spelling words from there. Throughout the years I used the Words Their Way assessment and I do this pencil and paper in the classroom so, I... there is always the fear of doing something, I think, at home online. That they could easily have the words out in front of them and be just typing them in, and so I use the words their way assessment in class in order to help me monitor their spelling throughout the school year. So, I did not do spelling last year because we adopted a new program that was supposed to take care of spelling, but I will probably go back to it this year because I noticed, I am in a 3rd grade now, and I noticed that third graders still need, they still need practice with spelling patterns and phonics and what not. And so I think I will have the kids take the

assessments in class. But it is very nice for me to be able to put it all into the system; it takes maybe a half an hour to do, once you get into the hang of it and the roll of things. And then the kids go on, they love it, they are happy about it, and that is one less thing I have to grade and use.

I: Awesome. So what… can you describe a little bit about your students' access to technology? In and out of school?

P: Yeah. So, two or three years ago when I began this, about 50% of my students had a computer at home. And those students who didn't I always gave the option of staying after school to use a computer or to use a… go with me into the info lab, because I don't think we had Chromebooks yet. To go ahead and complete this assignment in the classroom. Or, I had a parent volunteer (my mother) she would come, and she would help, she would give spelling tests to the students who did not have access to a computer at home. And over… the district passed the measure E bond two years ago? It was... yeah, about two years ago. And with that came all of this great money for technology. So now about 1/3 of my students have access to a computer in the classroom at all times. As well as my grade level has a full cart of Chromebooks. We share as a grade level. So bringing spelling back in it is going to be much easier for me to use and control and there should not be any excuse for a child to not be able to take a computerized spelling test or work on their spelling assignments because I have it. They have computer access in the classroom. So, but two years ago it was a little bit tricky because I had a student computer and a teacher computer and a computer lab and that was it. And I did notice, and my parents noticed this as well… that there was a difference between kids who were... in attitudes between kids who were using the computer in the classroom to do this assignment and kids who were not and were getting the traditional paper and pencil lists. Their words were still differentiated, but the students using the computer and using the technology seemed more engaged and more excited about it and it seemed to be less of a fight. So I think by parent word, I had, as the school year progressed and towards the end of the year, I had more parents willing to drop their child off at 7:30 in the morning, or let them stay 15 or 20 minutes after school to complete their spelling practice. Because they were tired of trying to get them to… fighting with homework, so… (Laughing) I had a prediction this would happen, I wish you had listened to me… (As if to parent)… And then I also noticed with this program that at first I would assign students games. And then I said I want you to play this certain game, I want you to practice these, and I want you to do sentence writing and what not. But when I stopped… I have the option of just posting the words and the students have choice in what they want to do with their assignments for that week to help practice their words. They seem more motivated with choice. Unfortunately, I didn't discover that until towards the end of the school year that first year. So, the next year I just said, "you do whatever you want" and they really liked it. They were able to talk up the games they were like "I did this, I did that" they tried applications and what not, so it was just a fun little activity in the class and they really enjoyed coming in, or seemed to enjoy coming in talking about it. And their scores and whatnot.

I: That sounds awesome. Amazing. So, now the questions are more general because you actually answered most of the other questions… (P: Great!) So, in general now, how do you feel technology has affected your assessments of students or their work, like beyond the spelling aspect?

P: I think... I think it has had a positive impact. We've… last year the district has adopted a new benchmark assessment program called iReady so students take their benchmark tests, or they are called iReady diagnostics online three times a year. Every month they have a mini-test to monitor their progress. Then from there iReady assigns lessons based on the child's levels. It is supposed to help differentiate instruction. And I am not sure if you remember Children's Progress for primary? (I: yes) So, iReady seems to be more of what Children's Progress promised to be. That is, differentiated instruction. I am able to compare student data based on class average, based on grade level average, not just based on their differentiated levels. It's not perfect, it's not something like Khan Academy where I am able to physically go in and see exactly where the errors are, but my parents... uh sorry… I used iReady for homework last year. So I said "you are in charge of… you get one reading lesson and one math lesson done in the class, or during the week. And I gave them class time as part of our blended learning rotation to complete those lessons. So, I had several parents tell me that homework was really easy, they didn't have to fight their child about it, or were excited about it, and whatnot. There wasn't stress about homework in general; the kids were getting differentiated instruction based on their levels. And from their… I felt I saw growth using the iReady program. I have also used technology… and we just signed up for something called Sumdog, which is a math competition nationwide. The kids loved, loved that. They were practicing different math games and doing this and doing that, and making teams, and they really enjoyed to see how they… how X school compared regionally or nationally, or throughout the state. So that was really fun for them. I have also used technology to have the kids build their classroom websites. Last year we did a huge… we became paleontologists, we studied dinosaurs, the kids picked a dinosaur, or a topic around paleontology. SO maybe fossils or extinction and they… granted, this is third grade so I don't want you to think these were stellar reports or websites, but the kids… researched their information and wrote a multi-paragraph essay and from there turned that into a Google website. And they were so… and then we presented them at open house so the kids were so excited to bring their parents into the room and go through their website and whatnot. I did this when I… two years ago I taught a first-second grade combo and I did this about animals. And so a group of students would research a certain aspect of a particular animal I assigned and then, as a group, they created a page for their animal. And I still get share messages today; even though I have taken the site offline, or you know what, let's kind of close it… former students still want me to share their website with them so they can check it out. So that tells me that this is a very engaging project. If they are going back to it after two years, to show things off and whatnot, I think with both the animal website and then the paleontology website everyone was excited about it. They all wanted to create that website. Everyone wanted to participate, it's something they wanted to do, they wanted to share the information, they wanted to show off the websites, they really wanted to make them public, and they really valued that. I think overall technology has enhanced my classroom and my teaching experiencing and has made things more engaging for my kids. It's wonderful.

