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Teachers and Technology Use in Secondary Science Classrooms: Investigating the Experiences of Middle School Science Teachers Implementing the Web-based Inquiry Science Environment (WISE)

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Teachers and Technology Use in Secondary Science Classrooms: Investigating the Experiences of Middle School Science Teachers Implementing the Web-based Inquiry Science Environment (WISE)

A dissertation submitted in partial satisfaction of the

requirements for the degree Doctor of Education

by

Rachel Corinne Schulz

2015

ABSTRACT OF THE DISSERTATION

Teachers and Technology Use in Secondary Science Classrooms: Investigating the Experiences of Middle School Science Teachers Implementing the Web-based Inquiry Science Environment (WISE)

By

Rachel Corinne Schulz
Doctor of Education
University of California, Los Angeles, 2015
Professor William Sandoval, Chair

This study investigated the intended teacher use of a technology-enhanced learning tool, Web-based Inquiry Science Environment (WISE), and the first experiences of teachers new to using it and untrained in its use. The purpose of the study was to learn more about the factors embedded into the design of the technology that enabled it or hindered it from being used as intended. The qualitative research design applied grounded theory methods. Using theoretical sampling and a constant comparative analysis, a document review of WISE website led to a model of intended teacher use. The experiences of four middle school science teachers as they enacted WISE for the first time were investigated through ethnographic field observations, surveys and interviews using thematic analysis to construct narratives of each teachers use. These narratives were compared to the model of intended teacher use of WISE. This study found two levels of intended teacher uses for WISE. A basic intended use involved having student running the project to completion while the teacher provides feedback and assesses student learning. A more optimal description of intended use involved the supplementing the core curriculum with WISE as well as enhancing the core scope and sequence of instruction and aligning assessment with the goals of instruction through WISE. Moreover, WISE projects were optimally intended to be facilitated through student-centered teaching practices and inquiry-based instruction in a collaborative learning environment. It is also optimally intended for these projects to be shared with other colleagues for feedback and iterative development towards improving the Knowledge Integration of students. Of the four teachers who participated in this study, only one demonstrated the use of WISE as intended in the most basic way. This teacher also demonstrated the use of WISE in a number of optimal ways. Teacher confusion with certain tools available within WISE suggests that there may be a way to develop the user experience through these touch points and help teachers learn how to use the technology as they are selecting and setting up a project run. Further research may study whether improving these touch points can improve the teachers' use of WISE as intended both basically and optimally. It may also study whether or not teacher in basic and optimal ways directly impact student learning results.

This dissertation of Rachel Corinne Schulz is approved.

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2015

Dedication Page

I dedicate this dissertation to my daughter, Sophia Lorraine, and my son, Titus Witton. Jon Kabat-Zinn wrote: "Acceptance offers (us) a way to navigate life's ups and downs- what Zorba the Greek called 'the full catastrophe'- with grace, a sense of humor, and perhaps some understanding of the big picture, what I like to think of as wisdom." In many ways, this dissertation represents a "full catastrophe" for me. There were *many* of life's ups and downs that occurred along the way, but in the midst of it all, I serendipitously gave birth to these two bright lights. Both of them have given me the grace, sense of humor, and necessary understanding of the big picture to complete this work. They literally are the wisdom of my life. Sophia's name means "*wise one*" in Greek. Titus's middle name is a derivative of an old English surname that means, "*to come from the wise one's house*." Given the impact these two have had on my journey, it seems not only fitting that I studied the Web-based Inquiry Science Environment (WISE) but also that this dissertation would be dedicated to them.

Sophia and Titus, may you find and follow your passions, accept all of life's ups and downs with grace, a sense of humor and some understanding of the big picture, and always know that you are loved unconditionally.

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First and foremost, I have to thank my chair, Dr. William Sandoval for helping me to persevere through each and every obstacle that stood in my way. I also want to thank my committee for helping me simplify my research and making me feel capable of getting it done. Additionally, I want to thank my parents, Bob and Linda Smith, who moved heaven and hell to support me. It came with personal sacrifices for them, but it allowed me to have my second child and cross the finish line. Alongside them, I want to thank every childcare provider that endured my crazy schedule and absorbed my stress while keeping the kids safe and sound, especially Cady Haskell and Kathrin Fomenko. These two young women were brought into my life exactly when I needed them, and they gave me the peace of mind to focus on what I needed to do. There is also a long list of dear friends who cheered me on every step of the way. They each know who they are and I am forever in their debt. Forever.

Special thanks I give Dr. Michael Wray, Tim Schulz, and my children, Sophia and Titus. Dr. Wray sat me down three years ago and encouraged me to keep going when I was thinking about quitting. He offered the right advice at the right time all throughout this process. I am so thankful he did. Tim Schulz embarked on this journey with me six years ago, and it took us both through some of the biggest changes and most difficult times of we have ever had in our lives. While it has been rough, I am so thankful for the two beautiful children we had together along the way and the love that created them. As for my children, Sophia and Titus, they both gave me the wisdom and purpose to finish. They came along at the perfect times, more perfect than I could have planned, and the completion of this work would not mean the same without them. Even though I have no idea where it will take me next, I know it was meant to be. Thank you all.

VITA

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CHAPTER 1

Statement of the Problem

In the United States, most students can demonstrate only a partial mastery of the knowledge and skills that are fundamental for proficiency in secondary science. According to the most recent Nation's Report Card, only 30% of our eighth graders and 21% of our twelfth graders demonstrated competency (National Center for Education Statistics, 2012). A review of empirical studies on technology integration in science demonstrates how the use of Information and Communication Technology (ICT)-based resources in science can positively improve student outcomes and lead to greater learning gains (Chiu, Chen, & Linn, 2013; Hays, 2005; Lee, Linn, Varma, & Liu, 2010; Papastergiou, 2009; Taylor, Casto, & Walls, 2007). The most positive learning gains have been associated with ICT-based resources involving Technology-Enhanced Learning (TEL), like the Web-based Inquiry Science Environment (WISE), which are designed to promote inquiry, collaboration, and knowledge integration (Campbell, Wang, Hsu, Duffy, & Wolf, 2010; Novak & Krajcik, 2004; Raes, Schellens, & De Wever, 2013). WISE, in particular, has repeatedly demonstrated its ability to help students comprehend hard to grasp concepts in science (Chiu et al., 2013; Kim, Hannafin, & Bryan, 2007; Williams, DeBarger, Montgomery, Zhou, & Tate, 2012). Using a Knowledge Integration pattern and design, WISE is built upon the idea that the key to deeper student understanding in science is not the technology itself. Rather, it is the design of the technology for student learning (Linn & Eylon, 2011b).

For the last twenty years, science teachers have been pressed to gain competencies in the planning and operation of technologies best suited for their subject matter. In 1996, the National Science Educations Standards (NSES) coupled the study of *inquiry* (an objective of science learning) with the study of *design* (an objective of technology learning) into one criterion for student mastery (National Research Council, 1996). It continued through the development of National Educational Technology Standards for Students (NETS-S) in 1998 by the International Society for Technology in Education (ISTE) (Thomas & Knezek, 2008). On the basis of these standards and the constructivist theory of learning, ISTE (2000) then developed a corresponding set of teacher standards and performance indicators called NETS-T so that teachers would be able to foster the development of information literacy in their students (Law, 2010; Morphew, 2012; Thomas & Knezek, 2008). Over the last decade, several policy briefings have called for tech-savvy teachers and classrooms in science courses (Alliance for Education 2011; American Association of University Women2000). Currently, the Next Generation Science Standards (NGSS) require an infusion of ICT-based resources in science courses in addition to the learning about technology's relationship with science (National Research Council, 2013).

However, effective uses of technology have not found their way into widespread classroom use in science (Fishman, Marx, Blumenfeld, Krajcik, & Soloway, 2004). Survey data from 1998 revealed that teachers who effectively use any ICT-based resource in the United States were rare and even more rare in science (Becker, 2000b; Becker & Anderson, 1998). In the most recent comparable survey, only 34% of teachers reported using ICT-based resources frequently, and of them, more than half reported that they had students use computers to practice basic skills (Gray, Thomas, & Lewis, 2010).

Through their investigations into why the basic teacher use of technology is low and largely ineffective, researchers have identified a number of barriers that teachers face when adopting technology (Becker & Ravitz, 2001; Cuban, 1986; Ertmer, 1999). The three most common and pervasive barriers are a teacher's access to technology, beliefs about student learning and technology use, and exposure and competency in technologies designed for student learning (Ertmer, 1999). Other barriers include the pedagogical practices of the subject matter and environmental factors found in the school context (Ertmer, 1999; Hew & Brush, 2007). This research is predicated on the belief that if schools address these barriers more teachers will use technology for student learning. While there is evidence that eliminating one or more of these barriers is, indeed, enabling (Becker, Ravitz, & Wong, 2000), eliminating barriers is not predictive of use (Becker & Ravitz, 2001; Cuban, Kirkpatrick, & Peck, 2001; Ertmer, 2005).

Need for This Study

Presently, there is a need to know more about what factors improve and predict the effective teacher use of technology designed for student learning. Much of the designed-based research, which governs the development of technology enhanced learning tools, consists of case studies about teachers using technology, examples of best practices, and student learning outcomes derived from the implementations of specific technology tools (Bagley, Rice, & Wilson, 2001; Bell et al., 2007; Lee et al., 2010; Mishra & Koehler, 2006). This body of research does not specifically address the similarities or differences between the ways in which designers intended the technology to be used by teachers and the actual use by teachers in the classroom for the purposes of student learning.

Several studies have identified the mismatch between intended use of a technology designed for student learning and the actual use by teachers as a problem that needs to be further investigated (Hmelo-Silver, Duncan, & Chinn, 2007; Jimoyiannis, 2010; Kirschner, Sweller, & Clark, 2006; Mama & Hennessy, 2013). Findings from these studies are often framed in terms of "fitness" or the way in which the technology, curriculum, and teacher work together. Fishman et al. (2004) argue that in order to understand the real limitations involved in the teacher use of technology for student learning, research needs to investigate technology's usability, scalability, and sustainability. Therefore, they developed the "usability cube" as a framework to gauge the fit of technology to the capacity of the school culture, capabilities, and policies. Understanding more about these dimensions of technology use can help researchers and developers of technology-enhanced learning tools learn more about what factors improve and predict teachers' use and what factors ultimately lead to more effective uses. This information in turn can support the design and development of technology-enhanced learning tools for applications in science classrooms that are frequently and consistently enacted by teachers.

Purpose of This Study

Given the need to know more about the gap between innovation and adoption in the use of technology designed for student learning, there was a two-fold purpose for this study. The first was to learn more about the intended use of a specific technology-enhanced learning tool and the second was to explore whether or not teachers used that tool as intended and why. Through analyzing and comparing these two paradigms, I sought to learn about what influences the use of technology designed for student learning. I investigated the documents related to the design and development of WISE, and the experiences of four middle school science teachers as they enacted the Web-based Inquiry Science Environment (WISE) for the first time in their classroom instruction. Through a qualitative research design, this study sought answers to the following research questions:

1. What is the intended teacher use of WISE?

2. What influences whether or not secondary science teachers new to using WISE and untrained in its use, enact it in the classroom as intended?

Research Design and Methods Overview

This study was exploratory in nature and therefore, necessitated a qualitative design. The data collection and analysis were both inductive and emergent. Data were collected in two parts. The first part involved a document review of the WISE4 website and hyperlinks to additional websites and documents related to the intended teacher use of WISE. The document review was conducted using theoretical sampling method. The second part of this study involved ethnographic narrative field observations of each participant's enactment of WISE project in their classroom. Observations focused on critical features and intended uses of WISE. In addition to observations, participants completed a pre-enactment survey, a daily use survey, and project-end survey distributed through Survey Monkey. These surveys captured the teacher's daily use of WISE features during the project's enactment. Lastly, participants engaged in 20-minute semi-structured interviews after the project was completed to discuss their experience with using WISE.

Data Analysis

Constructing meaning is a central characteristic in qualitative research (Merriam, 2009), and by acting as a guide in that process, I provide the study's interpretive construct. Data analysis took place concurrently with the data collection of each source. For the document review, I used the constant comparative method of a data analysis to determine the similarities and differences between the segments of data and group them into categories (Merriam, 2009). I identified patterns in the data that described the basic teacher use of WISE and the optimal teacher use of WISE during three Phases of implementation: Pre-enactment, Enactment, and Post-enactment. I also identified a pattern in the data that described the teacher's role in the classroom and use of teacher tools built into WISE. In the interpretation of these patterns, I developed a model of intended teacher use. For the second part of the study, I used thematic analysis to review the artifacts collected through the observations, surveys, and interviews of each teacher participant (Braun & Clarke, 2006). I engaged in an initial coding process using categories from the theory of intended use as themes for coding purpose. From the interpretation of these themes, I constructed a narrative of each teacher's of WISE. Using the constant comparative analysis again, I examined the similarities and differences between the theory of intended teacher use and the coordinating evidence in each teacher's narrative. The final discussion led to the theoretical construct of improving teacher use of TEL tools.

Technology Selection

WISE is a free, open-source, customizable digital learning platform offered through the University of California, Berkley and sponsored by the National Science Foundation. It offers many research-based, positive student-learning outcomes for students in secondary science classes. Students use computers collaboratively, usually in teams of two, to complete WISE modules. Teachers can evaluate and guide their learning through a suite of online tools and modify/design their own modules. I selected WISE because of its on-going research and development over the last twelve years. It has been studied internally at the University of California, Berkeley and externally by outside researchers and both parties have found that the built-in Knowledge Integration pattern allows for greater student outcomes (Chiu et al., 2013;

Chiu & Linn, 2011; Papastergiou, 2009; Raes et al., 2013). Collaborative teams of teachers, researchers, subject matter experts and developers continually work together to develop and expand the learning modules. WISE is also adaptive. It can be modified or designed to reflect aspects of the core curriculum or standards the teacher is focusing on or to meet the particular needs of the students in the teachers classroom.

Participant Selection

To specifically answer the second research question, I recruited four middle school science teachers using the referral method. I created a website through which potential participants could learn about the study and sign up as a participant. I began by contacting educators through alumni networks at various universities who would like to participate or refer me to someone who may like to participate in the study. I sent emails, posted on forums, and used social networks. Participation was primarily contingent upon availability and access to technology. If the site was able to support the implementation of WISE, then the only other considerations involved the teacher's status as a new user and verification that they teacher had not been previously involved in any research related to WISE out of the University of California, Berkeley. Participants were then asked them to register to use WISE and find one project to use.

WISE currently maintains approximately 10,000 teacher accounts worldwide. Of those accounts, middle school science teachers make up the largest segment. Last year, there were approximately 3,000 teachers accounts created in WISE. Within these new accounts, WISE administrators saw a trend of two or more new users sign up from the same school and/or district around the same time (D. Kirkpatrick, personal communication, August 10, 2014). Therefore, I primarily sought to recruit middle school science teachers and sought to find at least two participants from the same school. Of the four participants involved in this study, two middle school teachers came from a public middle school and two middle school teachers came from a charter middle school.

Summary of Findings

In sum, I found two levels of intended teacher uses of WISE. A basic intended use of WISE involved having student running the project to completion while the teacher provides feedback and assesses student learning. More optimal intended uses involved having the teacher use WISE to supplement the core curriculum and while using WISE enhance the core scope and sequence of instruction, and aligning assessment with the goals of instruction. I also found that WISE projects are intended to be facilitated through student-centered teaching practices and inquiry-based instruction in a collaborative learning environment. It is also intended that teachers would share the projects and lesson designs with other colleagues for feedback and iterative development towards improving the Knowledge Integration of students. Each of the four teachers who participated in this study reflected some intended use of WISE during their enactment in the classroom for the first time, but only one used the program with the most intended uses.

Significance of Research

The user experience from the point of view of the teacher is not often a subject of research. Many studies posit that professional development is needed to bridge the gap in technology use, but this study suggests that further research is needed to see if the technology itself may be designed to eliminate the need for extensive professional development. From the experience of one teacher, this study finds that it is possible to use WISE basically as intended from the first enactment. However, the use of WISE may not be sustainable in that capacity. The teacher using WISE accordingly, reported that she would likely never use it again. Additionally, all the participants expressed confusion with the tools available within WISE. Developing the user experience in response to areas of confusion could improve the intended use of them. With the evidence gathered through this study, WISE may further develop the way in which teachers select and set up a project run to efficiently support teachers in implementing WISE optimally. Further research may study whether improving key touch points within the teacher portal on WISE may correlate with student learning results.

CHAPTER 2

Literature Review

This research examines the science teacher's use of *Information and Communication Technologies (ICTs)*, more specifically, Technology-Enhance Learning (TEL) tools. Over the last twenty years, many studies have identified the learning outcomes that come from the design, development, and use of TEL tools in science. However, the use of technology in general is sparse and even more so in the subject of science (Becker, 2000a). Several studies have identified many reasons why teachers rarely the use ICT-based resources for greater student learning (Bauer & Kenton, 2005; Becker, 2001; Cuban, 1986; Ertmer, 1999, 2005; Ertmer & Ottenbreit-Leftwich, 2010; Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012; Hall, 2010; Hew & Brush, 2007; Judge & O'Bannon, 2007; Shamburg, 2004; Williams et al., 2012). Taking the reasons into account, current research seeks to understand more fully the interactions between the technology, teacher, and student that occur when TEL tools are implemented in order to design tools that are useable and effective (Fishman et al., 2004). Therefore, this review of the literature illuminates what is already known about how students can learn with technology in science. It also discusses the design of TEL tools and the different roles teachers play in the enactment of these tools that make for the effective use of them. Overall, this review of literature will highlight an *innovation-to-adoption* gap and the need to know more about the usability of TEL tools by teachers.

According to the National Science Foundation (NSF), ICT is the marriage of telecommunication, video, and computing technologies (1998). Examples include hardware such as computers, laptops, mobile devices, printers, projectors as well as the corresponding software and applications. It also refers to connectivity and access to the Internet and Internet applications. Under the umbrella of ICT-based resources are TEL tools. TEL tools encompass a wide range of efficient educational environments and applications currently available for use in science education, such as the Web-based Inquiry Science Environment (WISE). Other examples include simulation and modeling tools, microcomputer-based labs, web-resources and environments, spreadsheets and databases (Jimoyiannis, 2010). To this end, I specifically discuss WISE, what is known about it, and what needs to be known about the teacher use of it for student learning.

Barriers To Technology Integration

Two seminal surveys frame what is known about the low use of ICT-based resources like TELs in science: the "Teacher, Learning, Computer (TLC) Survey" (Becker, 1998) and the "The Teacher's Use of Educational Technology in U.S. Public Schools" (Gray et al., 2010). These surveys conducted twelve years apart from one another find that the use of technology for student learning is rare across the United States in all subject areas. There are many barriers to technology integration (Ertmer, 1999; Hew & Brush, 2007), and in the findings from the second survey, *Teacher's Use*, it is clear that in spite of efforts to address these barriers over the years, the use of ICT-based resources for student learning has only marginally improved (Gray et al., 2010).

