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Teachers' Adoption of Learner-Centered Technology

Melissa C. Warr

A thesis submitted to the faculty of  
Brigham Young University  
in partial fulfillment of the requirements for the degree of  
Master of Science

Richard West, Chair  
Charles R. Graham  
David Williams

Department of Instructional Psychology & Technology  
Brigham Young University

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## ABSTRACT

### Teachers' Adoption of Learner-Centered Technology

Melissa C. Warr

Department of Instructional Psychology and Technology, BYU  
Master of Science

In this thesis, I describe research on teachers' experiences with learner-centered technology. Specifically, this research investigated teachers' experiences with adoption of the learner-centered tools available from Imagine Learning, an online elementary school literacy program. This thesis includes an extended literature review describing learner-centered classrooms, technology integration, and models of technology adoption, followed by a journal-ready article that describes teachers' experiences throughout the process of adopting Imagine Learning. Finally, I provide a description my experiences throughout this project as well as a proposal for future areas of study.

Keywords: technology integration, data-driven decision making, elementary education

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## Chapter 1: Description of Thesis Structure

This thesis follows an article-ready format and is comprised of an extended review of the literature, a journal-ready article version of my research, and a summary of my experiences of the research process. In the remainder of this chapter, I describe two potential publication outlets for this work. In Chapter 2, I provide an extended literature review of teacher technology adoption and integration. In Chapter 3, I present the final article, co-authored with Dr. West. Dr. West advised me on methodology, provided feedback on data analysis and writing, and reviewed drafts of the article. I completed all data collection and analysis. In all, I completed 80% of the work on the article. Finally, in Chapter 4, I provide a summary of the research process, including an explanation of a shift in research methods as well as proposals for future articles based on this research.

### Publication Outlet

I applied West and Rich's (2012) rigor, impact, and prestige framework to evaluate journals for potential publication of my thesis article. First, I identified 12 publications that contained influential articles on teacher technology adoption. Then, I accessed each journal's website to determine the journal's aims and scope and analyzed articles for common topics and research methods. Finally, I accessed several journal reviews published in *Educational Technology's* series of journal reviews (Billings, Nielsen, & West, 2012; Cottle, Juncker, Aitken, & West, 2012; Juncker, Calvert, Clements, Kim, & West, 2013; Rackham et al., 2013; Zaugg, Amado, Small, & West, 2011) for more information on journal methods and topics.

I identified two possible journals for publication of the final article: *Journal of Technology and Teacher Education* (JTATE) and *Journal of Educational Research* (JER). The JTATE showed high rigor, as evidenced by a 15% acceptance rate, and moderate impact, based



on Google Scholar's five-year h-index of 11. This journal has published several influential articles on technology integration and teacher beliefs, including an article by Zhao (2001) on teacher use of technology and Norum, Grabinger, and Duffield's (1999) writing on teachers' views of technology integration. Additionally, Cottle et al.'s (2012) analysis of *JTATE* highlighted the journal's emphasis on technology integration and acceptance of interpretive research methods.

The *JER* also showed significant rigor and impact, including an 18% acceptance rate and Google Scholar's five-year h-index of 21. The *JER* has published several articles on teacher beliefs and technology integration. The editors seem to be supportive of narrative research methods: in 2009, the journal published a special issue on narrative in educational research.

According to their websites, *JTATE* and *JER* have similar submission requirements. Although each journal has a slightly different focus, both publications have published significant articles on teacher technology adoption, including articles based on narrative methods. The final from this research will be submitted to one of these journals.

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## Chapter 2: Literature Review

Since the formation of our public school system in the early 1900s, society's expectations of public schools have changed. During the Industrial Era, the United States government focused on efficiency in education, and the resulting public school model resembled factories: students went through the system in batches, and schools were expected to sort students based on ability (Bransford, Brown, & Cocking, 2000; Christensen, Horn, & Johnson, 2008; Horn & Evans, 2013). Today, schools are asked to fulfill a different role: to meet each student's unique needs and eliminate poverty (Christensen, Horn, & Johnson, 2008; Feinberg & Soltis, 2009). In order for schools to truly serve each student, schools must shift to a learner-centered model that assures each child masters the skills needed to succeed in the 21st century (Bransford et al., 2000; Guskey & Gates, 1986; Reigeluth, 1994).

In "How People Learn," Bransford et al. (2000) defined learner-centered classrooms as environments in which teachers know each student's skills, attitudes, and beliefs and closely monitor each student's academic progress, including identifying and addressing each student's unique skill gaps. Technological tools can help teachers create learner-centered classrooms. Software can identify each student's skill gaps and suggest diverse approaches to address these gaps (Chung et al., 2007). However, to be successful, technology must be carefully integrated into the classroom (An & Reigeluth, 2011; Moersch, 1995; Patrick, Kennedy, & Powell, 2013; U.S. Department of Education, 2014).