I: Great, that's awesome. So I have one last question and then I will ask if you want to add anything that wasn't covered in the interview. But the last question is, could you please describe how using technology to assess students has affected your understanding or beliefs about assessment, or how to assess students?

P: technology has shown me that there are more than one ways... I'm sorry; it has made me able to use different assessments to see if students are understanding the content. It's no longer a test or writing a paragraph or reading an English thing for certain words or comprehension instead, its… kids have more choice for how they want to demonstrate their learning to me. And I think that is very valuable as a teacher because some excel in multiple-choice tests I don't know… very few though… I'm one of them so I know how to take it… some do well in that, some like writing it, some students don't do well in either of those so now having this option of technology I have the students who in the past might have failed or not performed very well on an assessment or shown me on an assessment that they have very little knowledge about the task or the project are now able to excel and show their learning in multiple ways. They can build a website, they can do a PowerPoint, just the mere act of them typing a document and sharing it with me is phenomenal, and they are more willing and more ready to write and create because it is now on the computer as opposed to pencil and paper. , during those small points, or when we use it I have everyone's attention, so that's great, and they are going up and helping each other. I really think technology has really enhanced my education, my understanding of assessment. I really like that I am able to say this is what I need you to do, and then I will have several different students turn it in to me several different ways and I think technology really helps me do that.

I: Awesome. So, thank you for... those are all of the formal questions. Is there anything that we didn't cover that you would like to share about technology and assessment or just general thoughts?

P: Yeah, I personally feel that before any teacher does anything online with their students they should be taking some sort of digital citizenship classes or courses or training on how to use technology respectfully and responsibly. At the beginning of the school year, I do a lot with common sense media, teaching my students how to be respectful online and how to be safe online. Because once they are online... there is a lot… it is very easy to click on this or click on that and before you know it, it is asking for your credit card and blood type and… whatnot… and you are everywhere. And so I make sure, before I do any of this, I make sure my students have a healthy fear and a healthy respect for the Internet and what is online. Not to scare them, but just so that they know what is out there and so they know that when I say I need you to go to this website, they know why that one. Or I need them to go to the one I assigned as opposed to clicking on here, or following the little stars, or more, clicking on this little dog or… whatever. So that has been really helpful. Also, now all of our students in our district have Google for Education accounts and so they have a wide range of Google activities and applications that's all to them for free so I don't think I would be able to do any of this if my students had not had those accounts or if I had the technology, not the technology in my hands, right now. If I had one or two computers of course I would make it work, but it's so much easier now that I have, a third of my class can be on a Chromebook at one time. Or I have a class cart I can grab easily and then everyone is online so that has been really nice as well. Then I know Google for education has the survey apps and it has a lot of other ways that teachers can assess students and I just haven't dabbled with those yet. I am too new to 3rd grade to know what they need here, or what they don't need, or how to explain a survey to a kid online. So I'm still… I hope to use those also, but that might be another way for me to assess students I just need to play around with it more and make it comprehensible for them.

I: Awesome, I think that those are two very rich and very valid considerations that teachers should have as they are embarking on trying technology out. Not just to roll it out, but to ensure you're doing some digital citizenship work and also being aware of what technology can and can't do for you.

P: Yes, yes, oh, and I have also learned that it is very helpful to communicate and to have very clear communication with the parents. Why I am using technology as opposed to traditional pencil and paper, and share with my parents, and even show my parents the type of… how I go through the whole digital citizenship lessons and that whole unit before we even get on the computers, get our usernames or passwords, because some of my parents have been scared about allowing their child to just jump online and do all this stuff online. But once they see all the precautions that we take first and all the learning that happens first, they're more willing to allow their kid to be online, and the more trusting in me. So that has been really helpful.

I: thank you… etc.

P: If you ever want to come and do research in my classroom….

Participant 8:

I: Overview of the purpose of the research and the prep of selecting one lesson or unit… transcription and deletion information shared with the participant.

I: In thinking about a lesson or unit in which you have used technology to assess student learning, what grade level and maybe a little bit of context about the students or the school… what grade level were the students?

P: They are 6th through 8th grade and they are special ed. everyone has an IEP. It is reading comprehension to spelling to text reading, identifying words within letters to identify the sentence.

I: Okay, and what was one of the topics… what was one of the lessons that you used technology for?