Lack of Teacher Use in Science

The TLC survey was the one of the first large-scale studies of its kind to provide concrete data on the teacher's use of technology, best practices, and teaching philosophies (Becker & Anderson, 1998). The survey collected data from 4, 083 teachers, grades 4-12 across the nation

(Becker, 2001). From this sample of teachers, 516 of them were identified as *computer-using* teachers. These teachers subsequently completed U.S. subject specific questionnaires or telephone interviews. From the selection of 516 computer-using teachers, 45 math, science, English and elementary school teachers were then identified as exemplary, computer-using teacher (11 math teachers, 9 science teachers, 13 English Teachers, and 12 elementary teachers). The findings are based on self-reported data from the teachers. Taken altogether, this data tells us that the proportion of exemplary computer-using teachers in the U.S in 1998 was between 3-5%, and in science, the exemplary description of teachers represents less than .5% (Becker et al., 2000).

How Exemplary Users Differ from Typical User

Becker (2000b) identified exemplary teachers through their responses to five areas of technology use: 1) the goals they had for computer use, 2) the general function of computers in the classroom, 3) the saliency of the teachers approach to using technology for the major learning activities in class, 4) the types of experiences students had with specific kinds of software, and 5) the frequency of student computer use. Therefore, exemplary teachers were those who, for the most part, had students engaged in software and technology two-three times per week or intensively for certain units of instruction in ways that specifically enhanced the students' ability to understand the concept being taught. The specific ways in which the use of technology could enhance student learning varied by subject, but in general, the exemplary use was defined by the strength of its connection to the learning goals. It was not defined by activities involving rewarding students for completing other work, practicing basic skills, or enrichment.

Becker (2000b) also investigated exemplary teacher use by comparing it to typical teacher use. The report of findings uncovered several factors in the teacher's work environment, teaching practices, personal background, and experiences working with computers that could predict the "exemplariness" of teacher use. In the work environment, the existence of a social network of computer-using teachers at the same school, alongside the provision of resources to support technology use and organized professional development activities played a significant role in the sustained student use of computers for "consequential" activities. Becker (2000b) defined consequential activities as computer activities wherein the student was using technology to achieve a learning goal such as using the computer for writing an essay, rather than writing an essay to practice keyboard skills.

The report of findings also revealed that exemplary computer-using teachers were able to downgrade the importance of some curriculum content in exchange for computer activities that could enable more in-depth concentration on other content (Becker, 2000b). These teachers also emphasized small-group work and student choice with regards to using ICT-based resources to complete learning goals, and had ability to individualize and tailor student work through "computer-based integrated learning system or other method for automatically sequencing students through a series of software exercises " (p. 289). Ultimately, the purpose behind comparatively analyzing the typical teacher use of computers with exemplary teacher use, Becker (2000b) sought to identify interventions that could expand the practices of the best teachers to others and ultimately improve the frequency and effectiveness of teacher use.

Barriers

In examining why technology use is low, many researchers have identified barriers over the years, Ertmer (1999) organized these barriers into two orders: external and internal. The first order barriers are institutional barriers mostly related to access, resources, and support. The second order includes the more fundamental/personal barriers such as teacher's ICT competency and beliefs. While several more recent studies draw similar conclusions, a teacher's *access*, *competency*, and *beliefs* prove to be reoccurring impediments (Funkhouser & Mouza, 2012; Hew & Brush, 2007) with teacher *beliefs* acting as the primary cog in the wheel (Bauer & Kenton, 2005; Belland, 2009; Ertmer, 2005; Ertmer et al., 2012; Funkhouser & Mouza, 2012; Hew & Brush, 2007). In a more recent review, Hew and Brush (2007) examine 48 studies on barriers and found evidence that in addition to *access*, *competency*, and *beliefs*, the *impact of the institution* and the *subject culture* influence technology integration. Much has been studied about the first three barriers, but last two barriers have much less press in design-based research.

In urban environments, one study found that "curricular and administrative demands" were among the top four barriers to integrating technology (Shamburg, 2004). Another study found that as a result of many "constraints" (i.e. large class sizes, inadequate prep time, lower levels of training, inadequate classroom space, and outdated materials/technologies/resources) urban educators tend to emphasize a directive, controlling style of teaching (Songer, Lee, & Kam, 2002). This type of teaching aligns itself with "pedagogy of poverty" (Haberman, 1991) rather than the knowledge integration and inquiry-based learning pedagogies aligned with the subject of science (Linn, Slotta, & Baumgartner, 2000) and the constructivist pedagogy aligned with technology integration (Morphew, 2012).

Specifically, in science, a recent empirical review of research on scientific literacy Roberts (2007) identifies two visions for scientific literacy operating side by side to one another. The first vision, which traditional science teachers typically embrace, defines scientific literacy by looking at the tenets of natural science. The second vision, which *nouveau* science teachers typically embrace, defines scientific literacy through real scientific situations that the student may face or are facing in their lifetime. These visions according to Roberts (2007) are waging war with each other in the classroom. The contrast between them is summarized and further illustrated by Christensen and Fensham (2012). The traditional viewpoint observes science education in discrete disciplinary strands where technology is used for motivational purposes only. Knowledge is firmly established and learning involves the replication of static knowledge that lead to one single correct answer. Ultimately, scientific reasoning does not include risk and probability. By contrast, the *nouveau* viewpoint observes science education as interdisciplinary. Technology is both a tool and an objective of science learning. Knowledge is uncertain. Learning involves the testing of possibilities and probabilities, not a single correct answer, and risk is necessary to acquiring scientific reasoning. In sum, these varying viewpoints elucidate the complex paradigm shift that technology introduces for science teachers holding the traditional viewpoint (Christensen & Fensham, 2012). Most science teachers have been conditioned with the traditional viewpoint (National Science Teachers Association, 2013).

The findings from a report on the TLC survey highlighted some salient facts about the philosophical approach of science teachers that are important to the discussion here. The first of which is that science teachers in the late 90's were pretty evenly split between the constructivist approach to teaching science and the traditional approach. Forty-five percent of the science teachers surveyed indicated they believe that students gain more knowledge through constructivist practices and 32% indicated that students gain more knowledge through the traditional practices. Additionally, 37% saw their role in the classroom as facilitators while 32 saw their role as explainers (Ravitz, Becker, & Wong, 2000). More recently, in a literature review on science teacher's beliefs and practices, it was noted that found that a majority of science teachers hold a mix of constructivist and traditional approaches and practices (Mansour, 2009). He also found that the inquiry-oriented and constructivist teaching approach appeared to conflict with more the traditional beliefs about the nature of science and some aspects of science teaching and learning (Mansour, 2009). For example, within the constructivist view, science needs to be relevant to students' lives but in traditional science classes, students seldom see anything that they study as having relevance (p. 28).

These points may explain why in a comparison study between teachers who used technology and teachers who did not, (Akcay & Yager, 2010) found that in some cases the use of technology did not have any more impact on student learning outcomes than direct instruction. However, there was a difference in student outcomes when technology use was not the dependent variable. Teachers who employed a constructivist pedagogical approach had greater gains in student learning outcomes then those that did not. Since teachers tend to fall back on what they know when faced with something new (Belland, 2009), the use of technology often stays *mechanical* and *traditional*. It is difficult for teachers to progress in their development when they do not know the intended use of technology for student learning and do not have models of what they are supposed to be doing with technology to impact student learning (Kim et al., 2007).

Present Status of Teacher Use in Science

In the most recent comparable survey data about the teacher use of technology, it is again evident that while teacher use has improved, it is still not widespread. The National Center for Educational Statistics submits an annual report to the Office of Educational Technology under the purview of the U.S. Department of Education. The report, entitled "The Teacher's Use of

Educational Technology in U.S. Public Schools," provides data on the availability and use of educational technology (Gray et al., 2010). Prior to 2008, the survey focused on Internet access and use, as well as procedures to prevent students from accessing inappropriate material on the Internet and teacher professional development on technology use. In 2008, the survey was redesigned to focus on availability and use for a range of technology devices. In the 2010 survey data, researchers found that only 34% of math, computer science and science teachers combined used ICT-based resources frequently or had their students use them in spite of the fact that 92% of them reported having access to computers with Internet access in their classroom every day. Out of the few teachers using ICTs frequently, 56% reported that they have students use computers to practice basic skills (Gray et al., 2010).

There is an assumption that by addressing these barriers more teachers will use technology for student learning. While there is evidence that eliminating one or more of these barriers is indeed enabling, it is not, however, predictive of use (Becker, 2001; Cuban et al., 2001; Ertmer, 2005). As stated earlier, Becker et al. (2000) found if teachers had sufficient resources in their classroom, student-centered instructional practices, and a reasonable level of experience and skill in using computers, that they were more likely to have students using computers frequently. However, Cuban et al. (2001) found that abundant access to technology in the heart of Silicon Valley did not lead to the use it more frequently or more effectively. Ertmer (2005) echoes this sentiment indicating that even with all the conditions in place for technology integration high quality technology integration, there would still be other factors that present themselves. Overall, until sustaining technology is no longer a problem schools face, there will always be barriers to implementing technology-enhanced units (Linn & Eylon, 2011b).

Student Learning with TEL Tools in Science

Many studies focus on the teacher as the catalyst for change rather than looking at how technology can better designed for teacher use and student learning. For more than 20 years, questions about the world introduced through scientific research have often driven the development of technological products just as questions introduced by technological products have often driven scientific research. The reciprocal relationships between science and technology have stimulated research that rethinks science instruction. Advancements in personal computers, tablets, and mobile devices have enabled more students to learn with technology in science courses in recent years (Linn, 2003). Many policy makers, educators, and researchers advocate for the use of ICT-based resources after finding that it provides opportunities for active learning (Lee et al., 2010), births creativity (Bagley et al., 2001), enables students to perform at higher cognitive levels (Chiu et al., 2013), and promotes inquiry and conceptual change (Jimoyiannis, 2010).

While it is possible to have meaningful inquiry learning with or without technology, it is the use of *appropriate technologies* - technologies that fit with the curriculum and contribute to the student learning of required instruction - which bring about the most significant results. In a study of elementary and secondary schools, (Taylor et al., 2007) found that students had significantly greater pretest to post-test gains when the target subject matter was integrated with the *appropriate technologies* than when the same subject matter was not integrated with technologies. Likewise, in a two-year study comparing a teacher's typical instruction with instruction using WISE, (Lee et al., 2010) found that students were more likely to develop an integrated understanding of complex science topics from the inquiry units. This result is notable because the inquiry units were only five class periods long and their impact was measured at the end of the year, not immediately after enactment.

Development and Design of TEL tools

There are two technology trends that have informed the development and design of *appropriate technologies* for student learning: tailoring tools and customizing applications (Linn, 2003). Programming languages, calculators, graphic programs, modeling software spreadsheets, and word processors are examples of generic tools that becoming more and more tailored to specific uses so that users can spend less time programming the tool to do certain tasks. Tailored tools designed for specific uses become applications. Spreadsheets, for instance, serve as the platform for grading, attendance tracking, and reference library software in the field of education. In science, *Learning Environments* have emerged as applications containing coherent curriculum and a suite of tools to support teachers and students in learning, instruction, and assessment. (Bell et al., 2007). These are also referred to in literature as TEL tools. Given the wide range of textbooks, differences in standards state by state, and other variances, these *learning environments* are not entirely useful unless they can also be customized to the users' needs. In research, the customization of technology applications has led to "compelling comparisons" which provide the foundation for design-based research (Linn, 2003). In science specifically, textbooks as a source for curriculum, standards as the measure for identifying salient topics, and lectures as vehicle for transmitting information are the starting points for developing, designing and refining TEL tools, which both contribute to student learning and are usable by teachers. Other factors such as how the technology can incorporate student collaboration, models, simulations, visualizations, data collection and representation, and assessments are extensions of the development and design of TEL tools.

WISE

WISE is a free, open-source, fully customizable web-based platform for building coherent curriculum, enacting pre-made projects, and assessing learning. It is an example of a TEL tool and an *appropriate technology* developed and designed specifically for student learning in science. Students use computers with Internet access to collaboratively complete WISE projects through the web-based platform. Using a partnership design progress for curriculum development, WISE enables teachers to respond creatively to state standards, prior student experiences, student work, time commitments, and other available resources.

There is much already known about the way in which the WISE design impacts student learning. For example, a case study investigated one teacher's use of WISE over the course of two years (Williams & Linn, 2002). The design partnership in this study was comprised of classroom teachers, science education researchers, technology specialists, a NASA scientist, and other scientists at the University of Texas. They developed and designed a WISE project for enactment. The teacher who implemented the project in her fifth grade classroom was also part of the design team and re-design process that followed after she enacted WISE in her classroom the first year. The results indicate strongly that in the first year, the curriculum in the WISE project was successful in promoting knowledge integration among her students and in the second year, the results were replicated with students being able to display a deeper understanding of complex science topics than in the first year (Williams & Linn, 2002).

In addition, TEL tools like the Web-Based Inquiry Science Environment (WISE) offer many advantages to students who are typically underachieving. In a study of 19 secondary science classrooms enacting WISE, researchers found that low achieving students benefitted significantly from making their thinking visible and the open discussions in small groups (Raes et al., 2013). They also benefitted from the control WISE gave them over their own learning. This particular study lacked a control group but the implications suggest a further research into the way in which teacher's use technologies designed for student learning.

Knowledge Integration

Student learning with WISE is supported by thoughtful investigations of driving questions and collaborative construction of science knowledge through the Knowledge Integration framework (Kim et al., 2007). The key idea in the Knowledge Integration framework is that deeper learning in science requires student to integrate their ideas from multiple points of view. WISE also provides student with opportunities to collaborate (Meluso, Zheng, Spires, & Lester, 2012), integrate their own knowledge (Linn & Eylon, 2011b), and dynamically learn (Papastergiou, 2009). The Knowledge Integration framework specifically impacts student learning outcomes through the metacognitive scaffolds built into the projects (Chiu et al., 2013). An early study on WISE observed students' ability to monitor and regulate their thinking and learning processes during inquiry activities. The study found that WISE helps students revise misconceptions by providing metacognitive supports such as inquiry maps, hints on inquiry questions, and evidence pages with relevant scientific examples (Linn, 2003).

However, an empirical review of technology-enhanced inquiry tools found that metacognitive scaffolds built into tools like WISE can be used in substantially different ways, resulting in students developing partial understanding or no understanding at all (Kim et al., 2007). Among the possible reasons cited for this difference in outcomes were: 1) the role the teachers played in the classroom and 2) the way in which teachers interacted with students during the module.

Role of the Teacher

In inquiry and design practices with technology, the role of a science teacher can take on many forms. In a case study that examined the beliefs and practices of a high school biology teacher who successfully developed and sustained an inquiry-based classroom, Crawford (2000) identified ten roles this teacher played: 1) motivator; 2) diagnostician; 3) guide; 4) innovator; 5) experimenter; 6) researcher; 7) modeler; 8) mentor; 9) collaborator; and 10) learner. Similarly, in an analysis of eight teachers employing four different ICT-based resources including WISE, researchers found that for successful implementation to take place, the teacher has to envision the lesson, enable collaboration, encourage students, ensure learning, and evaluate achievement (Urhahne, Schanze, Bell, Mansfield, & Holmes, 2010). This kind of teaching clearly demands a great deal more from a teacher than traditional approaches, there is often little guidance as to the teacher facilitation of student-centered inquiry in technology-rich classrooms (Kim et al., 2007).

Many studies posit that the answer this problem is through professional development, but the technology itself, may be better designed for teacher use. For example, Varma, Husic, and Linn (2008) expressed that the purpose of their research around the development and use of TEL tools was to increase the number and diversity of teachers and students using high-quality technology-enhanced inquiry through a professional development program that enhanced the teachers' understanding of technology, science teaching, and student learning. The participants in their study included 16 principals, 42 teachers and 5,000 students. In the study design, they used a targeted approach to professional development. Teachers were able to determine the type and amount of support they needed. Prior to enactment, these issues were more focused on the logistics of preparing the technology. With these issues resolved, during enactment, teachers focused on instruction and requested help with enhancing their inquiry teaching strategies, and some even requested support for customizing projects. These findings specifically suggested the opportunity to build into the design of WISE additional supports for teachers that enable them to learn to use it.

Further, Gerard, Varma, Corliss, and Linn (2011) explored how professional development modeled after the Knowledge Integration teaching pattern helps support teacher adoption and use of WISE. The Knowledge Integration teacher pattern begins with posing a problem, eliciting ideas about the problem, adding to those ideas through experimentation, distinguishing those ideas through explanation and collaboration, and then reflecting upon the conclusions drawn. The Knowledge Integration pattern also involves repeating the process until the ideas are coherent. The findings from this study indicate that teachers engaged in such a professional development program for one year or more improved students' inquiry learning experiences in K-12 science classrooms. Teachers participating one year or less encountered common technical and instructional obstacles related to enactment of technology-enhanced learning projects that ultimately hindered success (Gerard et al., 2011). Again, in the discussion of findings, the design of the TEL tool raises the question of teacher use and whether or not with extended experience using WISE teachers could learn to adapt WISE on their own without professional development. The adaptation would mostly likely fit with the teachers existing teaching methods, which is often more direction instruction. It is unknown whether that factor impacts student learning.

Likewise, Gerard, Spitulnik, and Linn (2010) conducted a three-year study of three middle school teachers enacting WISE projects in their classrooms. Using teacher-teacher professional development that featured evidence-based customizations of technology-enhanced curriculum projects, this study found that the use of appropriate technologies could change teacher practice when combined with assessment of student learning and professional development. They also found that student learning across the three cohorts within each year of the student improved significantly as a result. These findings further support the alignment of professional development, curriculum, and assessment using the Knowledge Integration framework. They also suggest exploring the criteria teachers use to design and evaluate teaching and learning in further research. This is largely because understanding how teachers use technology outside of prescribed research methods is indicative of the technologies widespread scalability.

Another study suggests that the design and use of TEL tools like WISE can shift teacher practice over time, but again, the shift did not happen on its own. This study follows the experiences of a fifth grade teacher over three years as he learned to integrate WISE into his core science instruction (Williams, 2008). While the teacher's use of WISE was not necessarily prescribed, the teacher did benefit from several professional development workshops over the course of the three years. The topics of the workshops included core science content in the WISE curriculum, teacher reflections on prior experiences enacting WISE, customizing projects, and lesson planning.