Reformers have used several innovation adoption models to understand and facilitate teacher technology adoption. The Concerns Based Adoption Model (CBAM) is especially useful for modeling educational innovation adoption. The model recognizes that classroom teachers are rarely the decision makers of whether an innovation should be adopted, and teachers often

struggle implementing innovations chosen by administrators or lawmakers. The CBAM attempts to mitigate this by identifying and addressing teacher concerns throughout the change process (Hall & Hord, 2001; Hord, Rutherford, Huling-Austin, & Hall, 1987; Straub, 2009).

One indicator from the CBAM model that is particularly relevant to technology integration is the Level of Use scale. Hall and Hord (2001) described seven levels of use of educational innovations. The levels detail the behaviors of teachers throughout various stages of adoption and outline concerns and challenges associated with each level of use. This emphasis on *how* an innovation is used can be compared with common descriptions of technology integration. For example, Hokanson and Hooper (2004) observed, “Computer integration occurs along a spectrum of effectiveness and involvement” (p. 248). Research on technology integration must address this range of involvement.

The literature is rich with studies of technology integration, but less is known about the teacher’s integration experience, even though teachers are central to the change process (Hall & Hord, 1987). For example, the CBAM Levels of Use provide descriptions of what teachers do at each level of integration and accompanying concerns (Hord et al., 1987), but does not fully describe teachers’ experiences, such as their thoughts and feelings at different stages and how they make personal adoption decisions. Understanding the experiences of teachers throughout the adoption process will help us better facilitate teacher adoption of learner-centered tools.

In this chapter, I will outline literature related to teacher adoption of learner-centered technology as well as narrative inquiry, a methodology useful for further inquiry into this topic. Specifically, I will present research on four topics: technology-enabled learner-centered classrooms, technology integration in schools, the innovation adoption process, and narrative inquiry. I will first discuss my definition of learner-centered classrooms, including how

technology can facilitate this type of pedagogy. Next, I will outline several areas of research related to educational technology integration, including definitions of integration, factors that influence the process of integration, and the classroom teacher's role in integration. Third, I will discuss several innovation adoption models that reformers have used to model change in education. Finally, I will describe how narrative inquiry methods can deepen our understanding of the educational technology adoption process.

### **Learner-Centered Classrooms**

As discussed in the introduction, today's society expects public schools to identify and meet each student's unique needs (Christensen, Horn, & Johnson, 2008; Feinberg & Soltis, 2009). In order to address a widening diversity of needs, schools must create learner-centered classrooms. Bransford et al. (2000) described learner-centered classrooms as "environments that pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting . . . teachers in learner-centered classrooms pay close attention to the individual progress of each student and devise tasks that are appropriate" (pp. 133-134). Thus, teachers who lead learner-centered classrooms identify each student's needs, including gaps in student knowledge, and devise appropriate tasks and activities to address these needs.

Scholars have used many terms similar to "learner-centered," such as personalized learning and competency-based learning. Patrick et al. (2013) described personalized learning as "tailoring learning for each student's strengths, needs, and interests—including enabling student voice and choice in what, how, when, and where they learn—to provide flexibility and supports to ensure mastery of the highest standards possible" (p. 4). A related term is competency-based learning, which Patrick et al. described as an instructional strategy where students advance and move ahead based on mastery. According to these definitions, competency-based learning is an

important component of personalized learning. Additionally, personalized learning emphasizes student voice and choice in what and how they learn. Both personalized learning and competency-based learning are components of a learner-centered classroom. For the purposes of this study, I will define a “learner-centered classroom” as a learning environment in which teachers closely monitor each student’s progress and tailor instruction to each student’s individual needs.

### **Learner-Centered Technology**

Although learner-centered classrooms existed before the current digital culture, technological tools make this type of pedagogy easier to implement with limited resources (Chung et al., 2007). This means teachers must adopt two types of technologies: the concept of learner-centered classrooms, and the technological tools that make learner-centered classrooms possible. These two technologies, one describing an idea and the other a physical product, are examples of what Hooper and Rieber (1995) termed idea technology and product technology. They explained that product technology refers to physical products. For example, educational television, films, computers, and computer software are product technologies. Idea technologies, on the other hand, have no tangible form (Hooper & Rieber, 1995). According to Hooper and Rieber, product technologies are related to idea technologies in that “idea technologies are usually represented in or through some product technology . . . the idea is supported or made possible by the product” (p. 159). They described further, “Most of the historical attempts to use technology in education have focused on product technologies . . . consequently, the role and value of these product technologies were how they supported established beliefs and practices of classroom teachers” (p. 159). To change education, product technologies must be driven by idea technologies, transforming the beliefs and practices of teachers.