P: Oooh, you one specific…um…?

I: Maybe, do you want to think of maybe one specific technology tool that you have utilized and kind of talk about that.. Um…

P: Well, we use computers to do their baseline and their end-of-the-year as well as several little mile markers through this particular program. So the students…so it was like the class stays ongoing, checking in with them and doing our assessments.

I: Ok, so was it primarily language oriented, it sounds like?

P: Completely language.

I: Okay. And um… gosh, because it is special ed., the next question is kind of difficult… the question is: describe the learning goals and objectives, but in this case, each student would have their own learning goals and objectives, correct?

P: Correct, but within their learning goals and objectives, It was mainly reading comprehension and fluency. Although, of course, we always want our kids to know phonics, some of our kids will never be able to sound out words because there are just too many possible combinations, so we try to also teach them just rote memorization of words so they would be able to read fluently.

3:39 I: Okay, so how did… how do you utilize this tool in the classroom?

P: Well, the tools, number one, the most important one, are it is a direct reflection on my lesson. So, depending on how the students assess, will completely alter my lesson planning and the direction that I am heading. For instance, if I thought that the students completely understood the soft vowels or short vowels… and then we did the fluency test and they didn't, then I would go back and reteach in a different way to help them to understand it as well as try to get them to memorize more of the words.

I: Okay. Excellent. And do they use the… do they do these assessments in the classroom? Or do they do them at home?

P: In the classroom, in a computer lab, but they also have access at home to go into the program and practice.

I: Okay. And what kind of… can you give me a little background on what the program is like? Like, games to play, or like…?

P: Yes. So there are games online, and there are things like Sortagories, where it gives them a blending and then it will have them build the word… they get points for everything that they do… they have goals of how many points they want to try to achieve, the skills continually get harder as they master them, there's vocab building, where there's a word… it says the word, it gives them a definition, there is a short story where they have to identify the right word and the right meaning… so there's a bunch of building, stepping stones to help the students throughout the program.

5:34

I: Excellent, and now do your… do you as the teacher have the ability in this program to select what words or what blends or what sounds… do you…

P: I can choose the students' levels to make sure that they are in the right ability of it. The actual components of the game I do not have control over. They can also go back and redo things So if I see they have missed one, I can have them go back and try again.

I: So then, the computer program gives you the results.

P: Yes.

I: Ok, awesome. Let me see… you have answered a lot of the questions that I have already. So, let's talk about things in general. How do you feel technology, because you have been a technology user for quite some time?

P: Yes.

I: How do you feel technology has effected your assessment of students or of their work, in a general manner?

P: It allows me to understand more of their abilities because the different barriers aren't there anymore. So, for example, especially because I am special ed., a lot of my students hate, and unfortunately, they use that word, firmly. I hate that word, but they do hate writing. It is a chore for them. But when you put them in front of a computer, that can fix their grammar, that can give them spelling ideas, and they can use the internet to help them find a word that they are looking for it is spectacular. To see what is inside of these students' heads. And it is stuck inside of their heads because they can't find a way out. The technology shows the true ability of these students if we would stop judging them on the small criteria and look at the bigger picture.

I: Excellent, and in general how has technology affected your teaching practice with assessing students?

P: I can't live without it. In my classroom I have a projector, a document camera, my own photocopier and printer So, as I am able to assess students through their own laptops that I am purchasing with my own classroom funds or DonorsChoose, or Adopt a Classroom, I am able to print off things for them to take home and show their parents, to close that communication gap. Students are emailing me their homework, so they're not losing papers in the midst. And I am able to use that to directly impact my lesson. They are getting the instruction that they need, when they need it without the uncertainty of what they actually know and what they are taking, they have taken. They are showing me their true selves and I am able to use that to directly change my lesson.

I: Awesome. And so my last question is has technology and using technology to assess students affected your understandings, perceptions, or beliefs about assessment?

P: Yes. I… What year was I in BTSA? I was not a fan of data-driven lessons. I wasn't a fan of it because I thought, me, as a bad test taker, I am not going to show you on a test what I can really do. And using the technology, giving the students an ability to show me what they know without the fumbling of a pencil or a paper… it's amazing how much more they can accomplish when I follow the data-driven assessment. I was not a fan of it what, 5 years ago, six years ago? I could not stand all the data we were going over… I thought, these kids aren't numbers, they are names... where are their names? And now their names are typed out for me with the students showing me their true abilities and it has completely changed my practices and beliefs.

I: Awesome. Wonderful. This has been a great interview, a short interview because you are very concise, but you have great things to say. Is there anything else you might want to say that we haven't covered in the interview?

P: I think, honestly, the biggest thing is, I know that it is change, and that everybody is scared of change, and it does take time to know. You have to know how to use these tools, more than as just a spell checker, but until you know what it can really do for you as a teacher you are going to continue to hold back your students and continue to judge them on Friday's spelling test rather than judge them on their true abilities as a student. And in the future as a professional. And it is our job to prepare them for real life. And real life is every aspect of technology.

I: Wonderful. I really wanted to thank you for doing this interview.