It is also evident from these studies that students benefitted from the teacher's use of WISE regardless of their skill in inquiry teaching strategies, experience with WISE, and understanding of Knowledge Integration. On one hand, taken together, these studies indicate that the use of WISE should be accompanied by well-crafted, long-term professional development or it is unlikely they will operate as intended for student learning (Gerard et al., 2010; Gerard et al., 2011; Williams, 2008). On the other hand, these studies also suggest that TEL tools may not need such intensive support in order to be enacted as intended for student learning. Through the Knowledge Integration framework and the partnership design process, WISE projects are packaged for use in classrooms that contain computers, an Internet connection and a Web-browser (Linn, 2003). With these facts in evidence, theoretically, WISE and technologies like it have the potential to bridge the barrier between the researched development and design of TEL tools and their adoption into science classrooms (Linn, 2003). The two questions that need to be answered are involved identifying the intended teacher uses of TEL tools and then whether or not teachers untrained in their enactment can, in fact, use them outside the prescribed research methods.

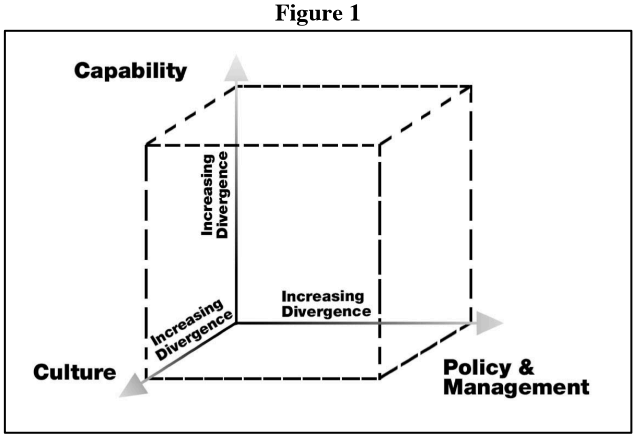
Research to Practice Gap

Researchers have acknowledged an *innovation to adoption gap* (Fishman et al., 2004; Linn & Slotta, 2000). As previously discussed, research around technology integration has extensively studied student-learning outcomes that come from the use of TEL tools and the reasons why technology use is low. However, there is much that we still do not understand about the teacher use of TEL tools in individual subject matter settings. Fishman et. al. (2004) called for the systematic research on cognitively-oriented technology innovations in a variety of settings and developed a Usability Cube to gauge the fit of technology with the school culture, capabilities, and policy management. Fishman et. al's premise is that if technology is not usable, it is unlikely to be adopted, and thus will be neither sustained nor scaled. This idea is supported by several studies that identify the differences between technology-using and non technology-using teachers (Becker, 2000b; Becker & Riel, 2000; Mueller, Wood, Willoughby, Ross, &

Specht, 2008; Pynoo et al., 2011; Voogt, 2010). In one such study, research found that a teachers acceptance of a digital learning environment depending significantly on the expectancy of their performance as a teacher and influence by superiors to use a digital learning environment (Pynoo et al., 2011). Another study found that the teacher's intention to use technology is influenced by the perceived usefulness, ease of use, attitudes towards use, and facilitating conditions (Teo, 2011).

One key question that arises though, involves what defines "usability." Fishman et. al. (2004) states that a technology or innovation "…is usable if a school organization can adapt the innovation to local context, enact the innovation "successfully" (as jointly defined by the school and the developer), and sustain the innovation (p. 51)." To illustrate this, Fishman et. al (2004) laid out school culture, capability, and policy/management in the form of three axes that all originate from one common point that represent the current capacity of the school district. This form a three dimensional space (see Figure 1). Any technology can be placed in the space created by the axis. The distance between the technology and the common point represent a gap

Figure 1



in school culture, capability, or policies and management that inhibit technology's ability to integrate with the school district. Successful integration, then, would require stakeholders to close the distance between those gaps, thus making the technology "usable". Technology integration in education is a process for teachers. The United Nations Educational Scientific Cultural Organization (UNESCO) developed an international education policy document that constructed a model for the staged development and integration of technology in schools (UNESCO, 2002). Within that model, UNESCO described four stages of maturity in technology use through which schools develop: 1) emerging; 2) applying; 3) infusing; and 4) transforming (Law, 2010). In examining the staged development of an individual teacher's adoption of technology in the classroom, Hall (2010) identified the need for an *implementation bridge* to guide teachers from policy and curriculum development outlining the mechanical use of technology to the regular targeted use of technology for student outcomes. In his research, Hall identified the five levels of use that teachers progress across: *non-use, orientation, preparation, mechanical, and routine*. First time users of technology often fall into *mechanical use* stage. Their practices and behaviors revolve around making the technology work in the classroom. However, if teachers are to progress across the implementation bridge, Hall (2010) stated, it is essential they move beyond *mechanical use* into *routine use*. *Routine use* is where teachers can focus on student outcomes.

However, a majority of technology-using teachers remain in what Donnelly, McGarr, and O'Reilly (2011) calls the "inadvertent user" or "selective adopter" stage of technology integration with little to no advancement onward towards the "creative adapter" stage wherein a teacher uses technology in a student-centered way to enable learning. It is difficult to say exactly why this is the case, but Hall (2010) identifies two other areas to consider in bridging the gap between research and implementation. The first involves studying the variation that exists between the *intended use* of technologies designed for student learning and the *actual use* by teachers. The second involves studying the concerns teachers face when beginning to use technology such as the impact the technology has on student learning; the time and logistics of fitting everything into the lesson; the teacher's personal feelings of uncertainty; and pressing matters that need to be addressed.

Several studies have cited the mismatch between intended use of a technology designed for student learning and enactment of it as a problem (Hmelo-Silver et al., 2007; Jimoyiannis, 2010; Kirschner et al., 2006; Mama & Hennessy, 2013). Several frameworks have been developed to guide the selection and use of technology for various instructional purposes. Puentedura (2011) developed one such framework. There are four components to Puentedura's framework that describe the purpose and use of technology: 1) substitution; 2) augmentation; 3) modification; and 4) redefinition. Within both the *substitution* and *augmentation* components, the primary use of the technology enhances student learning. With the next two components, *modification* and *redefinition*, the primary use of technology transforms student learning. This framework is helpful in conceptualizing what transformative uses of technology look like and how even teacher-directed technology uses can be connected to learning objectives. More research is needed to identify specific factors that facilitate a teacher's movement beyond the early stages and uses of technology, though.

Another way research began to look at the gap between innovation and adoption was through the study of knowledge teachers needed in order to be successful at selecting and using technology for the purposes of student learning. Webb and Cox (2004) developed a broad framework for pedagogical practices that accounted for the ways in which a teacher's knowledge, beliefs, and values contribute to the use of technology. The center of their framework identifies "affordances" that either the teacher or the technology possess. These affordances elicit learning activities that, in turn, directly impact a student's knowledge, understanding, or skill (Webb & Cox, 2004). In the context of a secondary science class, these affordances include inquiry-based processes (Kim et al., 2007; Loughran, Mulhall, & Berry, 2004). Depending on whether it is the technology or the teacher who possesses these affordances, further research may be able to identify imbalances that negatively impact student achievement and target support to correct them. Imbalance can be found in two ways: The first is when there is mismatch between the purpose for using technology and the technology selected for that purpose. The second is when there is a mismatch between the intended use of a particular technology designed for student learning and the way the teacher is using that technology.

Conclusion

The design-based research around the development of TEL tools in science demonstrates that technology can be designed for student learning. Given that the teacher's use of technology in general is low and even lower in subject of science for many reasons, researchers have to wonder if technology can also be designed for effective teacher use. Professional development is not necessarily the answer. Not only does professional development require an extended amount of time (Gerard et al., 2011), but also the link between it and student learning is dubious (Linn & Eylon, 2011a). In addition, the accomplishment of developing a mass force of expert computer-using teachers does not mean that problems will go away. In fact, more problems will arise from the greater demands that exemplary computer-using teachers make on resources and from their greater expectations about the utility of computer resources (Becker, 2000b). These problems and perspective require researchers to look at the problem differently. It is necessary to look at the technology as the agent of change. Therefore, by examining the intended uses of technologies designed for student learning alongside the teachers' use for them, we may begin to see how technology has affected them as teachers. We may also begin to see how technology needs to affect them in order to improve student learning.

CHAPTER 3

Methods

Given the need to know more about the usability of technology-enhanced learning tools for student learning and how teachers use that technology, this study investigated the experiences of four middle school science teachers enacting the Web-based Inquiry Science Environment (WISE). The purpose of this study was to learn more about the experiences of secondary science teachers using a research-based, technology-enhanced learning (TEL) tool in order to understand how developers can design those technologies for teacher use as well as student learning. The Web-based Inquiry Science Environment (WISE) served as the TEL tool in this investigation because of the on-going development and design process and because of the many positive student-learning outcomes resulting from it. Therefore, using a qualitative research design, this study explores the following research questions:

1. What is the intended teacher use of WISE?
2. What influences whether or not secondary science teachers who are new to using WISE and untrained in its use, enact in their classrooms as intended?

The Technology Selection

WISE is a free, open-source, customizable digital learning platform offered through the University of California, Berkley and sponsored by the National Science Foundation. It offers many research-based, positive student-learning outcomes for students in secondary science classes. Students use computers collaboratively, usually in teams of two, to complete WISE modules. Teachers can evaluate and guide their learning through a suite of online tools and modify/design their own modules.

As a learning management system, WISE includes the student-learning and project-authoring environments, grading tool, and user/course/content/management tools. According to *WISE Features*, (https://wise.berkeley.edu/pages/features.html) WISE is designed to be a foundation for student learning and flexible to the localized learning goals the user may have for it. On the WISE homepage (www.wise.berkeley.edu), there are two links to WISE's *Open Source Partnerships* (http://wise4.org/). The *Open Source Partnerships* provides an overview of WISE and its features. Additionally, there are several other places where WISE's free and open-source nature is mentioned. Two of note are located in the *Top Ten Reasons to Use WISE* (https://wise.berkeley.edu/pages/wise-advantage.html) and the *Research and Technology* (https://wise.berkeley.edu/pages/research-tech.html). As open source, web-based software, WISE also makes available the customizable code for download onto a localized server or computer through a link on the open source partnerships home page. Educators, districts, or institutions can elect to download the code and install it on their own server for use and customization. However, teachers who want to use WISE in their classrooms do not need to download the code onto a server. They only need to create an account through the WISE homepage (www.wise.berkeley.edu) and select or create project for implementation. Both software locations are customizable, but there is more institutional customization that can be made by downloading the software onto a localized server.

There are several contexts in which WISE projects can be enacted: classrooms, museums, after school, and home school. There are also a number of different types of users. In *WISE in Action*, it states that WISE is "customizable and can be adapted to a variety of contexts and needs - beyond the traditional classroom. Researchers, content experts, classroom teachers, and technology developers can all engage with WISE according to their needs. However, among the various users and contexts, the traditional teacher and classroom are by far the most common and the one in which student learning outcomes have been studied the most.

I selected WISE because of its on-going research and development over the last twelve years. It has been studied internally at the University of California, Berkeley and externally by outside researchers and both parties have found that the built-in Knowledge Integration pattern allows for greater student outcomes (Chiu et al., 2013; Chiu & Linn, 2011; Papastergiou, 2009; Raes et al., 2013). Collaborative teams of teachers, researchers, subject matter experts and developers continually work together to develop and expand the learning modules. WISE is also adaptive. It can be modified or designed to reflect aspects of the core curriculum or standards the teacher is focusing on or to meet the particular needs of the students in the teachers classroom.

To date, WISE has not published a user guide. For the purposes of this study, an intended teacher use of WISE in the classroom was constructed from the *WISE* homepage as well as pages and publications to which it links. It was further informed from the formal process through which WISE guides teachers in setting up a project run and through exploring the various tools built into the *Teacher Management* homepage. Teachers gain access to the *Teacher Management* homepage after creating an account. From these sources, I categorize the findings from the document review into three phases of implementation: pre-enactment, enactment, post-enactment; and two dimensions of use: the teacher's role and the teacher tools. Overall, the fact that WISE is open-source, adaptable, and flexible to localized user needs and the fact that it is community driven governs the way in which the intended teacher use of WISE is identified and subsequently analyzed in the teacher participants' use of WISE.

Participants

Because the goal of this study was to better understand the experiences of teachers using a technology designed for student learning, I recruited four middle school science teachers, asked them to register to use WISE and find one WISE project to use during the 2014-15 school year. Recruitment of participants initially began through contact with the administrators of public middle schools and charters schools to solicit interest and verify eligibility. I expanded that effort to include teacher alumni networks from several universities. Through the alumni networks, I contacted alumni directly via email using my recruitment script (Appendix 1) and posted on alumni forums and social media with a link to my recruitment website (Appendix 2). The teacher's participation was primarily contingent upon the ability of the school to provide him/her with enough technology to support groups of 2-4 students per device. The site also had to be able to provide participants with an Internet connection, modern web-browser –preferably Chrome or Firefox, an updated Adobe Flash Player plugin, and an updated Java plugin. These were the basic requirements necessary to enact WISE. If the site was able to support the enactment of WISE, then the only other requirements were that teacher was a new user and had not been previously trained in the use of WISE. Teachers who fit the description and were interested in participating signed up through the aforementioned recruitment website I created.

Eight teachers in total signed up through the website, but only four participated in this research. Of the four female middle school teachers who participated and enacted WISE in their classrooms, two (Colleta and Jenna) were seventh grade teachers from the same public middle school located in the Silicon Valley of California, and the other two (Anna and Rebecca) were seventh grade and eighth grade teachers respectively from the same charter school in Oakland, California. The names of the participants are pseudonyms.

Of the teachers who withdrew participation, one high school biology teacher reported difficulty in finding a WISE project to fit within the core scope and sequence of instruction. Two more high school teachers who taught multiple grade levels/sections of high school science delayed in responding to scheduling requests because the technology became unavailable in the time allotted to enact WISE. They also expressed difficulty in finding projects that they could use. The fourth high school teacher was excluded, because their fully online classroom context did not align with the design of this research.

I specifically sought out secondary sciences teachers. WISE currently maintains approximately 10,000 teacher accounts worldwide. Of those accounts, middle school science teachers make up the largest segment. Last year, there were approximately 3,000 teachers accounts created in WISE. Within these new accounts, WISE administrators saw a trend of two or more new users sign up from the same school and/or district around the same time (D. Kirkpatrick, personal communication, August 10, 2014). This trend was evident among the participants who engaged in this study.

Research Design

The exploratory nature of this study called for a qualitative design using Grounded Theory methods (Merriam, 2009). The structure of the data collection and analysis, therefore, was inductive and emergent, and I served as the primary instrument used in these activities (Merriam, 2009). Data collection took place in two parts. The first part consisted of a document review to define the intended teacher use of WISE. The second part involved observing and video recording teacher participants as they enacted WISE in the classroom, collecting daily surveys during the schedule project run, and conducting reflective interviews with each participant. These sources served as the corpus from which I derived meaning and drew theoretical conclusions about the intended use of WISE and what may have influenced the way in which secondary teachers enacted it in their classrooms.

Data Collection

WISE Document Review

To answer the first research question, I conducted a document review using theoretical sampling method (Glaser & Strauss, 1970). With some guidance given by the director of WISE at the University of California, Berkeley, I began with the *WISE4* homepage, also referred to as the *WISE* homepage in my findings. This is page new users review to learn about WISE. Therefore, it served as my primary source. I divided it into sections and summarized the content from each. From the *WISE4* homepage, I identified twenty-five hyperlinks, fifteen subpages, four additional websites, and one book to review and summarize. These secondary and third sources all contained information related to my research question.

The twenty-five hyperlinks came from the "What's New" Section of the *WISE4* homepage. I reviewed each hyperlink and identified sixteen to be relevant to my research question. These along with fifteen subpages on the *WISE4* homepage served primary sources. Of those sixteen hyperlinks relevant to my research question, three linked to and/or reference a book written by the director of WISE. The book is also referenced in the footer or every email correspondence I had with the director of WISE. As a third source to triangulate my findings, I reviewed each chapter and summarized the content.

From the *WISE4* homepage, I identified four additional websites to review. These served as secondary sources. The first was the *WISE2* homepage, which is the older version of the WISE4 platform. The second was the *Teacher Management* homepage, which is the teacher portal for navigating WISE. This is also referred to as the Teacher Dashboard in my findings. The third was the *Student Management* homepage, which is the student portal for navigating WISE. It, however, did not provide any data related to the teacher use of WISE. Lastly, I reviewed the *Technology-Enhanced Learning (TEL)* homepage, which describes all the research conducted around WISE.

Observations, Interview, and Surveys

To answer the second research question, I first conducted ethnographic field observations of each participant as the enacted one WISE project. To facilitate the observations I used a time-stamped observation protocol (Appendix 3: Observation Timestamp Protocol). Observation notes focused on the teacher's actions in the classroom and interactions with critical features of WISE. The length of each project run was determined by the estimated computer hours and the access each teacher had to the technology. According to the *WISE* homepage, project runs typically last five consecutive days with students working collaboratively. However, depending the aforementioned factors and how the teacher configured the project run, the length varied from 2-8 days. I observed every day each teacher enacted WISE in her classroom, except Jenna. Jenna's project run was originally scheduled over three non-consecutive days, where on two of those days (the first and last), she planned to enact WISE in the computer lab. However, the computer lab was not available on the third day, and she unexpectedly enacted the project over two consecutive days. As a result, I was only able to observe half of her enactment. Each observation was videotaped using a GoPro camera mounted to a tripod. It was placed in a part of the classroom with the most visibility into the teacher's movements and it was focused on the teacher. I reviewed the videotape to refresh my memory and make further notes on the observation protocol.

The teacher's interaction with the tools and features within WISE could not be entirely captured in classroom observations. Therefore, I developed and distributed via Survey Monkey "Daily Logs" each day of the teacher's scheduled project run (Appendix 4: Daily Logs). The logs were in survey format and took less than five minutes to complete each day. They were designed to simply document whether or not the teacher's used specific tools. I also distributed a pre-enactment survey via Survey Monkey to document what parts of WISE with which the teacher interacted to plan the enactment of WISE in her classroom (Appendix 5: Pre-Enactment Survey). This was sent after the first observation to avoid influencing any decisions the teacher made. I also sent a project end survey to the teachers via Survey Monkey (Appendix 6: Post-Enactment Survey). This survey documented any interaction the teacher may have had with the homepage and the community of users during her project run.

Lastly, I conducted a semi-structured interview with each participating teacher after the final observation. These interviews explored the teacher's planning, perception of student ability and learning, interaction with tools and features of WISE, influence of the subject matter or school on the enactment, and thoughts on future uses of WISE. The questions were derived from research around what is already known about the challenges teachers face when enacting WISE as well as what needs to be investigated about the hindrances and affordances either the technology or the teacher possess to enact it as intended for student learning (Appendix 7). The interviews were recorded using an iPad and iPhone equipped with the application, Supernote, and transcribed by the web-based service, REV.com.