Similar to Hooper and Rieber's (1995) emphasis on product technologies enabling idea technologies, Hokanson and Hooper (2004) emphasized the abilities of technology to facilitate better instructional methods and procedures. They explained, "Different technologies, whether potatoes or computers, have specific advantages that must be recognized and used to fulfill their potential. It is the recognition of the specific advantages that drives improvement in instructional method" (p. 248). Similarly, Dwyer, Ringstaff, and Sandholtz (1992) asserted, "The use of technology does not guarantee fundamental change in the teaching-learning process and consequently in learning outcomes" (as cited in Moersch, 1995, p. 41). Thus, providing schools with product technologies will not change education. To create effective student-centered classrooms, teachers and administrators must use the specific advantages, or affordances, of product technologies to support the idea technology of student-centered learning.

One of the affordances of some educational technologies are their abilities to facilitate learner-centered classrooms. Chung et al. (2007) described how technology is able "to make practical many of the ideas central to individualizing instruction" (p. 2). First, technology can streamline assessment, provide immediate feedback, and require active participation. Second, appropriate technology can provide "cost-effective embedded assessments supporting feedback, diagnosis, and selection and delivery of appropriate instructional parcels" (p. 2). Ertmer, Gopalakrishnan, and Ross (2001) and Norum, Grabinger, and Duffield (1999) also emphasized how technology enables student-centered learning.

In this study, I will define "learner-centered technology," as product technologies that facilitate learner-centered classrooms. Specifically, learner-centered technology delivers instruction specific to each student's needs, provides teachers with detailed information about



each student's skill gaps and academic progress, and suggests resources that teachers can use to address identified skill gaps.

### **Technology Integration**

If creating learner-centered classrooms requires teachers to integrate both the idea and tools of learner-centered pedagogy into the classroom, how do we facilitate this integration? In this section, I argue that effective technology integration centers on the connection between idea and product technologies. First, I will offer several definitions of educational technology integration. Second, I will outline how different scholars have emphasized the relationship between idea and product technologies in their theories on integration. Finally, I will outline research related to facilitating technology integration, including factors that affect integration and the role of teachers in integration.

#### **What is Integration?**

As described above, effective technology integration involves more than putting computers in a classroom. It requires connecting idea technologies with product technologies, resulting in learning *with* technology, not learning *from* technology (Hokanson & Hooper, 2004; Jonassen, Carr, & Yueh, 1998; Mills & Tincher, 2003). Technology integration changes teaching and learning; it “change[s] how teachers teach, students learn, and administrators operate” (Norum et al., 1999, p. 188). Mills and Tincher (2003) explained, “Technology integration in classrooms is more about teaching and learning than it is about [product] technology” (p. 382). Hokanson and Hooper (2004) emphasized that technology needs to be “dispersed physically and pedagogically” (p. 249) to reach its potential. Buabeng-Andoh (2012) and Knezek, Christensen, Miyashita, and Ropp (2000) emphasized the need for teachers to adjust

content and pedagogy to maximize technology use. Each of these examples highlights the importance of pairing the advantages of product technologies with changes in pedagogy.

When teachers have truly integrated technology, it becomes a core element of the classroom, seamlessly blending idea and facilitating product technologies. Hooper and Rieber (1995) explained, “Integration represents the ‘break through’ phase. This occurs when a teacher consciously decides to designate certain tasks and responsibilities to technology, so, if the technology is suddenly removed or is unavailable, the teacher cannot proceed with the instruction as planned” (p. 158). Marcinkiewicz and Welliver (1993) asserted that when integrated, “The absence of computers would prevent the implementation of instruction” (p. 2). If technology is fully integrated, teachers have infused it into pedagogy to the extent that they cannot effectively teach without it.

### **Integration Theories**

Several theories about technology integration center on the relationship between idea and product technologies. I will describe two such theories: Jonassen’s work on technology as constructivist mindtools (Jonassen et al., 1998) and Mishra and Koehler’s (2006) theory on technological pedagogical content knowledge. Each of these theories emphasized that effective use of educational technology must center on pedagogy, not technology.

**Mindtools.** Jonassen’s work on mindtools emphasized pedagogical change as the foundation of technology integration (Jonassen et al., 1998). In particular, Jonassen et al. (1998) emphasized the computer’s ability to facilitate constructivist learning environments. They explained:

Technologies should not support learning by attempting to instruct the learners, but rather should be used as knowledge construction tools that students learn with, not from. In this

way, learners function as designers, and the computers function as *Mindtools* for interpreting and organizing their personal knowledge. (p. 24)

Ertmer and Ottenbreit-Leftwich (2012) similarly promoted using “technology as a cognitive tool to facilitate authentic student learning” (p. 176). This type of technology use enables students to solve complex, real-world problems.