Data Analysis

Constructing meaning is a central characteristic in qualitative research (Merriam, 2009), and by acting as a guide in that process, I provide the study's interpretive construct. Because the data collection methods involved theoretical sampling, the data analysis took place concurrently with the data collection of each source. For the document review, I used the constant comparative method of a data analysis to determine the similarities and differences between the segments of data and group them into categories (Merriam, 2009). I identified patterns in the data that described the basic teacher use of WISE and the optimal teacher use of WISE during three Phases of implementation: Pre-enactment, Enactment, and Post-enactment. I also identified a pattern in the data that described the teacher's role in the classroom and use of teacher tools built into WISE. In the interpretation of these patterns, I developed a theory of intended teacher use.

For the second part of the study, I used thematic analysis to review the artifacts collected through the observations, surveys, and interviews of each teacher participant (Braun & Clarke, 2006). Using Atlas (http://www.atlasti.com/) to develop the codebook, I engaged in an initial coding process using categories from the theory of intended use as themes for coding purpose. I defined each theme and further refined them as I became more familiar with the data. Additional patterns became evident as I analyzed the data. These were noted and grouped into the categories of hindrances and affordances. From the interpretation of these themes, I constructed a narrative of each teacher's of WISE. Using the constant comparative analysis again, I examined the similarities and differences between the theory of intended teacher use and the coordinating evidence in each teacher's narrative. The final analysis led to the theoretical construct of improving teacher use of TEL tools.

Ethical Issues

There were several issues I needed to consider while conducting this research. Because I recruited teachers through a word of mouth, I needed to ensure the participant's understood the requirements for participation, what was expected of them, and what their rights were. . Therefore, I created a website that guided teachers through this information. By submitting an intent to participate, teachers acknowledge they had read and agreed to the content found within study information sheet. Second, I needed to protect the privacy of the participants. Therefore, each school site and participant will received a pseudonym and care was taken to ensure that identifiable characteristics were disguised. Lastly, because I was video recording the participants' interactions with students, I distributed a study information sheet to the teachers, which was given to the parent's of students prior to enactment.

Role as Researcher

In my role as a researcher, I was strictly an observer. There was no presumed bias in my role because I was neither part of the program or university that developed WISE, nor was I an employee of the school district or charter organization in which the participants were employed (Alkin, 2011). Because the purpose of the study was to observe how *new users untrained in the use of* WISE enacted it in the classroom setting, it was important that the participants depend on the website resources and helpdesk rather than me. Any support I provided the participants may have influenced how they used WISE. By discussing my role with them prior to enactment, I avoided becoming the *de facto* tech support when the participants ran into obstacles. When they approached me with questions, I directed the participants back to the resources available online. I made note of the obstacles and questions the participants had as they came to my attention and this information proved valuable in the final analysis.

Credibility

Even though there is no presumed bias, the primary threats to the credibility of my study were my own experiences as a secondary teacher using technology in the classroom. To ensure that credibility of my findings and minimize the effect of my bias, I employed data collection methods based on theoretical constructs, protocols grounded in empirical research, and systematic data analysis procedures. I gathered information from a variety of sources, which is one aspect of *triangulation*. Triangulation is a process that reduces the risk of bias by not relying on only one source or method (Maxwell, 2005). For instance, I reviewed the videotapes of the lessons I observed to capture further evidence of the teacher's role in the classroom and enactment of WISE. I also distributed surveys to capture the teacher's use of the WISE tools and features, which may not have been observable.

Taken altogether, I was identify information that comes from more than one source and determine the rate of reoccurrence in the data, thus making it more credible. The intended use of WISE only needed to be in evidence once in the data collected to indicate that it was present in the participant's practice. However, the more often the unit was referenced the more credible the data became. Hence, by collecting data from a variety of sources and in a variety of ways, I was able to draw inferences that could not have been gained from one source alone.

Assumptions

The use of WISE to transform science learning has been widely studied (Chiu et al., 2013; Lee et al., 2010; Liu, Lee, & Linn, 2010, 2011), but teachers in these studies have used WISE in ways prescribed by researchers. It was assumed, therefore, that if the participants in this study use the program as intended, student outcomes would follow. This link was not studied. It was also assumed that the intended of use could be observed in the participant's first use of WISE. Research indicates that pedagogical content knowledge is difficult to capture in qualitative research because it may not be evident within the confines of one lesson (Loughran et al., 2004). This may prove true for other units of analysis being explored in this study.

External Factors

There were external factors at play in the context of the classroom and school, which could not be entirely mitigated or ignored in this research. These factors were taken into account if in evidence. For example, curricular and administrative demands are among the top four barriers to integrating technology, especially in urban schools. Other constraints such as large class sizes, inadequate prep time, lower levels of training, inadequate classroom space, and outdated materials/ technologies/ resources could have also impacted the participant's ability to enact WISE. One external factor that was mitigated, for the most part, involved access to technology. Participants had to access to computers with the Internet in order to enact WISE, and they needed to indicate they had enough devices to run the project accordingly.

CHAPTER 4

Findings

The first part of this study explored the intended teacher use of WISE. Using the document review methods described in Chapter 3, I found two intended uses of WISE. The first is a more basic enactment of WISE and the second is an enactment of WISE that maximizes its potential to impact student learning. The actions associated with these intended uses are indicated by the terms: ***Basic*** and ***Optimal***. *Optimal* specifically refers to research findings that associate specific teacher uses of WISE that positively impact student learning. Both the basic and optimal uses of WISE describe how and when a teacher should enact WISE and interact with WISE software. Therefore, the intended use of WISE is first framed within the following phases of implementation: 1) *Pre-enactment*: the planning and preparation to use WISE; 2) *Enactment:* the implementation of a WISE project in the classroom context; 3) *Post-Enactment*: the reflection and assessment of student learning through WISE. Within each of these phases of implementation, there are two dimensions of teacher use. They involve the *roles* the teacher may play and the *tools* built into WISE the teacher may use.

The second part of this study investigated the experiences of four middle school science teachers who were new to using WISE and untrained in its implementation to see if they used WISE as intended. Through the observations, interviews, and daily logs compiled for each teacher, I identify the ways in which each teacher used WISE as intended through each phase of implementation, the role they played, their use of the teacher tools, and the context in which they taught WISE. In summary, I identify either the hindrances and affordances found in the either the teacher or the technology that influenced whether or not they used WISE as intended.

Intended Teacher Use of WISE

The Model of Intended Teacher Use of WISE is detailed in **Error! Reference source not found.**, 2, and 3. The *optimal* teacher use of WISE includes the entire description of *basic* teacher use of WISE unless otherwise noted. In Table 4, I identify the teacher roles and tools/features of WISE that facilitate the intended use as described. In subsequent sections, I further expound on the evidence and reasons why these activities and interactions with WISE are classified as intended teacher uses.

In answering the first research question, I found that the *basic* intended teacher use of WISE involves planning and preparation, running the project to completion, providing feedback, and assessing student learning. In the *basic* enactment of WISE, the teachers are intended to be monitors, managers, and evaluators of student learning utilizing features of the project library, student management tool, and grading tool. More *optimally*, I found that the intended use of WISE involves supplementing the core curriculum, enhancing the core scope and sequence of instruction, and aligning assessment with the goals of instruction. WISE projects are intended to be facilitated through student-centered teaching practices and inquiry-based instruction in a collaborative learning environment. Ultimately, it is intended that teachers share the projects and lesson designs with other colleagues for feedback and iterative development towards improving the knowledge integration of students. In the *optimal* enactment of WISE, teachers are intended to be curriculum designers, guides, evaluators, monitors, managers, and community members utilizing the full suite of WISE tools and features to enhance student learning. These findings are evidenced in the following discussion around the phases of implementation and dimensions of use.

Phases of Implementation

Pre-enactment

In the first phase of implementation, WISE intends for teachers to plan and prepare. This *basically* involves reviewing projects and selecting one that fits the core scope and sequence of instruction. It also involves deciding how to configure the project run to meet the student learning goals, how to register students, and how to assess student learning. *Optimally*, this involves customizing or authoring projects to meet student learning needs and goals. More extensively, planning and preparation to use WISE involves the department-wide alignment of curriculum, instructional strategies, and professional development with the Knowledge Integration pattern and framework of WISE. This last optimal use is unlikely to be evidenced in a teacher's first use of WISE. The research this is based on indicates that such an alignment takes years to develop (Gerard et al., 2011).

The basic description of planning and preparation is derived from the *FAQs* (https://wise.berkeley.edu/pages/teacherfaq.html) and the *Quick Start Guide* (http://wise.berkeley.edu/pages/gettingstarted.html). The *FAQs* covers the topics of student management, project management, assessment of student work, the real time classroom monitor, and technical questions. The *Quick Start Guide* goes over the technical requirements for running WISE, how to register for an account, how to run WISE projects in the classroom, and how to setup a test student account. The *optimal* description of planning and preparation is derived from the same sources and research published by WISE that indicates these uses are connected to student learning.

Further, there are supports built into the design of WISE that indicate the *basic* and *optimal* uses of WISE in the planning and preparation to implement WISE such as the *Contact*

WISE link that is embedded on almost every page of WISE, the searchable project library, and the process of setting up a project run. Contacting WISE is specifically connected to the

Table 1: Model of Intended Use | Pre-Enactment

Basic Use Specifications	Optimal Use Specifications	Rationale
Plan/ Prepare to use WISE basically by:	*Plan/ Prepare to use WISE optimally by:*	*WISE research indicates that teachers the more teachers plan and prepare to use the WISE the more enhanced knowledge integration occurs (Clark & Linn, 2003).*
• Reviewing info link in each project.	• Reviewing the info link and previewing projects entirely.	*WISE research shows that teachers who are more familiar with the content of the project have better learning results (Liu et al., 2010).*
• Selecting a project that fits the core scope and sequence of instruction.	• Authoring or customizing a project to fit core scope and sequence of instruction and/or meet specific student learning needs and goals.	*WISE is currently conducting research on what specific customizations lead to better learning results. (Slotta & Peters, 2008).*
• Setting up a Project Run.	• Setting up a Project Run with the following criteria: 1. Students run the project in groups of 2-3 students per device. 2. Recording the data on high 3. Enabling the Classroom Monitor 4. Running a "Compatibility Check" and updating computers as needed prior to use	*An integral part of the WISE design for student learning involves collaboration and using data to be able to provide individualized at the time the student needs it. Research indicates student learning is maximized when each of these steps are taken. (Linn & Eylon, 2011b).*
• Planning the assessment of student learning through the use of the grading and feedback tools.	• Planning assessment of student learning through the use of the grading, feedback, and authoring tools whereby teachers also: 1. Author and customize assessments to align with the learning objectives. 2. Align curriculum, instructional strategies, and professional development with the Knowledge Integration Pattern and Framework throughout the department.	*A study showed that, when appropriately designed, knowledge integration assessments can be balanced between validity and reliability, authenticity and generalizability, and instructional sensitivity and technical quality. Results also showed that, when paired with multiple-choice items and scored with an effective scoring rubric, constructed-response items can achieve high reliabilities (Liu et al., 2011).*
• Pre-registering students to use WISE.	• Monitoring and managing students as they register for an account and login themselves.	*The WISE design for student learning supports students autonomy in all things (Linn, Clark, & Slotta, 2003)*

collaborative theme integral to every interaction a user is intended to have with WISE. The searchable *Project Library* can be accessed with or without a teacher account. From the *Project*

Library teachers can review projects, view targeted grade levels, view estimated durations, view technical requirements, access the authoring tool to customize existing projects to fit instructional needs, and share projects and project runs with colleagues. Once a teacher has identified a project they would like to use, they can select "run project" from a link in the project library. The teacher is then taken through five steps to setting a project run: 1) confirm project, 2) archive existing runs, 3) selecting class periods, 4) configuring the run, and 5) reviewing the project and recommended compatibility check. The choices that WISE makes available in the process of setting up the run are designed to bridge the teachers' use of WISE as intended. These choices are examined further in the findings on hindrances and affordances.

Enactment

In the second phase of implementation, WISE intends for teachers to run the project to completion. *Basically*, this means teachers would survey student ideas, enable and facilitate student collaboration, periodically address the whole class about difficult concepts, and guide and evaluate the learning process by providing feedback. *Optimally*, running the project to completion means that teachers monitor and manage students as they register for an account, login, and begin working on the project. They facilitate student collaboration with each other in groups. It also means that they follow Knowledge Integration Instructional Pattern during the project run of eliciting student ideas, experimenting and adding ideas, distinguishing ideas, and providing opportunity for reflection.

The basic description of how to run the project to completion is derived from the *Teacher Tools* page (https://wise.berkeley.edu/pages/teacher-tools.html) and the *WISE in Action* page (https://wise.berkeley.edu/pages/wise-in-action.html). These pages are the ones the teachers would more likely review prior to enacting WISE because they are referenced on the teacher

Table 2: Model of Intended Use | Enactment

Basic Use	Optimal Use	Rationale
Basically run a project to completion by:	*Optimally run a project to completion by:*	*WISE is designed for student learning. By completing the project, the students are using WISE as intended. However, research shows the teachers play a significant role in the depth of student learning (Liu et al., 2010).*
• Using collaborative teaching strategies to facilitate in whole group instruction.	• Using collaborative teacher strategies to support student working in groups of 2-3 students per device.	*An integral part of the WISE design for student learning involves collaboration and specific strategies for optimizing collaboration are discussed in (Linn & Eylon, 2011b).*
• Minimizing whole group instruction and/or using it to survey student ideas.	• Minimizing whole group instruction and follow a KI pattern of instruction which includes the following: 1. Survey student ideas collaboratively. 2. Student experimentation and opportunity to add ideas collaboratively. 3. Student engagement in distinguishing ideas collaboratively. 4. Student reflection.	*Knowledge Integration is the framework around which WISE is built. Thus, a KI pattern of instruction further supports student learning (Clark & Linn, 2003; Linn et al., 2003; Linn & Eylon, 2011b).*
• Providing support through whole group, small group or individual instruction as needed.	• Providing support through whole group, small group or individual instruction by following individual and group progress with the tools available on teacher dashboard.	*WISE is designed to support a teacher's ability to provide individualized instruction, therefore following student progress in real-time enables this to take place efficiently (Clark & Linn, 2003).*
• Providing verbal and/or written feedback using the tools available on the teacher dashboard.	• Providing verbal or written feedback using the tools available on the teacher dashboard in real time during class as students are submitting work.	*Real time feedback also enables teachers to support student learning as it is happening. Research is still being conducted on what type of feedback provides the most support for student learning (Liu et al., 2011).*

management page. They overview what tools and features are available for use and also describe experiences of teachers using WISE. The journal article, "Pushing the Right Buttons," (http://www.tc.columbia.edu/news.htm?articleID=8502) and the research article, "Professional Development for Technology-Enhanced Inquiry Science" (Gerard et al., 2011) helped to construct the *optimal* enactment of WISE. "Pushing the Right Buttons" discusses the benefits of teaching using technology to assess student learning, target instruction, as well as reinforce and build up instruction. The research article looked at how professional development modeled after the Knowledge Integration pattern enhanced teachers support for students' inquiry science learning.

Supports built into the design of WISE for teachers to access during enactment also indicate the way in which is intended to be used. From the *Teacher Management* homepage, teachers can access the grading tool, preview the project, edit content in the project, makes notes on the project, manage announcements to students, contact WISE, edit the run settings and manage students. The grading tool is prominently displayed and facilitates the teacher's ability to give timely feedback and score student responses. Within the grading tool there is also a pause button, which allows the teachers to freeze computer screens to deliver instructions.

Post Enactment

In the last phase of implementation, WISE intends for teachers to be assessing student learning, reflecting on the project run, and sharing it with colleagues. *Basically*, WISE intends teachers to score student responses and develop rubrics like the Knowledge Integration sample they provide on the *FAQs* page to assess student learning. Because critically grading each step is time consuming for teachers, WISE recommends that teachers select a few salient steps to grade that may best demonstrate a students understanding of the complex concepts covered in the project. Teachers can edit the point values for each question to reflect this change.

To *optimally* assess students' knowledge integration, teachers should assess both what a student is learning and how the student learned information through a two-tiered assessment strategy. WISE facilitates this strategy through the grading tool. KI framework built into WISE projects first draws out students' prior ideas (which are often incorrect) and guides them through the difficult concepts to self-correct. Teachers are able to see the iterative development of student

Table 3: Model of Intended Use | Post Enactment

Basic Use	Optimal Use	Rationale
Basic assessment of student learning by:	*Optimal assessment of student learning by:*	*Assessment is an integral part of the WISE design for student learning (Liu et al., 2011<Linn, 2011 #101).*
• Scoring student responses either using teacher tools available through the teacher dashboard or some other system.	• Applying a two-tiered assessment strategy using the teacher tools available through the teacher dashboard	*Scoring student responses is the most basic way to assess student learning but according to research discussed in Linn (2011), applying a two-tiered strategy leads to more knowledge integration.*
• Developing rubrics to grade student responses.	• Developing rubrics to grade student responses that are aligned to the KI framework.	*Using rubrics to grade student responses is the most basic way to ensure students are learning from WISE as intended, however aligning those rubrics with the KI framework enables the teachers to assess the knowledge students have gained (Liu et al., 2011<Linn, 2011 #101).*
Basic participation in WISE community by:	*Optimal participation in WISE community by:*	*WISE is open-source and community driven.*
• Sharing the project runs with other teachers.	• Sharing customized project runs with other teachers.	*Case studies on the partnerships used to create WISE lessons demonstrate that sharing customized projects enable teachers to improve upon instruction and further student learning (Gerard et al., 2010; Linn, 1995)*
	• Engaging in WISE Facebook page, interacting with other teachers, researchers, and developers on WISE forum, and following the WISE Twitter account	*Research shows that teachers engaged in a collaborative professional development community have better student learning outcomes with WISE (Gerard et al., 2011).*

ideas and the correction of those ideas. On the *FAQ* page, WISE suggests grading the first step or two at the end of the first day of a project run. Then at the beginning of class the next day, teachers should share with the whole class some sample responses and have the class critique the work. Teachers can then direct the students to go the My Work section of their project run to review the comments and grades.

In this phase of implementation, WISE also intends for teachers to reflect and share their projects with other registered users of WISE. The teacher who receives the project must also be a registered user of WISE. The user then can select whether or not the teacher can view the project run or view and grade the project run and share the project with another teacher. Sharing is part of being a member of the WISE community. Specifically through the Teacher Tools link on the *WISE* homepage, it states: "WISE users can share projects with other teachers who may want to run the projects in their classrooms and/or further customize them. By sharing projects, curriculum authors can collaboratively edit and refine WISE units."