Technological mindtools can perform several functions. Jonassen et al. (1998) outlined five types of mindtools: semantic organization tools, dynamic modeling tools, information interpretation tools, knowledge construction tools, and conversation and collaboration tools. Each mindtool represents an element of Jonassen’s constructivist pedagogy, and Jonassen et al. provided examples of related product technologies that enable each pedagogical element. Semantic organization tools help students structure knowledge and reflect on their learning, a core component of constructivist learning theories (Driscoll, 2005). Product technologies such as databases or concept mapping tools assist students in semantic organization. Dynamic modeling tools help learners study the relationships among ideas. For example, students can use spreadsheets to represent, calculate, and reflect on quantitative relationships in mathematics. Jonassen et al. also categorized expert systems, such as simulations that model relationships between elements of a system, as dynamic modeling tools. Information interpretation tools, including search engines or mathematical visualization software, can help learners access and process information. Knowledge construction tools help students design objects that represent their own understanding of ideas, such as hypermedia or multimedia presentations. Finally, conversation and collaboration tools allow students to collaborate with others more easily through email, message boards, or video conferences.

Similar to the views of Hokanson and Hooper (2004), Jonassen emphasized utilizing the unique properties of technology to support pedagogy and enhance learning. He believed computer systems “should perform calculations, store, and retrieve information” (Jonassen, Campbell, & Davidson, 1994, p. 33) so learners can focus on cognitive processing. Current research on adaptive instruction and intelligent tutoring systems demonstrate a similar focus on technological affordances. It’s possible that Jonassen’s emphasis on using technology’s affordances to facilitate learning can also extend beyond the constructivist pedagogy Jonassen was known for. Technology can deliver individualized, targeted instruction to students when providing each student with a personal tutor isn’t feasible. Thus, in addition to enabling authentic learning contexts, technology can afford student-centered learning by delivering personalized instruction.

**Technological Pedagogical Content Knowledge (TPACK).** Akin to Jonassen’s emphasis on product technologies that enabled constructivist learning, Mishra and Koehler (2006) posited teachers must develop pedagogical methods specific to maximizing affordances of technology. Mishra and Koehler explained, “Merely knowing how to use technology is not the same as knowing how to teach with it” (p. 1033). They outlined three key areas of knowledge: technology, pedagogy, and content. In order to effectively teach with technology, teachers must develop technological pedagogical content knowledge, or TPACK. Mishra and Kohler described:

TPACK is the basis of good teaching with technology and requires an understanding of the representations of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that

students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge and to develop new epistemologies or strengthen old ones. (p. 1029)

Thus, technology integration means change within teachers: they must develop TPACK and infuse it into their teaching, resulting in pedagogical idea technologies that drive the use of product technologies.

### **Facilitating Integration**

Given technology integration means connecting idea and product technologies in such a way that they become core elements of the classroom, how do we facilitate effective integration? Scholars have studied many facets of this issue, including factors that affect integration, the central role of teachers in integration, barriers to integration, and characteristics of exemplary technology-using teachers.

**Factors affecting technology integration.** Technology integration literature is rich with studies analyzing causal factors of technology integration. Scholars have studied the impact of factors at both the teacher- and organizational-level. Zhao and Frank (2003) emphasized that teacher- and organizational-level factors should be studied together to account for the dynamic, ecological nature of the integration process. Current literature provides various perspectives on the interaction of school- and organizational-level variables. For example, O'Dwyer, Russell, and Debell (2004) studied teachers' constructivist beliefs, beliefs about efficacy of technology and organizational-level professional development, leadership, and school policies in their factor analysis of technology adoption. By building a model to describe the influence of each of these variables on the variance in teacher technology use, O'Dwyer et al. found 86–94% of variance in teachers' technology use was within schools, while 6–16% of the variability was between

schools. Similarly, Tondeur, Valcke, and Van Braak (2008) explored the influence of several independent variables on types of technology use, including teacher gender, computer experience, constructivist teaching beliefs, traditional teaching beliefs, and innovativeness as well as school-level openness to change, availability of computers and internet, ICT training, and perception of school policy. They also found more variance among teachers within schools (82%) than across different schools (18%).

Zhao and Frank (2003) identified teacher-level variables (perceived relative advantage of technology, peer support, and compatibility with teaching style) as accounting for more of the variance in technology use (86%-89%) than district-level variables (district-level training, administrative support). Finally, Hsu and Ping-Yin (2013) studied the interaction of teacher variables (background, gender, years of teaching, graduate degrees, training hours, and perceived school support, and perceived effectiveness of technology of efficiency and student learning) and school variables (computer and internet stability, teacher training hours, teachers' perception of administrator encouragement, and peer support among teachers). They found analyzing the factors as independent variables resulted in teacher variables accounting for 89.7% of the variance and school-level variables accounting for 10.3%. However, when the same data was analyzed with a method that focused on interaction among variables, 26.9% of variance at the teacher level and 55.5% of variance at the school level was explained by interactive factors.

In the factor analysis studies described above, the strongest predictors of teacher technology use at the teacher level include teacher gender (male teachers showed greater use of technology for creating materials while females demonstrated more proficiency in word processing and internet searches; Hsu & Ping-Yin, 2013), compatibility of computers with teachers' pedagogical beliefs (O'Dwyer et al., 2004; Zhao & Frank, 2003), perceived

effectiveness of technology on teacher efficiency and student learning (Hsu & Ping-Yin, 2013; O'Dwyer et al., 2004; Zhao & Frank, 2003), and peer support (Zhao & Frank, 2003). Strong predictors of use at the organizational level included access and stability of computers and internet (Hsu & Ping-Yin, 2013; O'Dwyer et al., 2004), and few restrictive policies on technology use (O'Dwyer et al., 2004).

Zhao and Frank (2003) found the amount of district-level training was not a good predictor of teacher technology use, whereas Hsu and Ping-Yin (2013) and O'Dwyer et al. (2004) found hours and intensity of teacher training strongly influenced technology use. Hsu and Ping-Yin and O'Dwyer et al. also claimed that encouragement from school administrators was more important than school-wide ICT plans, reflecting Fullan's (2007) belief that developing a "shared meaning" (p. 38) within a school is more important than administrator-set priorities and goals.

**Central role of teachers in integration.** The factor analyses described above demonstrated that, although school characteristics are relevant and important, the central driving force to integration is the individual teacher. Zhao and Frank (2003) illustrated this issue well:

To summarize, although there are many possible influences at multiple levels of the educational hierarchy, two factors ultimately determine the degree and types of computer use by teachers: (a) the nature of the uses, and (b) the result of the teacher's analysis of the uses. All other factors contribute to these two. In other words, most factors do not directly influence technology uses in a linear fashion; rather, their influence is mediated or filtered by teachers' perceptions. (p. 817)

Norum et al. (1999) similarly described:

Leverage comes from the individual . . . The individual teacher must be willing to make changes in teaching strategies, scheduling, and allocation of time. The individual teacher must be willing to take risks, be a model and mentor to peers, [and] educate others on issues related to the integration of technology in the classroom. (p. 202)

Many of the teachers Norum et al. interviewed “pointed to themselves as the place where change efforts need to begin” (p. 188), demonstrating their beliefs that teachers drive change. Finally, in 1987 Hall and Hord posited, “The most significant way to improve schools is through improving the instructional performance of teachers. Changing a teacher's practices and improving instruction is the bottom line, but teachers need assistance to change and develop” (p. 4).

Although organizational level variables impact technology integration, it is the teachers that must mitigate these factors and drive integration efforts.

**Barriers to integration.** Because teachers are central to integration, several researchers have investigated barriers teachers face when integrating technology. P. L. Rogers (2000) separated barriers into those external and internal to teachers. External barriers were grouped in three categories: availability and accessibility, technical and institutional support, and stakeholder development. Barriers related to availability and accessibility included access to useful, relevant, and appropriate hardware and software, and the need for quality software and hardware. Technical and institutional support barriers included user services and media specialists, technical support, lack of funding, and low levels of administration support. Finally, stakeholder development barriers were lack of time for development at the individual and institutional development (Rogers, 2000). Rogers emphasized that these three categories interact and are interdependent on each other, resulting in complex relationships among them, and



successful integration efforts address all three categories simultaneously. She highlighted teacher attitudes and perceptions as the source of internal barriers. She observed that the difference between early technology adopters and other teachers was the perceived potential and benefits of technology.

Ertmer and Ottenbreit-Leftwich (2012) similarly separated barriers to technology integration into two categories, namely first-order and second-order barriers. These categories were similar to Rogers' external and internal barriers: first-order barriers described barriers external to teachers, such as resources and training, while second-order barriers focused on teacher beliefs and attitudes about educational technology as well as technological knowledge and skills. Ertmer and Ottenbreit-Leftwich noted that past efforts focused on addressing first-order barriers have not led to more effective technology use in the classroom. They noted that some teachers with few resources (high first-order barriers), were able to achieve high levels of integration, and "teachers with many resources but strong traditional beliefs have been observed to limit their students' technology uses" (Ertmer & Ottenbreit-Leftwich, 2012, p. 177). They further explained, "This is not to suggest that a lack of technology resources cannot act as a gatekeeper, but that teachers with strong beliefs in the pedagogical value of technology have been observed to overcome these barriers" (p. 177).