Dimensions of Use

The role of the teacher in the enactment of WISE is critical to the success of student learning. WISE is not intended to run on its own without teacher influence. The use of teacher tools is intended to more effectively facilitate classroom management tasks so that teachers are free to focus on diverse students' learning needs. The tools enable teachers to interact with individual students and gain insights about classroom learning as a whole. The various intended roles of the teacher and the intended uses of the teacher tools and features for student learning were primarily derived from *WISE Experience* page (https://wise.berkeley.edu/pages/wise-in-action.html) and the *Teacher Tools* page (https://wise.berkeley.edu/pages/teacher-tools.html) respectively. Research around student learning outcomes with WISE also informed the construction of the various teacher roles ((Lee et al., 2010; Linn, Shear, Bell, & Slotta, 1999; Liu et al., 2010, 2011; Varma et al., 2008). The Table2 illustrates these findings. It describes the way in which the teachers' role in the enactment of WISE and their interaction with WISE tools and features is intended to coincide with their use of WISE.

Teacher as a Monitor and Manager

From the information presented in the *FAQs*, *Quick Start Guide,* and description of *Teacher Tools*, it is evident that that WISE *basically* intends for the teachers to monitor and manage students through the project run. WISE documents indicate that these roles are primarily facilitated through the teacher's interaction with the *progress monitor*. Enabling the *real time classroom monitor* in the project run setup allows teachers to quickly assess the progress of each

Table 4: Teacher Role

	Intended Use of WISE		**Teacher Role**	**WISE Tools and Features**
Pre-enactment	Basic	Planning and Preparation	Manager	Project Library Preview Project Info link
	Optimal	Customization and Alignment	Curriculum Designer	Authoring Tool Grading Tool
Enactment	Basic	Running project to completion	Monitor and Manager	Progress Monitor Real Time Classroom Monitor Manage Students link Flagging Tool Pause Button
	Optimal	Student centered teaching practices and collaboration	Guide and Evaluator	My Notes My Announcements Grading Tool Pause button
Post-enactment	Basic	Assessing student learning and sharing project runs	Evaluator and Community Member	Grading Tool Share Project
	Optimal	Applying two-tiered assessment strategy and contributing to the WISE community	Curriculum Designer, Evaluator, Community Member	Grading Tool Show All Work feature My Notes Share Project WISE Forum WISE Facebook Group WISE Twitter

student group and determine whether individualized or class-wide interventions are necessary. By clicking on individual students or groups, the teacher can see the percentage of students who have completed particular steps and activities in WISE projects. This feature is called the *step completion display*. It is intended to provide a quick and simple way of determining how the class is progressing through a project. With the information gathered, WISE intends that teachers would pace and vary instruction accordingly. The *flagging tool* and *pause button* also facilitates a teacher's ability to monitor and manage. With these, teachers can identify student work to share with class anonymously and freeze student computers to discuss. Additionally, using the *mynotes* tool, teachers can take public and private notes on the project run.

Singling out the teacher's role as a manager, I found that it has two intended parts: student management and project management. Student management involves common problems like handling students who forget their username/password, group reassignments, changing student passwords, and finding access codes for project runs. It also involves managing student groups. Project management involves checking the compatibility of the technology prior to enactment, facilitating student registration, and providing access to the project run. Project management also involves fitting the projects and curriculum together, setting up the project, managing the time it takes to complete the project, grading student work, providing student feedback, reviewing teacher materials and making adjustments, and troubleshooting issues that arise.

WISE intends for teachers to use the *project library*, *announcement manager*, and *student manager* to facilitate this role. In the *project library*, teachers can preview projects as students would see them, view targeted grade levels of the project, estimate the computer time needed, view the technical requirements and run a compatibility check. The *announcement manager* enables teachers to create a note to for students to see the next time they log into WISE. The *student manager* enables teachers to see student registered to run this project, check to see if they have been assigned a team, assign them a team, view their information, change individual passwords, change all passwords, identify the period they are in, and remove them.

Teacher as a Curriculum Designer

Teachers who use WISE are *optimally* intended to be curriculum designers. They should be well acquainted with the projects they enact. They should either customize them for fit, clarity and alignment or author projects from scratch so that they support specific learning difficulties students have in science. The pattern of instruction and assessment that follows should align with the KI principles, patterns, and processes. The construct of this teacher role is gathered from the frequent references to "customization" and "authoring" throughout the *WISE* homepages and supporting links.

WISE projects are customized and authored through the authoring tool. WISE's authoring tool was designed to enable teachers to customize existing projects to fit instructional needs and to create entirely new projects. While customization and authoring are strongly encouraged, there are limitations in what WISE developers intend teachers do with the authoring tool. As mentioned early, WISE specifically cautions teachers against shortened projects. Shortening projects tends to eliminate salient inquiry elements necessary for knowledge integration. WISE also cautions teachers from editing the project while the project is active because it may result in the loss of student data. While the teacher's role as a curriculum designer is primarily played out in the pre-enactment of WISE, customization is also *basically* supported in the grading tool through which teachers can choose which steps to grade and adjust the point values during the project run. WISE encourages teachers to develop their own rubrics for assessing student learning.

Teacher as a Guide and Evaluator

Teachers enacting WISE are *optimally* intended to guide and evaluate the learning process. Teachers guide students through generating ideas, selecting the best ideas, and refining those ideas. Guidance may also take the form of pre-teaching, surveying student ideas, giving written or oral feedback, individual help and support, or whole group instruction. Evaluation may take the form of grading new and revised work as well developing rubrics to assess student learning. The construct of the teacher's role as guide and evaluator are gathered from the *FAQs*, *Teacher Tools* and *WISE in Action* links on the *WISE* homepage. WISE research indicates that without this iterative guidance, students often fail to link ideas together to create new ideas (Linn & Eylon, 2011b).

The *grading tool* is a key part of facilitating the teacher's role as a guide and an evaluator. There are presently two grading tools, an old one and a new one. The old one is currently being phased-out. Teachers can guide and evaluate students using the *feedback* and *commen*t boxes to provide timely feedback to students on their work. The *show all work* feature enables teachers to gain insight into student thinking. Teachers can access work in real time, flag ideas for discussion, assign point values to specific assessments, score student responses, and send comments. The data gathered from these activities is very different from what teachers would get from year-end tests. It shows where knowledge broke down. According to a description of *grading tool*, teachers can "easily view student work to submit scores and comments that students can review and reflect on." Teachers can grade student work by step or by student team. Teachers can also "edit and use templates for commonly utilized feedback comments on student work," and it states teachers can "create pre-made comments to streamline the process of generating feedback for hundreds of student responses." A new and developing feature of the *grading tool* is the ability to score student work using WISE's autoscoring algorithms, which aims to assist teachers in "quickly and accurately assessing student work on key curriculum steps."

Teacher as Community Member

Lastly, WISE both *basically* and *optimally* intends for teachers to become part of a community of researchers, content experts, classroom teachers, and technology developers. By checking the "I agree to the terms of use" box on the teacher registration page, teachers are consenting to participate in WISE research regarding teacher and scientist beliefs about technology and the Internet, as well as best ways to support community members as they prepare to use WISE projects and author WISE curricula. Teachers participate in the WISE community through engagement with the WISE Community discussion forum, the WISEtels Facebook page, and WISEtels twitter account. Teachers can also participate in the community by sharing their customized or authored WISE projects with another colleague through the *share button*.

Teacher Use of WISE

To answer the second research question, I first had to identify whether or not teacher's used WISE as intended. I present my findings in two parts. First, the patterns of teacher use as aligned with the intended use are summarized Table 3 (basic) and 4 (optimal) throughout the phases of implementation. Together, the tables show that Rebecca followed both the basic and optimal models of intended use more than other three teachers. They also suggest that the public middle school teachers, Colleta and Jenna, are more similar to each other than the pair of teachers working at the charter middle school, Rebecca and Anna.

Besides summarizing how teachers enacted WISE through the phases of implementation in the models of use, a summary of the roles and WISE tools used by each teacher is provided in Table 7. I observed all teachers play the monitor, manager, and evaluator roles, although here too, Rebecca used more of the WISE tools than her peers. Table 5 also shows that Rebecca was the only teacher from my sample to take on the designer and guide roles.

Narrative Analysis of Teacher Use

Table 5, Table 6: Optimal Intended UseTable 6, and Table 7 show a broad picture of teacher use of WISE. In this section, I analyze how the known challenges influence each teachers use of WISE illuminating some aspects of the teacher's role and conflicts I found in the various goals for using WISE. Given Rebecca's highly aligned use, I primarily focus my analysis on what influenced her use of WISE, interaction with the tools, and her role in the classroom. I compare Rebecca's enactment of WISE with the other teachers when relevant to identify additional hindrances and affordances that influenced all of their uses of WISE. To begin, I briefly summarize each teacher's teaching context and enactment. Rebecca teaches at a charter school in Oakland with very restricted access to technology. She was the only eighth grade Physical Science teacher in this study, the only one to run the "climate change" project, and the only one to run a project to completion. The other three teachers taught seventh grade, ran the "Photosynthesis" project, and did not have students run their projects to completion.

Knowledge Integration

WISE is designed upon Knowledge Integration framework. Of the challenges known to impact teacher use of WISE, the first is that the Knowledge Integration framework is counterintuitive to the way teachers have traditionally taught science. Traditionally, information has been the key to transmitting knowledge, but with Knowledge Integration, eliciting student ideas is the most important part (Linn & Eylon, 2011b). Teachers often use an absorption pattern of instruction where they motivate, instruct, and assess student learning. It is common belief that transmission of information is most efficient way to instruct and cover a wide-body of material (Becker et al., 2000). However, it's not the most effective for student learning. The right

Table 5: Basic Intended Use

	Intended Use	Charter MS		Public MS	
		Rebecca	Anna	Colleta	Jenna
Pre-enactment	Reviews project details	x	x	x	x
	Selects project fits core scope and sequence	x		x	x
	Sets up Project Run	x	x	x	x
	Plans how to assess student learning	x			
	Pre-registers students				
Enactment	Runs project to completion	x			
	Enables and/or facilitates student collaboration	x	x	x	
	Surveys student ideas	x		x	x
	Addresses the whole class about difficult concepts	x		x	x
	Works individually with students	x	x	x	x
	Provides feedback	x			
Post-enactment	Scores student responses	x			
	Develops or uses rubrics	x			
	Shares the project run			x	

technology tools can ideally help teacher's cover content in less time and improve student learning. In this study, each teacher used WISE as the instruction part of their teaching pattern. Prior their enactment of WISE, three teachers, Rebecca, Jenna, and Colleta offered opportunities to elicit students' ideas or "pre-teach" as recommended in the *FAQs*. Both Rebecca and Jenna reported reading the *FAQs* prior to enactment.

Rebecca reflected an instructional pattern that was that most inline with the intended use of WISE, but she still spent some time transmitting information. Two of the three days Rebecca was in the computer lab with her students, Rebecca started off class with some pre-teaching. She conducted the pre-teaching by guiding the students through some facts they had already covered in class. For example, on the first day, Rebecca writes “Chemical Reactions and Climate Change” on the board and instructs students to title their notes with it. She asks the students, “What is a chemical reaction? Check your notes.” All of the students checked the notes they had

Table 6: Optimal Intended Use

	Intended Use	Charter MS		Public MS	
		Rebecca	Anna	Colleta	Jenna
Pre-enactment	Previews Project Entirely	x	x		
	Customize or author projects				
	Groups students into pairs of 2-3	x	x		
	Records data on high	x			x
	Enables the real time classroom monitor	x			x
	Runs a compatibility check				
	Aligns assessment to student learning goals				
	Evidence of department-wide alignment				
	Monitors and managers students as they register for an account and login.	x	x	x	x
Enactment	Elicits student ideas			x	x
	Guides students to experiment and add ideas			x	
	Monitors students as they distinguish ideas	x			x
	Provides opportunity for reflection		x		x
	Facilitates and manages collaboration in groups	x	x	x	
Post-enactment	Applies a two-tiered assessment strategy	x			
	Contributes to the development and refinement of WISE projects				
	Participates in the WISE community				

made previously during a lecture Rebecca gave, then one student responds to Rebecca’s question. Rebecca acknowledges the students response. She asks another question: “What is a Chemical change?” A student volunteers the answer. Rebecca asks the student to put it in his own words. He responds in own words. Rebecca then asks for more examples and fields responses from students. This continued until she introduced the WISE project. The next time that the students were in the computer lab, she conducted similar pre-teaching on the topic of Thermal Energy. During this pre-teaching, the Rebecca spent most of the time in memory recall activities and transmitting information to the students rather than having them generate the information. Although the teacher is asking for students to respond and present their ideas, she is looking for a right answer. The same approach to transmitting information is observed in Jenna's

Table 7: Teacher Role and Teacher Tools

Teacher Role	Rebecca	Anna	Colleta	Jenna	WISE Tools and Features	Rebecca	Anna	Colleta	Jenna
Monitor	x	x	x	x	Progress Monitor	x	x		
					Real Time Classroom Monitor	x			x
					Step Completion Display	x	x		
					Flagging Tool				
Manager	x	x	x	x	Project Library	x	x	x	
					Preview Project	x	x		
					Info Link	x	x	x	
					Manage Student tool				x
					Pause Button	x			
Curriculum Designer	x				Authoring Tool				
					Grading Tool	x			
					MyNotes				
Guide	x				Feedback and Comment Boxes	x			
					My Notes				
					My Announcements				
					Pause Button				
Evaluator	x	x	x	x	Grading Tool	x	x	x	x
					Show All Work Feature	x			
Community Member			x		Share Project			x	
					WISE Forum				
					WISE Facebook Group				
					WISE Twitter				

classroom. She gives the students a writing prompt, and then asks for student responses. Like Rebecca, she is looking for the right answer rather than student thinking about a topic. Even though both Rebecca and Jenna were eliciting student ideas, the answers were restricted.

Colleta, on the other hand, opened class on the third day of enactment by projecting a video from inside the WISE project. Once the video was over, she asked some memory recall questions and solicited student responses. Two students share prior knowledge from experiments in fifth grade about the topic. Colleta connected it to the current experiments they were conducting in class on beans. Several students shared further questions and ideas, and Colleta explained they would investigate the results later in the week. Colleta's approach was more aligned to the Knowledge Integration framework. She also reported having "criteria" for the selection and use of technological resources in class. The criteria included that the visuals should to be clear and easy to read. The vocabulary and language access points should meet the students where they are at academically, and it should clearly connect to the learning objectives. These criteria are integrated with her regular instructional pattern.

Traditionally, teachers tend to try and motivate students when transmitting knowledge fails, but with Knowledge Integration, the content is ideally accessible and engaging (Linn & Eylon, 2011b). This was less of a challenge in each teacher's enactment of WISE because they all used WISE as the instruction part of their teaching pattern. Rebecca shared that, "overall, [the students] were engaged and when I walked around they were working together, and they were asking questions." Anna stated that her students were "running the show" for her. "They were helping each other with the technological issues," she expanded, "and they were helping each other find the answers, typing everything up and just thinking like scientists exploring the questions and exploring answers what would be a good response." Colleta stated: "Normally, I would use the projector and my computer and show visual images on either a video clip, or pictures I took off Google Images or Animations, and so the kids… that zone out more easily, I would have to redirect them more frequently." However, in using WISE, she did not have to redirect them as frequently. Jenna observed that “having every student engaged was beneficial… it [was] a nice break for the teacher, but they're still getting good content, rather than a video.” She continued by saying, “sometimes I'll [show a] *Bill Nye* video, but I feel like some kids check out. It's a lot harder to check out when there's a computer in front of you, and I can see when they're checking out, because I can walk around and say, ‘You haven't moved from this’.” The *FAQs* offer some suggestions for how to implement WISE into lesson plans.

Traditionally, teachers do not believe students can distinguish ideas and self-correct by identifying the wrong ones. They believe they have to tell students what the right idea is (Linn & Eylon, 2011b). However, Knowledge Integration is based on the premise that teachers and collaboration with other students can guide students through the process of distinguishing ideas. This challenge is best illustrated in one instance in Colleta’s classroom as the students were progressing through the WISE project run. A student asked Colleta about energy being created or destroyed and Colleta informed the student that it cannot be. The student gives an example of it being destroyed, and Colleta tells him that is not an example of it being destroyed. She repeats the definition for the student. Using more Knowledge Integrated approach, Colleta could have suggested the student discuss it with his partner while she listened to the discussion. For the most part, the patterns and processes the teachers employed to enact WISE reflected the nature of their “teacher-centered” classrooms on a day-to-day basis whether they are using technology or not. There is some evidence the WISE influenced a slight shift in teacher behavior, especially in Rebecca and Anna, during enactment because of the way WISE is set up to run, but for the most part, it ran as the teachers traditionally use it.

Lastly, among the known challenges, teachers traditional believe that active learning means that students are doing something, but the Knowledge Integration framework operates from the standpoint that active learning also means reflection. Through research, it is known that teachers enacting WISE for the first time may find the new inquiry-oriented instructional practices awkward at first (Gerard, et al, 2011, Linn & Eylon, 2011b). They have trouble shifting from their traditional approach to instruction. This may be demonstrated in the teachers shortening the length of a project run and deleting parts of the inquiry. In this study, Colleta, Jenna, and Anna reported that they though about cutting material from the next project run because the project went into "more depth" or was "over the student's head." Research shows that when teachers select to use only parts of the inquiry, the project run is less successful with student outcomes than the ones who implement the whole Knowledge Integration pattern. Incidentally, the students in Colleta, Jenna, and Anna's classes did not complete the project run. More about this "awkwardness" and the impact of time management is illustrated in the following discussion on the teacher's role in the classroom during a project run and the goals for using technology.

Teacher Role

Classroom management was a big part of enacting WISE for every teacher who participated in this study. Each teacher spent the predominant part of her enactment serving as either a monitor of student learning or a manager of the project run. Even in that, teachers found themselves mostly managing students in every act of implementation. Rebecca and Colleta appeared to be comfortable with their roles in planning and enacting the project run. From their uses of WISE, it seems that having criteria for use and planning ahead reduced the evidence of "awkwardness" when enacting WISE. Planning, though, appeared to make the most difference. Rebecca took about three hours total to plan her enactment of WISE. This planning is reflected in reason why she set up groups, her pre-teaching, and her assessment of student learning. During class, Rebecca assumed her role as monitor, manager, guide, and evaluator fluidly. She is observed walking around the room listening to student discussions, offering guidance, and monitoring progress. She is also observed reviewing student responses in real time and providing feedback. Her student all completed the project run for homework. Colleta took about thirty minutes to plan her enactment of WISE. The presence of her own personal criteria for selecting and using software helped her plan quickly. As previously discussed, Colleta used a WISE video to elicit student ideas around a part of the WISE project and allowed students to connect those ideas to the experiment they were conducting in class on plants. During the run, she allowed the students to talk with each other and is observed spending most of her time with three students who have a history of need more support with science content. However, when those students did not need help, Colleta walked around the room, interrupting students who were working to see where they were at in the project run and ask questions. About half of Colleta's students finished the project run.