Other research on barriers to educational technology use follow a similar emphasis on contextual barriers (Cuban, Kirkpatrick, & Peck, 2001; Fisher, 2006; Karmeshu, Raman, & Nedungadi, 2012; Norum et al., 1999), and teacher beliefs and attitudes about educational technology (Hokanson & Hooper, 2004; Karmeshu, et al., 2012; Norum et al., 1999; Oncu, Delialioglu, & Brown, 2008). Norum et al. (1999) noted that a prominent internal barrier involves teachers' professional identities. They explained, "As teachers are asked to take on

different roles, the professional identity of a teacher is altered. As the role of the teacher changes, relationships between teachers and students, and between teachers and teachers, change (Norum & Lowry, 1995)” (p. 190). For many teachers, using technology to create a student-centered classroom results in a major change in professional identity and teacher roles. This shift can become a barrier to integration efforts.

In addition to identifying barriers to educational technology use, Ertmer and Ottenbreit-Leftwich (2010) discussed factors that help teachers overcome barriers including contextual, cognitive, and affective characteristics. They emphasized that, although teachers need to feel supported in their technology integration efforts: “The best way to bring more teachers on board is not by eliminating more first-order barriers, but by addressing the second-order barriers of attitudes and beliefs” (2012, p. 177). Thus, efforts to address contextual factors should focus on supporting teachers in their technology integration efforts, not necessarily eliminating first-order barriers. Ertmer and Ottenbreit-Leftwich explained, “One of the conditions necessary for teachers to adopt student-centered technology use is their perception that external factors, or first-order barriers, will not impede their efforts. Thus, systems need to ensure that teachers feel supported by external factors” (p. 179). Ertmer and Ottenbreit-Leftwich suggested cognitive factors can be addressed by assuring teachers have the Technological Pedagogical Content Knowledge needed to be successful. Finally, the authors posited developing school culture and vision aligned with student-centered technology use leads to more effective technology integration, while top-down mandates negatively impact affective factors.

Other scholars also suggested a focus on supporting teachers’ efforts to integrate technology. Norum et al. (1999) explained, “Support is a major part of making changes, particularly when the change alters your professional identity and role” (p. 191). They suggested

support from administrators and the community, including adequate funding, time, a technology plan, and staff development, helped teachers integrate technology into their classrooms. More important, however, was support from other teachers. They explained, “Learning from the experiences of each other can alleviate discomfort and anxiety associated with [changes in professional identity]” (p. 191). Similarly, Kopcha (2012) reported that mentored teachers were more effective at overcoming barriers to technology integration than non-mentored peers.

**Exemplary technology-using teachers.** In order to better understand how teachers overcome barriers to technology integration, scholars have researched teachers who have been successful at using technology in the classroom. Several researchers emphasized the constructivist and student-centered beliefs common to exemplary technology-using teachers (Becker, 1994; Ertmer et al., 2001; Hooper & Rieber, 1995; Jonassen et al., 1998). Scholars have disagreed on whether use of technology merely reflects teachers’ original, underlying pedagogical beliefs (Becker & Riel, 1999; Miller & Olson, 1994; Hatvia & Lesgold, 1996) or can prompt a shift to constructivist practices (Ertmer et al. 2001). Ertmer et al. (2001) commented, “Our results suggest that although constructivist practices do not depend on the use of technology, technology may both support and facilitate these practices” (Technology: Enabler or Change Agent Section, para. 3). Similarly, Jonassen et al. (1998) emphasized that effective technology users apply technological tools to create constructivist-based lessons.

Other common traits of effective technology-using teachers include a high level of computer competence (Buabeng-Andoh, 2012), high technological self-efficacy (Buabeng-Andoh, 2012; Ertmer et al., 2001; Fullan, 2007; Moersch, 1995), persistence in working around barriers (Ertmer et al., 2001), initiative to pursue professional development opportunities (Ertmer et al, 2001; Norum et al., 1999), and a supportive school environment (Becker, 1994; Buabeng-

Andoh, 2012; Ertmer et al., 2001). Becker (1994) also noted successful technology-using teachers adjusted curriculum to accommodate technology use, showed a deeper interest in academic subject matter, and had accumulated more academic credits and degrees than other teachers. Becker observed that technology-focused teachers had more teaching experience than teachers who were less effective at using technology in the classroom; however, more recent research (Buabeng-Andoh, 2012; Ertmer et al., 2001; Hsu & Ping-Yin, 2013) found the opposite was true: teachers with less experience were more likely to successfully integrate technology, perhaps because younger teachers are often more familiar and competent with technology than well-seasoned teachers.

### **Models of Change**

Because effective technology integration represents a major change in educational tools and pedagogy, reformers must understand the change process to effectively facilitate integration. Scholars from many fields have researched change and innovation adoption. Some scholars asserted that effective educational change must be a revolutionary process, where a new system rises and overtakes previous practices (i.e., Christensen et al., 2008), or a radical reform, where the existing system is discarded in favor of a new system (Reigeluth, 1994). Others described change in a more evolutionary, or gradual way (i.e., Cuban et al., 2001; Fisher, 2006; P.L. Rogers, 2000; Zhao & Frank, 2003).

Ellsworth (2000) proposed that only systemic change, or change that addresses each part of the education system simultaneously, will successfully reform education. Systemic change is based on systems theory (Ellsworth, 2000). Each system is made up of discrete and interdependent components (Ellsworth, 2000). Ellsworth posited that in an educational change system, these components include the innovation, environment, process, and intended adopter,

and each component needs to be carefully managed throughout the change process. Ellsworth suggested that major adoption models address different components in the system. Thus, reformers should select the change model that best addresses the target component while remaining cognizant of other elements in the system (Ellsworth, 2000).

In this study, I will focus on one component of Ellsworth's (2000) systemic change model: the intended adopter. Several theories have described the dynamics surrounding the intended adopter. For example, Fullan's (2007) theory centered on change agents highlighted the experience of individual teachers and change. Straub (2009) outlined three additional frameworks commonly used to model and evaluate teacher's adoption of technology: E. M. Rogers' Diffusion of Innovation, the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT), and the Concerns-based Adoption Model (CBAM). Each of these frameworks emphasized a different aspect of the teacher's change process.

### **The Meaning of Change**

In his theory on change agents, Fullan (2007) presented three phases of the change process: initiation, implementation, and institutionalization. These phases do not outline a linear process; rather, each phase can feed back into and alter decisions made at previous stages (Fullan, 2007). Furthermore, he posited the change process cannot be demarcated into sub phases or given a precise timeline. Rather, "change is a process, not an event," (Fullan, 2007, p. 41) and if we focus on change as a learning experience for all, "we will be going a long way in understanding the dynamics of the factors of change" (Fullan, 2007, p. 85).

Although not discrete stages, each of Fullan's (2007) three phases have distinct characteristics. Initiation, Fullan (2007) described, is "the process leading up to and including

the decision to proceed with implementation” (p. 69). Fullan listed several factors associated with initiation decisions, including existence of and access to innovations, teacher advocacy, policy, community pressure, and administration advocacy. Fullan believed it is important to push change past initiation into implementation quickly, as “that is where knowledge, skills, understandings, and commitments get sorted out” (p. 68).

Fullan’s (2007) second phase, implementation, “consists of the process of putting into practice an idea, program, or set of activities and structure new to the people attempting or expected to change” (p. 84). Implementation is influenced by several interactive factors: characteristics of the change, such as need, clarity, complexity, quality, and practicality; local characteristics, including district, community, principal, and teachers; and external factors such as government and other agencies (Fullan, 2007). Two of these factors, need and clarity, warrant further discussion. First, the need for an innovation is often difficult to discern. Schools commonly have overloaded improvement agendas, and the importance of one innovation is relative to other needs (Fullan, 2007). Furthermore, needs are rarely clear at the beginning of a complex change process and can only be clarified during the implementation phase itself (Fullan, 2007). Clarity is also a complex factor. In an attempt for clarity, innovations can become oversimplified, resulting in poor implementation and no change to student learning (Fullan, 2007). For example, a school may simplify a pedagogical innovation by focusing on using textbooks that represent the innovation. Thus, teachers may use the textbook without implementing the idea technology behind it.

Fullan’s (2007) final stage of the change process is institutionalization, also called continuation, incorporation, or routinization. In this stage, innovations are built-in as a core

component of the system or disappear due to a decision to discard or through attrition (Fullan, 2007).

In addition to outlining the three phases of the change process, Fullan (2007) described how change agents can best facilitate the change. His suggestions included focusing on how innovations support school goals such as closing the achievement gap or attending to basics (literacy, numeracy, and well-being of students), respecting each person's dignity, recognizing successful strategies are socially based and action-oriented, establishing positive pressure, and building public confidence. These ideas reflect research on facilitating technology integration. Specifically, they echo Ertmer and Ottenbreit-Leftwich's (2012) findings on the importance of focusing on student results and building a school-wide culture of collaboration and support, and Ely's (1999) emphasis on the implementation stage of adoption.