For Anna, the "awkwardness" of her role in the classroom during enactment manifested itself in her attempt to control the noise level and the increasing structure she added to the way in which students to worked together. Students were observed engaging in lively conversations during the project run. However, her management slowed student progress through the project run. Students were observed "shushing" each other and spending time worried about how loud they were talking. Additional, because the groups were larger than WISE recommends, some students expressed frustration with their groups. Anna responded to this frustration by having all four students log one tablet to work. This took some ingenuity to accomplish, because WISE only allows for groups of 2-3. A student found a hack where if she paired every student in the group with someone different in the group, she could log all of the group members on together. However, this hack took several minutes to do every day on one tablet. Additionally, the tablets were very small and a few students expressed difficulty seeing what was on the screen. When Anna became aware of this issue she instructed all students to have one person read the question aloud, take turns watching the visualization, write their own individual responses in their notebook, share the responses with their group, and decide together what to type into the WISE. Ultimately, the students did not finish the project run.

Jenna also demonstrated a little "awkwardness" in class. She instructed the students to only ask her for help and then she found herself managing a number of technical issues while trying to also help students who needed guidance or to talk with someone about what they were learning. She is observing moving around the classroom as if putting out fires, and checking everyone's computer screens to make sure they were moving along the project run. At one point, there were a number of hands in the air while she was trying to help a student who was having problem logging into his account and work practically came to a stand still in class while everyone was waiting for the teacher. As with Anna, the students did not end up finishing the project run.

Priorities of Use

Becker (2000b) identified exemplary computer-using teachers through their survey responses to five areas of technology use: 1) the goals they had for computer use, 2) the general function of computers in the classroom, 3) the saliency of the teachers approach to using technology for the major learning activities in class, 4) the types experiences students had with specific kinds of software, and 5) the frequency of student computer use. Therefore, exemplary teachers were those that, for the most part, had students engaged in software and technology two-three times per week or intensively for certain units of instruction in ways that specifically enhanced the students' ability to understand the concept being taught. The specific ways in which the use of technology could enhance student learning varied by subject, but in general, the exemplary use was defined by the strength of its connection to the learning goals. It was not defined by activities involving rewarding students for completing other work, practicing basic skills, or enrichment.

Becker (2000b) also investigated exemplary teacher use by comparing it to typical teacher use. The report of findings uncovered several factors in the teacher's work environment, teaching practices, personal background, and experiences working with computers that could predict the "exemplariness" of teacher use for consequential activities. Becker (2000b) defined consequential activities as computer activities wherein the student was using technology to achieve a learning goal such as using the computer for writing an essay, rather than writing an essay to practice keyboard skills.

Stemming from Becker's research, this investigation of intended use identified three different priorities of use that appeared to be in conflict with one another. The first priority is the one WISE intends. WISE intends the platform be used for inquiry learning in science. As discussed previously, this priority is evident from the Knowledge Integration pattern built into the WISE design as well as all research and development around the student use of WISE.

The second priority is the purpose the teacher sets for using WISE. Rebecca used WISE to bring together two very complicated science topics and capstone her instruction. Her purpose for using WISE was aligned with WISE's purpose. Colleta and Jenna, on the other hand, used WISE to cover a complicated section of standards based content quickly and take a "break" from lecture-style instruction while Anna used WISE to get a “feel” for the technology and to give her students an opportunity to practice their technology skills. These uses were not in line with WISE’s goal for use. In turn, Colleta, Jenna and Anna all reported that students were rushing through the project to get it done. Their purposes for using WISE seemed to support the third goal for use that emerged- the students’ goal. Students simply want to complete the work assigned to them. In contrast to Colleta, Jenna, and Anna’s students, Rebecca’s students were observed grappling with the content and trying to understand the material rather than finish it.

Influences

Rebecca demonstrated many intended uses of WISE indicating that is possible to use WISE as intended on the first use without training. Her use of WISE was influenced by a several factors. These factors can be summarized in two sections: 1) Fitness of the Technology, and 2) Design for Teacher Use.

Influence of Fitness

The fitness of the WISE and how it influenced each teacher’s use is comprised of several parts. One part involves how well teachers perceive that WISE aligns with the curriculum and established instructional norms at the school site. In Rebecca’s enactment of WISE, she felt conflicted using it to teach her unit because at her school site, there is an established norm to stick to the book. The textbooks “are supposed to be matching up with the standards,” she stated. She goes on to say that because the school is “very test oriented” she felt “a little pressure doing the project…feeling like it wasn't the most productive way [to teach the lesson] because the *SBAC* test (a state standardized test)” was coming up. Rebecca expressed difficulty finding a project in the library that matched the book. “There weren't many options,” Rebecca noted. While WISE projects are espoused to align with California State content standards, in my document review, I found that many of the projects in the project library do not specify the standards covered. After previewing several projects, Rebecca selected the “Climate Change” project because it brought together two concepts she had recently taught.

Customization is another aspect of fitness that facilitates a teacher’s ability to use WISE in the classroom. Teachers are afforded the option of authoring or customizing projects through the authoring tool if they cannot find one that fits in within the core scope and sequence of instruction. The use of the authoring tool is not associated with the basic intended application of WISE, but it associated with optimal intended uses. *Optimally*, student learning is maximized when the curriculum and instructional strategies align with the Knowledge Integration framework, which combines Constructivist theories about how teachers teach with Cognitive theories about how students learn. In my document review, I found this use of WISE embedded in the research articles published on the website, but many of those articles are not accessible by teachers. In Rebecca’s enactment of WISE there is no evidence of this kind of alignment. When asked if she considered using the tool, Rebecca replied, “I didn’t trust myself to figure any of that out.”

Time is another aspect of fitness. This was also a concern for Rebecca. It took Rebecca three hours to familiarize herself with WISE and plan the enactment of it. Rebecca stated several times that the project very time consuming, and she felt WISE underestimated how long it would take to run the project. WISE typically recommends a week, but each project has its own estimated computer time. She planned the enactment of WISE for three days in the computer lab over a six-day project run. However, the students were not able to finish the project run in class and as stated earlier she instructed the students to complete the project for homework instead. In reflection, Rebecca said: "I felt like it was time consuming. The [visualizations] were very difficult to understand… the learning curve of them being able to just use the program, create their own pictures, and how to write a response just seemed pretty slow for my students." Rebecca was able to manage around these time issues, but time contributed to the reasons why two of the other teachers did not complete the run with their students.

Anna, for example, did not report how long it took her to plan, but shared that she had expected it to take three days in the computer lab over a five-day spread. It ended up taking four days over an eight-day spread. Given that it took over 30 minutes to register students, Anna grew concerned about running out of lab time, but she also wanted the class to stay in sync with each other so she held up all the groups until most of them could start work. She was observed repeatedly instructing students to register quickly and work quickly the first two days, but at the same time, she was also observed slowing them down by adding increasingly greater tasks to how they worked together in groups. Anna's students did not complete the project run. Neither did Jenna's students. Jenna reported "not planning very much at all, maybe twenty minutes." She also only allowed two days to run the project and was comfortable with the fact the students did not finish all the parts because she felt the last section was too advanced for them. In examining the differences between the time spent planning and preparing, I found that this part of using WISE as intended depended almost entirely on the teacher. Documents like the *FAQs* and the *Quickstart* guide help support the intended teacher use *basically*, but there is not a tutorial on how to plan and prepare to use WISE *optimally*. Consequently, students did not complete the project run.

Registering students for accounts and logging in as groups also took time for Rebecca. The WISE website indicates this process should only take ten minutes. WISE intends for students to conduct the registration process themselves. The FAQs state that "WISE makes student registration simple and intuitive." All a teacher needs to do is direct students to the *WISE* homepage, provide them with the access code and the students should be able to be registered in under ten minutes. For Rebecca, it took approximately twenty minutes to get all the students working on the project. The biggest delay observed involved logging students into groups. Rebecca's experience was similar to Anna's in that it took over thirty minutes for a majority of the students to begin working on the project. Again, the biggest delay involved logging students into groups and negotiating how to use the technology between them. Since both Rebecca and Anna teach for only an hour a day, this delay on the first day influenced the time the students had to complete the project run. While Rebecca's had students complete the project out of class, Anna did not require her students to complete the project and consequently, she also did not assign a grade to it in her grade book.

For Colleta and Jenna, students registered for accounts, logged in, and ran the project in closer to ten minutes. Neither Colleta nor Jenna had students working in groups. Of the few students between the teachers that took more time to log in, the issue involved their username/password. The *Quick Start Guide* notes that student usernames all take the form of the students' first name, followed by last initial, followed by birth month and date (JohnB0210, for example). WISE intends for this username format be easy for students to remember. However, if a student should forget their username or password, WISE recommends that teachers first have students write down this information when they register and second, try to solve the problem themselves. Both teachers had students do this, but the students spelled something wrong when registering. If they still cannot solve the problem, then teachers can look up the student's username/password through the *manage students* link in the active project run on the *Teacher Management* homepage. Neither Colleta nor Jenna could find where the student usernames/passwords were located from *Teacher Management* page. Both are observed spending most of class on the first day with these few students trying to help them figure out what they did wrong. Consequently, Colleta and Jenna had some students finish the project quickly, while others found themselves way behind. Neither required students to run the project to completion. It is evident that the use of groups requires more set up time than students working individual. It consequently influenced the teacher's use of WISE as intended.

Access to technology is the last aspect of fitness that influences teacher use. Through each teacher's use of WISE, I found that whether perceived or real, the limited and/or complicated access to technology further impacted the time it took to run the project and use it as intended. At Rebecca and Anna's school, tablets were locked in a cabinet inside an administrator's office. The administrator was the only one with a key and the administrator was not always on campus. Each time Rebecca or Anna wanted to use the tablets, they had to send students to get them and bring them to a room across campus where the Internet had the best speed. Subsequently, they both would discover they needed chargers and send for students to get chargers. Additionally, they both discovered that when the project began to play the videos out loud, the students needed headphones. So they both sent students to get headphones. Every day of the run, similar issues came up resulting in delays and chunks of time being lost. Specifically with Anna, the access to technology influenced her perception WISE's fitness. One of the days she planned to have students in the lab, she had to cancel because the administrator with the key to access the tablets was not on campus. While for Rebecca access was an obstacle that influenced her ability to manage students to project completion, for Anna, it was obstruction. Her students did not complete the run.

Access further influenced Rebecca's ability to make sure the technology was prepared for the students to learn. In the pre-enactment of WISE, it is intended for teachers to run a compatibility check of WISE software on the devices the teacher will be having the students run the project. There are number of places on the WISE homepage and within each project in the Project Library where the *compatibility check* is linked. Clicking on the *Compatibility Check* link performs a system check of the device in use to determine whether the browser and networks can run the WISE and provides the user with status. For example, the check may say, "you can run WISE" or "you need to update Javascript to run WISE." It may also provide warnings. It may also say you can run WISE but you may not be able to run some of the Java applets if you do not update them. Then it provides you with an overview of all the tech requirements.

Rebecca expressed that she wanted to run a compatibility check but the lack of access made it impossible. This, in turn, impacted the students on one step of the project where they were unable to see a demonstration embedded into the question. Rebecca, once again, demonstrated her ability to work around these types of hindrances to use WISE as intended. She pulled up a preview of the project on her laptop and as students reached this step, she let them watch it as many times as they needed. Colleta and Jenna had similar issues with being able to run compatibility checks prior to enactment. They did not have access to the computer lab or permission to update the plugins on the computers in the lab. Colleta sought help from tech support at the school site, but tech support indicated that they could not update the plugin because would cause other software on the computer to stop working. As a result, they had issues with videos, visualizations, and animations not playing on some of the computers. Colleta had students look on another friend’s computer. Jenna would individually talk each student through what the video, visualization or animation was doing. At one point, she could not remember what the animation was, so she just had students skip the question. WISE states that all is needed to use WISE are a computer with an Internet. However, it is evident more is needed to run WISE efficiently.

Influence of WISE Design for Teacher Use

In my document review, I noted that the *progress monitor* was difficult to locate from the *teacher dashboard*. Eventually, I found that the *progress monitor* was a feature of the *grading tool* and it is labeled, *student monitor*. It utilizes the *real time classroom monitor,* which is feature highlighted a number of times in WISE documents to support the teacher’s roles as a monitor and manager. Rebecca and Jenna were the only teachers to actually use the *real time classroom monitor* to check student progress through the run during class. However, they both pointed out the same confusion I found in my document review.

Rebecca said that the website highlighted certain features and tools, but it was not intuitive to her. It was difficult figuring out what tool was what and where everything was located. When she finally found the *progress monitor* for example, she was not sure what it did or how it could help her enact WISE. Clicking around helped her figure out some things, but overall, she said, “there were all of these features that weren't apparent to me, and they weren't clearly explained in any way.” Jenna echoed the same confusion when discussing her use of the *manage students tool* and the *grading tool*. “Just trying to figure out how to monitor the kids” Jenna shared, “when I say ‘monitor,’ to me…[that] would be seeing their progress. And the button that was labeled *Classroom Monitor* was literally just their screen names, or their usernames, and the ability to change their password, or to remove them from the class. So, in order to monitor them, you had to actually go to the grading tool." In her recollection of the tools, Jenna mistook what she called, the "classroom monitor" for the *Manage Students* link. In this example, Jenna is further illustrating the confusion that exists in finding the appropriate teacher tool to perform the intended teacher tasks. As a result, she looked at it but did not really interact with it. In reflection, Jenna shared that she would have used it more if she could have figured it out quickly in class. Anna also indicated that she lacked clarity with regards to the teacher tools: "I would say that I kept using, I forgot the exact name, but it's where I got to keep track of the progress, the student progress. I wanted to see especially in the middle of it how often, how far along were they or I'd check at the end of the day, how much did they actually get done." She figured it out by "just playing with it and exploring." Anna, however, did not enable the *real time* feature of the *progress monitor* when setting up the project run so she was not aware of student progress through the run until after the students saved their work and logged out.

Influence of Configuration

Access also influenced how Rebecca chose to group students during the project run. Rebecca organized students into their "teams" of two students per device. When asked why she chose to have her students work in pairs, she said: "I honestly was concerned about having enough tablets… so I never considered the option of doing it individually. Once we got there… I realized that there were enough tablets to do pairs… Originally, I was thinking of groups of three to four. I'm really glad I was able to do pairs. I think honestly doing it individually would have been a little to difficult for them." Within the context of the classroom, WISE basically intends for students to run through the project working collaboratively. The *optimal* use of WISE is to have student collaborate in groups. According to "Science Teaching and Learning," collaboration is when two or more people are engaged in a learning activity together. Students must communicate, seek feedback, and jointly try to solve a problem. It requires students to respect each other, appreciate the roles each person is playing in the collaboration, and to help each other out (not give each other the answer). For collaborative activities to succeed the teacher should establish norms, design or select effective collaborative activities, model promising ways to work with each other, group students (heterogeneously) who have the potential to help each other, implement valid methods for assessing the individual and group. In the *Quick Start Guide* and in the *FAQs*, WISE states that it is recommended students work in pairs of two per device.

Like Rebecca, Anna chose to have students work collaboratively because the limited access to technology and because her students rarely did group work. When I asked her about her reasons for grouping students, Anna said: "I wanted them to work in groups because they're so used to working independently. Just because of my formation of the classroom, it's lecture. It's check for understanding and then it's independent work … I've always talked to them about having to work in groups and with other people whether they like it or not, so this was a perfect reason for it because then also some [students] feel stuck and this could be a way for them to help each other or for some people to learn that you have to work with other people in this world. There is no way that you can just be a solo human being in a cave." She also explained that, "once they were in there [registered in groups on WISE], it went pretty smoothly. It was just a matter of getting them to work together to actually complete the assignment."

Colleta and Jenna, on the other hand, both opted to use the computer lab instead of their iPad carts because they purposefully wanted the students to work on their own because they wanted the students to be accountable for their own learning. “ My students,” Colleta explained, “where they are in terms of technology, is that they need that individual accountability piece where they are going to have to be typing something in, or looking at it themselves, or interacting with the device themselves.” Colleta did not group students but she allowed them to talk to each other and ask for help during enactment. Jenna reported that when she used the iPads for another “Berkeley Interactive,” the students worked in pairs and they tended to mess around. In her enactment of WISE she wanted students to be more accountable. It is evident that access to technology influences the configuration of the project run, but the greater influence evidently is the teachers’ beliefs about a capability of their students to learn.

Influence of Progress Monitoring and Feedback

Feedback on student work is an intended part of enacting WISE. Any and all feedback is *optimal*. There are two types of feedback loops involved in the intended use of WISE: peer-to-peer and teacher to-student. The peer-to-peer evaluation and feedback loops are facilitated by a number of tools embedded into WISE projects. It is highlighted as a key feature of WISE in the introductory slide show on the *WISE* homepage because it encourages students to “self-monitor progress and solidify ideas before moving on.”

In Rebecca’s enactment of WISE, she reviewed student work in real time as they progressed through project. She also provided feedback along the way. In doing so, Rebecca appeared more in control of the student learning. She was observed targeting individual support and guidance to pairs of students regularly throughout the run rather than running from one group to the next answering questions. Her use of the grading tool and progress monitor were largely influenced by the time she took preparing to use WISE. These tools, in turn, influenced her ability to individualize student instruction and help. Her students are not observed rushing through the project.

As Anna ran the project, she is observed wandering around the room. Primarily, she would answer questions and insert instructions into what students were working on. Anna noticed in her project run that some groups were trying to get through it really quickly. By the second day some students claimed that they were done. She reviewed their responses and had them revise it by adding more evidence and giving them a minimum number of sentences to write for each response so that they would dig deeper into the content. Students in Colleta and Jenna's class also attempted to race through the project. Colleta only reviewed student responses at the end of the project run. She provided no feedback to students during the project run other than what she verbally shared with them in the classroom. Colleta reported that some students were declaring they were finished on the first day. Colleta is observed reviewing responses with them and asking them to write complete sentences and redo some steps. Jenna chose to review student responses at the end of the run even though her students did not finish. She provided no feedback during the project run. Jenna reported that her students rushed through the project. It is observed several students saying they were finished by the end of the first day. Jenna reviewed their responses and saw they had skipped steps. She had them go back and completed them. The speed and quality with which students worked through the project was influenced largely by teacher's progress monitoring and feedback.

Challenges

Integrating technology into classrooms has always faced barriers in one form or another (Ertmer, 1999; Ertmer & Ottenbreit-Leftwich, 2010). With the influences around teacher use in evidence, three challenges were noted. One challenge involved making the patterns of instruction (i.e. the Knowledge Integration Framework) that facilitate student-centered learning visible, accessible, and natural for teachers to enact. Another challenge involved addressing the traditional teacher's role in the classroom and designing the teacher's interaction with WISE in such a way they feel confident and empowered to shift away from that role. One further challenge involved the need to resolve the conflicting priorities of use that evidently exist between the technology, the teacher, and the student.

Making Intended Patterns of Instruction Visible

Hall (2010) identified the need for an *implementation bridge* to guide teachers' mechanical use of technology to the routine use of technology for student outcomes. Mechanical use of technology focuses simply on making the technology work in the class. Routine use is where teachers can focus on student outcomes. Bridging the gap between the prescriptive use of WISE in research, which is known to lead to significant student learning and the unscripted use of WISE in the real world where results are still unknown is paramount to its sustainability.

In studying the intended uses of WISE, I found the Knowledge Integration Framework is the backbone of student learning in WISE, and it is intended to be operationalized inside of an instructional pattern that elicits student ideas, facilitates the experimentation and process of adding to those ideas, guides iterative process of distinguishing between all the ideas, and provides opportunity for reflection. However, this pattern of use is almost entirely camouflaged to teachers who are new to using WISE and untrained in its applications. To encourage the use of WISE optimally, teachers would benefit from guidance within the design of WISE that makes the instructional patterns supporting student learning with WISE visible to them. However, as it currently stands, this suggestion tests the open source, flexible, and adaptable nature of WISE thus presenting a challenge. While on one hand, making the instructional pattern visible enhances it use, on the other hand, it has the potential to limit what users do with it.

Addressing the Teacher's Role

WISE intends for teachers to play a number of roles during the enactment of a project run. Out of all these roles, I found that teachers predominantly played the traditional roles of monitoring and managing students. The design of WISE does a great job of acknowledging the teacher's traditional role in the classroom and as a result, it makes WISE usable by teachers who are attached to those roles and uncomfortable with student-centered instruction. The next challenge WISE encounters, though, is in enhancing the design to facilitate and empower teachers to embrace additional roles. From observing Rebecca's enactment, it is evident that it is possible for a teacher to assume all his or her intended roles as monitor, manager, guide, and evaluator fluidly. Taking into account the amount of time Rebecca spent planning and clicking around the teacher dashboard to acquaint herself with WISE, it seems the next step is to further investigate the teacher experiences with WISE and identify exactly what can be done to optimize the process in which teachers engage to familiarize themselves with new technologies. Given the curricular and administrative demands teachers encounter (Shamburg, 2004) alongside several constraints like large class sizes, inadequate prep time, lower levels of training, inadequate classroom space, and outdated materials/technologies/resources (Songer et al., 2002), teachers tend to emphasize a directive, controlling style of teaching. These demands and constraints are not totally insurmountable, though as Rebecca demonstrated. Equipping teachers with these internal supports has the potential to reduce planning time and empower them to enact other roles in the classroom, developing in their instructional practice towards student-centered teaching over time.

Reconciling User Priorities

WISE has one priority in both the *basic* and *optimal* models of intended use: student learning. However, in this study, I found that while the teachers who participated admired that quality in WISE, student learning was not the primary reason they wanted to use it. All of the teachers except Rebecca primarily wanted to cover a great deal of content quickly. Students wanted to use WISE simply to get the work done. Learning was not their priority. Thus, WISE faces a challenge in its design to resolve these conflicting priorities. Rebecca's enactment of WISE provides insight into what that may look like. In using WISE as a capstone activity and taking the time to plan instruction, she was able to reconcile these conflicting priorities. In contrast to the other three teachers who had students rush through the project run, I observed her students grappling with the hard to grasp topics collaboratively. As a result, they were the only ones to actually complete the project. Designing the technology to facilitate and support the teacher's lesson planning may help them set priorities for use that are more in sync with WISE. Further research into defining and resolving the logistics of these priorities is needed.

Summary of Findings

In sum, to answer my first research question, I found that WISE has two intended uses: *Basic* and *Optimal*. The *basic* intended teacher use of WISE is involves planning and preparation, running the project to completion, providing feedback, and assessing student learning. Teachers are *basically* intended to be monitors, managers, and evaluators of student learning while utilizing basic features of the project library, student management tool, and grading tool. The *optimal* intended use I found involves supplementing the core curriculum, enhancing the core scope and sequence of instruction, and aligning assessment with the goals of instruction. WISE projects are intended to be facilitated through student-centered teaching practices and inquiry-based instruction in a collaborative learning environment. Ultimately, it is intended that teachers share the projects and lesson designs with other colleagues for feedback and iterative development towards improving the Knowledge Integration of students. In the *optimal* enactment of WISE, teachers are intended to be curriculum designers, guides, evaluators, monitors, managers, and community members utilizing the full suite of WISE tools and features to enhance student learning.

To answer my second research question, I first found that WISE could be used as *basically* intended on the first use. Rebecca expressed interest in using WISE again, but not until the some of the other influences such as time planning and access were better. The other three teachers all expressed a desire to use WISE again, but with changes that would eliminate salient portions of the inquiry in the WISE project they used. Optimal uses were virtually non-existent across the board because there are not very many supports built into the design of WISE to help teachers understand how to use it in ways that impact student learning. Outside the design of WISE, time and access to technology were noteworthy influences over how teachers decided to have students register and run a project, but beliefs about how students are capable of learning predominantly dictated how teachers configured it. For the most part, the patterns and processes the teachers employed to enact WISE reflected the nature of their teacher-centered classrooms rather than the student-centeredness. There is some evidence WISE influenced a slight shift in teacher's instructional pattern towards student-centeredness during enactment, especially in Rebecca and Anna, because of the way WISE is set up to run, but for the most part, the teachers employed traditional instructional patterns. Finally, I found the *real time* teacher use of the *feedback* and *progress monitoring* tools influenced the speed and quality with which students engaged with WISE.

CHAPTER 5

Discussion

This study sought to understand more fully the design and intended use of a technology-enhanced learning tool designed for student learning in science and whether science teachers who were new to using it and untrained in its use, implemented it as intended in their classrooms. By examining the intended uses of technologies designed for student learning alongside the teachers' use for them, I sought to discover the ways in which the design for technology-enhanced learning tools had the potential for shifting instructional practice towards student-centeredness. Given the scale of this study, the findings are limited in scope. However, the influences of fitness, design, configuration, and progress monitoring prove to be factors in determining how teachers use WISE. Parallel to addressing the factors that influence the way in which teachers use WISE, the technology also faces the challenge of making the instructional patterns visible, addressing the teachers role in the classroom, and reconciling the various user priorities. These factors need to be further verified and explored. WISE is proven to improve student learning through design. My findings suggest that the current design of WISE allows for it to be used by teachers *basically* as intended, and in conclusion, I offer some recommendations in the design of WISE to enhance teachers' ability to use it *optimally* as intended.

Recommendations

Overall, WISE can be basically used as intended despite the challenges it faces. This is evidence of good design. Drawing from the influences that primarily impacted Rebecca's use of WISE, I offer some recommendations in this section for improving upon that good design to address the factors that influence teacher's use and the challenges that became evident through this research.

Recommendation #1: Improve Perceived Fitness

WISE can improve the perceived fitness of the technology in three ways: 1) WISE can provide additional guidance selecting and using projects through web-tutorials, power points, and research papers; 2) WISE can link all projects to Next Generation Science Standards; and 3) WISE can offer suggestions for customization and link to web-based tutorials on how to use the authoring tool.

Currently the "Getting Started" page is helpful in addressing the technical and logistical concerns teachers have as they prepare to use WISE for the first time. This page is a prime place to providing additional guidance in planning and preparing to use WISE optimally. It can be divided into sections: Pre-Enactment, Enacting, Post-Enactment. Within those sections, the Getting Started guide can address the basic and optimal ways for using WISE and provide a rationale as I have done in Table 1. In addition, I recommend WISE develop web-based video tutorials on a number of topics related to using WISE tools like the authoring tool for example and the classroom monitor. I also recommended a tutorial on KI Instructional Patterns that fit with one or two sample lessons as a guide for teachers and a tutorial on developing KI based rubrics. These tutorials can be linked to in key parts of the Getting Starting guide and Teacher Dashboard. Further, the Getting Started page is also the place to provide research to teachers that can inform the decisions they make in planning, preparing, grouping students, running the project to completion, and assessing student learning.

Of the eight teachers who volunteered to participate in this study, four expressed difficulty in finding a project that fit with their curriculum. In discussing the content they were trying to fit, I was able to find projects for all of them because I had previewed all the projects extensively. Given the purpose of this study, I did not provide the teachers with this information and consequently, two teachers withdrew because they could not find it on their own. As stated in the findings, many WISE projects are not linked to standards. With the introduction of the Next Generation Science Standards, WISE and technologies like it, have the opportunity to go through their project libraries and clearly connect them to the standards so that at a glance, teachers know the project will fit with the core scope and sequence of instruction they are providing. Tagging projects in this way in project details box will enable more teachers to find projects that meet their learning objectives quickly.

Further, offering suggestions for customization along with links to web-based tutorials can help teachers decide how to adapt the project to their students' needs and learning objectives. WISE can support the construction of a collaborative and iterative community of users WISE seeks to inspire, WISE can also link to a discussion forum on the project where teachers can share best practices and how to address common challenges students face in grappling with the concepts. Such links could facilitate and support the teacher's intended role as a community member and gradually introduce them to more ways they can improve their practice, collaborate, and participate.

Recommendation #2: Update the Design of User Experience

My findings indicated that WISE is usable. It is easy for teachers to get started with very little preparation once they have found a project that works and gained access to the technology needed to run the program. However, the intended use of WISE is not intuitive. There is some confusion that exists around form and function of the grading tool, progress monitor, step completion display, student monitor, and real time classroom monitor. Without the support, teachers in this study determined what they believed to be the function of the tool and consequently, that use was not always aligned with what WISE intended. For example, three of the teachers discussed cutting material from the WISE projects, which is a specific use WISE discourages because teachers tend to eliminate salient portions of the inquiry process. Teachers will feel more comfortable in their role as designers if they understood what that entails and how it is intended to improve student learning.

I recommend that WISE identify the difference between a teacher tool and a feature, label them consistently, provide tutorials for tools and screen shots of features with research-linked explanations that help teachers understand the optimal use of them. While the lack of clarity overall does not necessarily prevent the intended use of WISE, the current design of the teacher dashboard does not do enough to enable teachers. More clarity is needed for efficiency. As Rebecca suggested, WISE's design for teacher use should be intuitive and facilitate a teacher's gradual understanding of how to use WISE more and more optimally. If a teacher is not aware of what the technology is capable of, then it is unlikely they will use it as intended. Further research is needed on what can be improved upon in the user experience.

Recommendation #3: Capitalize on the Configuration Process

As evidenced in this study as well as others, teachers have beliefs about how students learn and about the capability they have in completing difficult tasks (Albion & Ertmer, 2002; Becker et al., 2000; Ertmer, 2005; Ertmer et al., 2012). They bring those beliefs into the decisions they make while setting up a project run. Some of those beliefs limit the potential students have for learning with WISE. In defining the intended use of WISE through the document review and analyzing what influenced each teacher's use of it as intended, I saw opportunities within the steps to set up a project run to support teachers' planning and in turn, potentially improve their enactment of WISE as intended from the first use. Currently, the steps to setting up the project run support a teacher's understanding of a project run and the importance of previewing the project. However, they do not articulate the differences in grouping students, data collection (high or low), or what enabling the real time class monitor all do for student learning. For example, on step four when teachers configure the project run, WISE asks teachers whether they would like students to work individually or in groups. Some guidance may be built into this step to help teachers learn more about this option and to make a more informed choice when selecting what would be best for their students. Tutorials on the different ways to incorporate collaboration can also be included. More than just clarifying use as was discussed earlier, this specific recommendation addresses the gateway to their enactment. Arming teachers with the ability to make informed decisions about how they set up WISE has the potential to influence their shift in practice.

Recommendation #4: Demonstrate Progress Monitoring and Feedback

Lastly, I found that the speed and quality with which students worked through the project was largely influenced by how closely the teachers monitored student progress and provided feedback. Even though Rebecca demonstrated the most intended use of these features, like the other teachers she did not entirely understand its purpose. Demonstrating the ways in which teachers can monitor student progress and provide feedback is fairly easy to provide. The WISE community can also source this information so that the development of these materials remains consistent with WISE's core philosophy and function. Research shows that part of the reason teachers default to traditional teacher-centered methods of instruction when integrating technology are because they essential lack a model for use (Becker, 2000b; Becker, 2001; Becker et al., 2000). Demystifying the intended use and providing tutorials and examples supports the difficulty teachers have in visualizing the capabilities and possibilities that exist in this technology.

Conclusion

A few studies indicate that the use of TEL tools like WISE should be accompanied by well-crafted, long-term professional development or it is unlikely they will operate as intended for student learning (Gerard et al., 2010; Gerard et al., 2011; Williams, 2008). On the other hand, these studies also suggest in their conclusions that TEL tools may not need such intensive support in order to be enacted as intended for student learning. In this study, found that it is possible to use WISE as intended without professional development, but more guidance definitely needed to facilitate that use. Future research should examine whether or not professional development can be built into the design of these technologies. Doing so may be more effective at changing teacher practice and more effective at increasing widespread use than having teachers formally attend professional development workshops.

APPENDICES

Appendix 1: Recruitment Email Script

Dear [Insert Contact Name],

I was given your contact information through Libby Gerard at the University of California, Berkley, and I am writing to see if you may be interested in participating in a study that I am conducting for my dissertation.

In collaboration with the University of California, Berkley, my study investigates the experiences of secondary science teachers' using technology. Specifically, I am looking at the experiences of 4-5 middle school science teachers who would like to try to apply WISE (Web-Based Inquiry Science Environment) in their classrooms for the first time. You can find more information about the program by following this link: www.wise.berkley.edu.

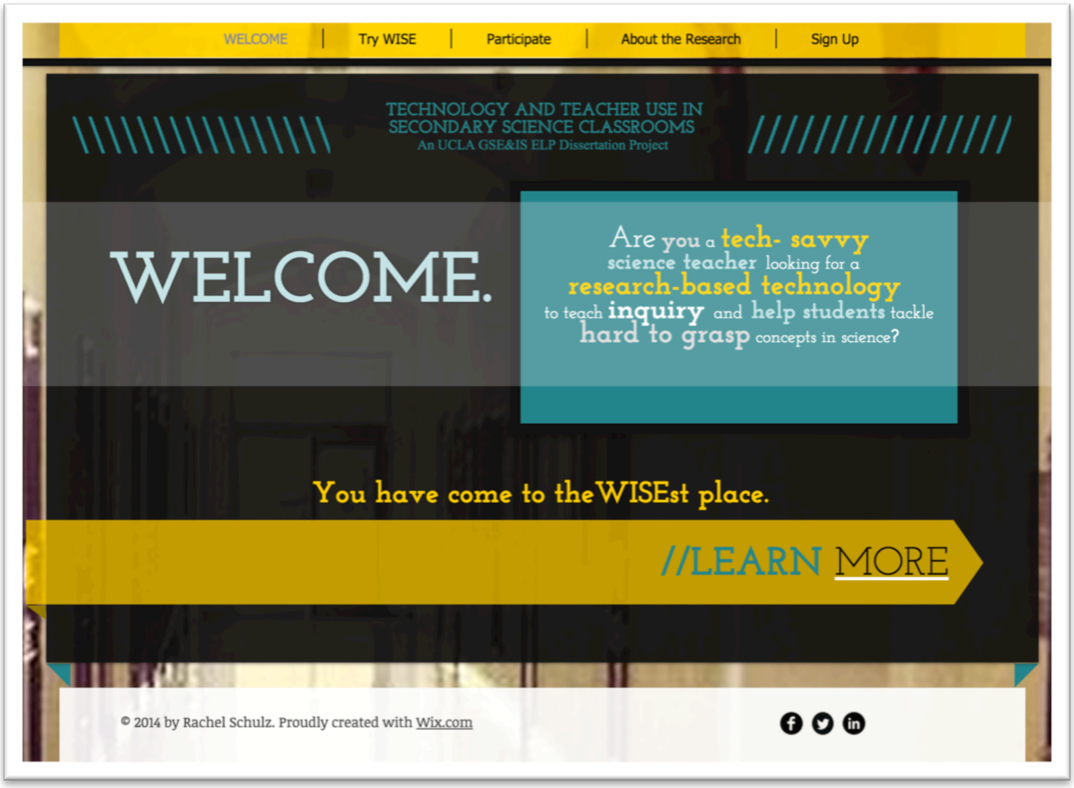
The science teachers who participate will receive an Amazon Gift Card and possibly an invitation to formally participate in WISE research out of UC Berkley the following school year. Participation in Berkley research would come with stipends, tech support, additional training and other perks, but it is important to note that these opportunities are pending the funding of a grant and would not be available for this study.

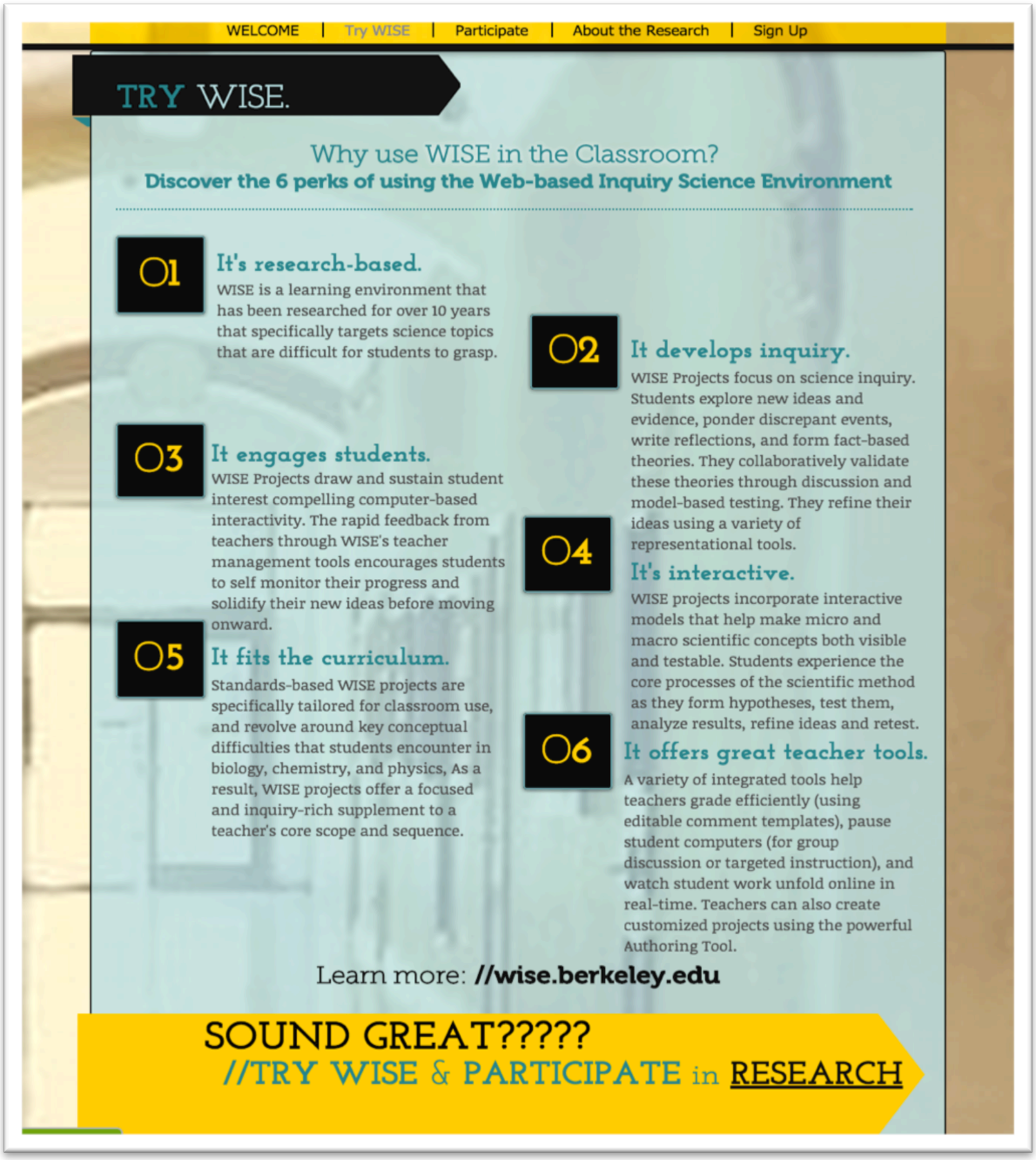
Participation tentatively requires attendance at a workshop where I introduce WISE, two interviews and some observations of the teachers using technology and using WISE, and a brief survey. These activities would take place between November 2014-February 2015. I will not be collecting data on students. There are also some technological requirements that need to already be in place at your school (i.e. the presence of a computer lab or laptop cart) for this study to happen. The program unfortunately does not run effectively on IPads yet. As a former teacher and administrator in Los Angeles, I know your time is valuable. I would greatly appreciate your participation in this study. If you are interested, please let me know. All I would need a letter of support stating your intent to participate. I can provide a template for you.

Thank you so much for your consideration,

Rachel Schulz
UCLA Doctoral Student
Educational Leadership Program

Appendix 2: Recruitment Website




WELCOME | Try WISE | Participate | About the Research | Sign Up
TRY WISE.
Why use WISE in the Classroom?
Discover the 6 perks of using the Web-based Inquiry Science Environment
01
It's research-based.
WISE is a learning environment that has been researched for over 10 years that specifically targets science topics that are difficult for students to grasp.
02
It develops inquiry.
WISE Projects focus on science inquiry. Students explore new ideas and evidence, ponder discrepant events, write reflections, and form fact-based theories. They collaboratively validate these theories through discussion and model-based testing. They refine their ideas using a variety of representational tools.
03
It engages students.
WISE Projects draw and sustain student interest compelling computer-based interactivity. The rapid feedback from teachers through WISE's teacher management tools encourages students to self monitor their progress and solidify their new ideas before moving onward.
04
It's interactive.
WISE projects incorporate interactive models that help make micro and macro scientific concepts both visible and testable. Students experience the core processes of the scientific method as they form hypotheses, test them, analyze results, refine ideas and retest.
05
It fits the curriculum.
Standards-based WISE projects are specifically tailored for classroom use, and revolve around key conceptual difficulties that students encounter in biology, chemistry, and physics, As a result, WISE projects offer a focused and inquiry-rich supplement to a teacher's core scope and sequence.
06
It offers great teacher tools.
A variety of integrated tools help teachers grade efficiently (using editable comment templates), pause student computers (for group discussion or targeted instruction), and watch student work unfold online in real-time. Teachers can also create customized projects using the powerful Authoring Tool.
Learn more: //wise.berkeley.edu
SOUND GREAT?????
//TRY WISE & PARTICIPATE in RESEARCH

WELCOME | Try WISE | Participate | About the Research | Sign Up

PARTICIPATE.

You can always try WISE on your own, but why not get an $100 Amazon gift card for participating in research while you do it!?

Eligibility.

This research project is looking for "tech-savvy" secondary science teachers from charter, private, and public schools (preferrably middle school) who have access to the following:

- Enough computers, laptops, or IPads to group students in teams of 2-4.
- Computers, laptops or IPads must have an internet connection, modern web-browser (preferably Firefox or Chrome), an updated Adobe Flash Player Plugin, and an updated Java plugin for the browser.

***Please note that some aspects of the program do not work well on IPads yet, but its not a deal breaker. There are modules that don't use Java.

Participation.

- Explore the WISE website and create a teacher account.
- Choose a WISE module use in one of your classes and prepare to use it.
- Allow a researcher to record and observe your implementation of WISE in one of your classes over the course of three days (approximately 3 hours in class total).
- Fill out a **Teacher Use Log** every day during your implementation of WISE
- Engage in a recorded interviews about your use of WISE (30 minutes each).

Total Time Commitment (approximately 4.5 hours + your personal prep time)

Incentives.

Teachers who are selected to participate will receive:

- $100 Amazon gift cards after the study is completed.
- Possible stipends for participation (Pending Grant Funding)
- Future opportunities to participate in paid research through the University of California, Berkley.
- Future training on WISE.

TO PARTICIPATE - CLICK HERE

TO LEARN ABOUT THE RESEARCH - CLICK HERE

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WELCOME | Try WISE | Participate | More

ABOUT THE RESEARCH.

Study Information Sheet

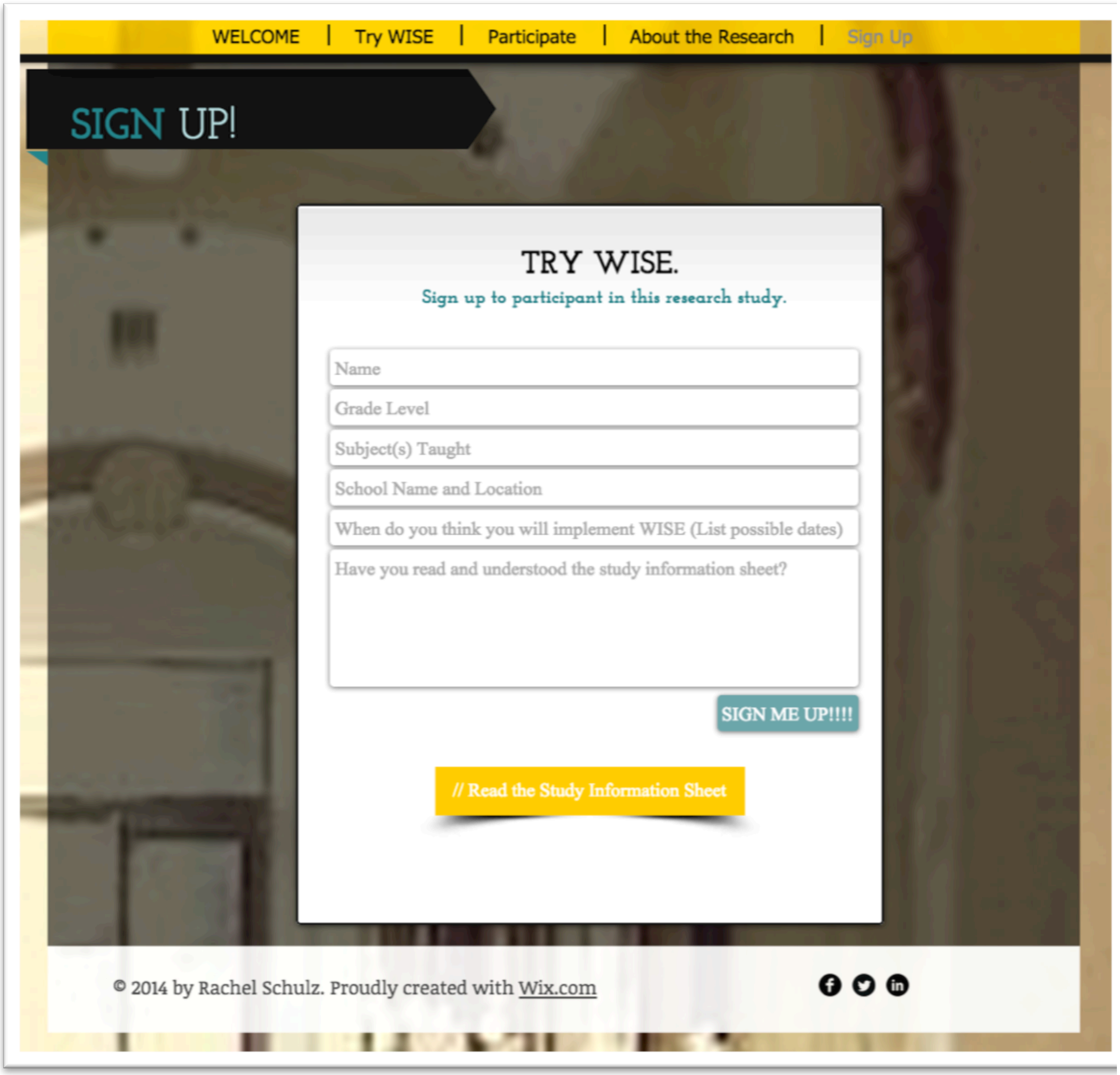
Rachel Schulz under the advisement of Professor William Sandoval from the Graduate School of Education and Information Studies, Educational Leadership Program at the University of California, Los Angeles (UCLA) is conducting a research study.

You were invited to participate in this study because you are a technology-using middle school science teacher who may be interested implementing one module of Web-based Inquiry Science Environment (WISE) during the 2014-15 school year. Your participation in this research study is voluntary.

Why is this study being done?
There is a need to know more about how secondary science teachers learn to use and apply computer technologies with web-based applications in student-centered instruction. The purpose of this research is to learn more about the factors that influence the way you use this technology enhanced learning tool in your classroom.

What will happen if I take part in this research study?
If you volunteer to participate in this study, the researcher will ask you to do the following:

- Register for a teacher account on the WISE Website (www.wise.berkeley.edu)
- Choose a module to implement in at least one period of science between January-March 2015 and prepare for that implementation.
- Participate in a 30-minute interview describing the influences that contributed to the way in which you implemented and used WISE.
- Participate in follow-up brief (15 minute) interviews or email exchanges as needed.
- Supply any lesson plan documents you may have created in regards to the implementation of WISE.
- Provide the researcher with the opportunity to observe and videotape your implementation of a WISE module over three days during one class period.


WELCOME | Try WISE | Participate | About the Research | Sign Up
SIGN UP!
TRY WISE.
Sign up to participant in this research study.
Name
Grade Level
Subject(s) Taught
School Name and Location
When do you think you will implement WISE (List possible dates)
Have you read and understood the study information sheet?
SIGN ME UP!!!!
// Read the Study Information Sheet
© 2014 by Rachel Schulz. Proudly created with Wix.com

Appendix 3: Observation Timestamp Protocol

	TEACHER NAME:	Teacher Role	Tools	Known Factors	Knowledge Integration	Setup	Preparation	Enactment	Assessment
Time Stamp	**Evidence**								
12/3/14 7:38 PM	Type evidence here. Hit Enter to move to the next cell.								

Appendix 4: Daily Logs

WISE Teacher Use: Daily Log

***1. Did your students work on WISE projects today?**

- ○ Yes
- ○ No
- ○ I don't know

Other (please specify)

***2. Are you using the "Grading Tool" inside the classroom monitor to score every step of the project?**

- ○ Yes.
- ○ No.
- ○ I don't know.
- ○ Other (please specify)

***3. Did you use the "Grading Tool" to score any student responses today?**

- ○ Yes, using the auto-scoring feature built into WISE
- ○ Yes, using my own scoring system
- ○ Yes, using both my own scoring and the auto-scoring features
- ○ No.
- ○ I don't know.

Other (please specify)

Page 1

WISE Teacher Use: Daily Log

***4. Did you use the "Grading Tool" comment or provide feedback on any student work today?**

- Yes, I wrote my own comments or feedback to students
- Yes, I used the autocomment/feedback feature.
- Yes, I wrote my own comments/feedback and I used the auto comment/feedback features
- No, I did not comment or provide feedback on any student work today.
- I don't know.

Other (please specify)

***5. Did you use the "grading tool" to score, comment or provide feedback on any REVISED student work today?**

- Yes.
- No.
- I don't know.

Other (please specify)

***6. Did you use the "flagging tool" to flag any student work today?**

- Yes.
- No.
- I don't know.

Other (please specify)

WISE Teacher Use: Daily Log

***7. Did you use the "My Notes" feature to make any notes today?**

- Yes.
- No.
- I don't know.

Other (please specify)

***8. Did you use the "Manage Announcements" feature to make or publish any announcements today?**

- Yes.
- No.
- I don't know.

Other (please specify)

***9. Did you use the "Classroom Monitor" to review individual and/or group progress today?**
(You can choose more than one yes option)

- Yes, in real time during class
- Yes, after class
- Yes, but only group progress
- Yes, but only individual student progress
- No.

Other (please specify)

WISE Teacher Use: Daily Log

10. Did you use the "pause" feature to pause student screens in class today for any reason?

- ○ Yes.
- ○ No.
- ○ I don't know.
- ○ Other (please specify)

Appendix 5: Pre-Enactment Survey

WISE Teacher Use: Pre-Enactment Survey

***1. When browsing projects in the project library, did any of the following elements influence your decision?**
(You can choose more than one)

- ☐ The teaching tips provided
- ☐ The estimated computer time
- ☐ The connection to state standards
- ☐ The preview of the project
- ☐ The ability and/or need to customize the project

Other (please specify)

***2. Did you use the Authoring Tool?**

- ○ Yes.
- ○ No.
- ○ I don't know.

Other (please specify)

***3. Did you use the Authoring Tool to customize the project you selected?**

- ○ Yes, I used the authoring tool to customize the project I selected.
- ○ No, I did not use the authoring tool to customize the project I selected.

Page 1

WISE Teacher Use: Pre-Enactment Survey

***4. If you customized a project, what were the reasons for which you made changes? (Select as many as apply)**

- ☐ to improve clarity for my students
- ☐ to align content with standards or core curriculum
- ☐ to adjust the value of each step for grading purposes
- ☐ to eliminate steps and shorten the project.
- ☐ I did not customize a project.

Other (please specify)

***5. When setting up the project run, which method did you decide to have students work?**

- ○ Individually
- ○ In groups of 2-3 per device

***6. When setting up your project run, how did you choose to register students for accounts?**

- ○ I used the access code to pre-register all the students myself prior to the start of class.
- ○ I am opting to have the students register themselves on Day 1 of the WISE unit and use the access code to launch the project.

Other (please specify)

***7. When setting up the project run, which did you select?**

- ○ High (recording all student activity)
- ○ Low (recording only student work submitted)

WISE Teacher Use: Pre-Enactment Survey

8. Did you enable the Real Time Classroom Monitor?

- Yes
- No
- I don't know

Other (please specify)

***9. Did you run a compatibility check on all student devices?**

- Yes
- No
- I don't know.

Other (please specify)

10. Did you preview the project entirely?

- Yes
- No
- I don't know

Other (please specify)

Appendix 6: Post-Enactment Survey

The Project End Survey

This is the LAST survey in our series!

Again, it should only take less than five minutes. Please answer every question honestly. You are not being evaluated. We want to know how you honestly used WISE. This information helps us understand how to make technology enhanced learning tools more usable by teachers.

1. Prior to enacting WISE in your classroom, did you review any of the following: (Select all that apply)

- ☐ Quickstart Guide
- ☐ FAQ page
- ☐ Top 10 reasons for using WISE
- ☐ Research linked to through the WISE website
- ☐ Messages in the "What's New" box on the main page
- ☐ Messages on the teacher dashboard

Other (please specify)

***2. Did you contact WISE using the online contact form at any point before, during, or after enacting WISE in the classroom?**

- ○ Yes
- ○ No

3. If yes, why did you contact WISE? (Select all that apply)

- ○ Help using WISE
- ○ Problem with a Project
- ○ Student Management
- ○ Help Authoring
- ○ Feedback to WISE
- ○ I did not contact WISE at all.

Other (please specify)

4. Did you post or respond to a post in the WISE community forum?

- ◯ Yes
- ◯ No

5. Did you like, post, respond, view or interact with the WISETELS Facebook page?

- ◯ Yes
- ◯ No

6. Do you follow the WISETELs Twitter page?

- ◯ Yes
- ◯ No

7. Did you share your project with another colleague?

- ◯ Yes
- ◯ No

8. Do you plan to share the project you used with another colleague?

- ◯ Yes
- ◯ No

9. Did you archive the project you ran?

- ◯ Yes
- ◯ No

10. Did you plan to use WISE again?

- ◯ Yes
- ◯ No

Appendix 7: Interview Protocol

[Introduction]
Hi! Thank you so much for taking the time to speak with me.

As you know, I am studying how teachers like yourself experience technology enhanced learning tools, like WISE, for the first time. The purpose is better understand how and why teachers use these tools so that technology developers can get some insight into how these kinds of tools help teachers accomplish their work. I want to ask you some questions about your recent experience with WISE in your classroom. It shouldn't take more than about 20 minutes. Just to be clear, there are not any right or wrong answers to the questions I'm going to ask, I'm just looking to understand your experience. Also, I am not involved with the WISE group at all, so I do not have any investment in particular kinds of answers to these questions. If you don't want to an answer a question, that's ok, just let me know; and you can stop the interview at any time, for any reason. Any questions?

Let's get started.

1. Tell me about your planning process for enacting WISE in your classroom.
   PROBES, only if not mentioned:
   - How much time did it take to plan?
   - How did WISE fit with the curriculum?
   - Did you do any pre-teaching
   - What were your learning goals?
   - Why did you choose to have students work individually or in groups?

2. How do you think your enactment of WISE went?

3. What features of WISE did you use the most and why?

4. What changes, if any, did you make to the WISE project?
   PROBE, only if there were changes and it wasn't mentioned:
   - When did you make the changes?)

5. How did you assess student learning?

6. How do you feel WISE helped you accomplish the learning goals you had for your students?

7. How did using WISE affect your role in the classroom?

8. How did your students respond to WISE?
   PROBES, if not mentioned:
   - How would you describe the abilities of your students?
   - What do you know about their backgrounds and prior knowledge?
   - What challenges, if any, do they have in academics?

9. What, if anything, did you find confusing or difficult about using WISE?

10. What, if anything, would you like WISE to have that it doesn't?

11. How do you think your school or district, or your colleagues, support using technology like WISE?

12. Would you use WISE again? [Why or why not?]

[Conclusion]
That's all the questions I have. Thank you so much for your time and candor!

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