### **Diffusion of Innovation**

Diffusion of Innovation (DOI) is a communications theory that models how innovations are diffused into populations through communication channels (E. M. Rogers, 2003). The theory addresses three main components of the adoption process: characteristics of the innovation, characteristics of the innovator, and environmental context (E. M. Rogers, Medina, Rivera, & Wiley, 2005; Wejnert, 2002). The DOI framework was first applied to farmers' adoption of hybrid seed in the late 1930s (Valente & Rogers, 1995). Later, E.M. Rogers' book "Diffusion of Innovations" led to an expansion of the theory to fields outside of rural sociology (Valente & Rogers, 1995). Currently, researchers from many fields use the model to understand change (Straub, 2009; Wejnert, 2002).

The Diffusion of Innovation model is particularly useful for understanding social influence on adoption decisions. Hazen, Wu, Sankar, and Jones-Farmer (2012) posited DOI was

“beneficial to explaining how potential users become aware of and why they intend to adopt educational innovations” (p. 305). Straub (2009) agreed: “The strength of Rogers’ theory is the broad foundation it provides to understand the factors that influence the choices an individual makes about an innovation” (p. 630). Frank, Zhao, and Borman (2004) extended the theory to connect individual and organizational-level adoption decisions in education. They explained, “[In education] the process is more one of diffusion of innovation within the organization, since each actor has some autonomy to make his or her own decision partly in response to ideas, information, and other social forces to which he or is exposed” (p. 150). The strength of DOI in education lies in its’ ability to illuminate how individuals hear about and make the decision to adopt an innovation, and how individual decisions spread through an organization.

Educational researchers have used the theory to study the adoption of many idea and product innovations. E.M. Rogers (2003) highlighted the use of the model to understand the adoption of kindergarten programs, driver’s education classes, and new math curriculum. Karmeshu et al. (2012) used the DOI framework to model the adoption of a personalized learning curriculum. They emphasized the influence of teacher training on adoption patterns. Finally, Frank et al. (2004) focused on the role of social capital in the diffusion of computer technology in schools.

### **Technology Acceptance Model and Unified Theory of Acceptance and Use of Technology**

Where the DOI framework models the flow of innovation ideas and initial adoption decisions, the Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT) emphasize actual use of the innovation, an integral component of educational technology integration. Hazen et al. (2012) explained, “Because the ultimate goal of educational innovation dissemination is the routine usage of the innovation, the TAM and the



theories on which it is based may be useful in examining the adoption and routine usage stages of the dissemination process” (pp. 304-305). The DOI theory models how innovation ideas and initial use spread, and the TAM and UTAUT provide insight into actual use of the innovation.

Both the TAM and the UTAUT originated in the computer science field (Straub, 2009). These theories focus on the characteristics of an innovation and the effect the characteristics have on the intended adopter, including perceived usefulness, ease of use, and effects of social influence. The TAM models the influence of two variables on usage behavior: perceived usefulness and perceived ease of use (Davis, 1989). Specifically, Davis found that perceived usefulness of a technology was strongly correlated with usage behavior, and perceived ease of use was moderately correlated with usage behavior. Davis, Bagozzi, and Warshaw (1983) posited ease of use is a more significant factor to early technology use than later use. Davis (1989) proposed a causal chain of factors: perceived ease of use, perceived usefulness, and finally usage behavior.

Venkatesh, Morris, Davis, and Davis’s (2003) UTAUT integrated eight related models on innovation usage, including TAM and a theory based on DOI. Venkatesh et al. identified both direct determinants of the intention to use a technology (performance expectancy, effort expectancy, and social influence) and determinates of usage behavior (intention and facilitating conditions). Additionally, Venkatesh et al. found experience, voluntariness of adoption, age, and gender to indirectly influence innovation usage.

### **Concerns-Based Adoption Model**

The Concerns-Based Adoption Model (CBAM) was specifically designed to address educational change, included innovation usage behavior. Hall and Hord (2001) developed the theory to understand teacher and curriculum change. The model focuses on teacher concerns

during the change process, and many scholars have used the framework to study technology integration (Straub, 2009).

The CBAM is especially effective for modeling educational change because usually teachers are not the final decision makers of whether to adopt an innovation (Hokanson & Hooper, 2004; Mills & Tincher, 2003; Straub, 2009). However, even though teachers may not choose which innovations to adopt, they are ultimately responsible for implementation of the innovations and are central to the change process (Ertmer & Ottenbreit-Leftwich, 2010; Fisher, 2006; Horn & Evans, 2013; Norum et. al, 1999). Thus, the CBAM highlights the concerns of teachers throughout the process and provides tools to evaluate and address teacher concerns (Hord, Rutherford, Huling-Austin, & Hall, 1987; Straub, 2009).

Hall and Hord (2001) based the CBAM on six foundational principles:

1. Change is a process, not an event
2. Change is accomplished by individuals
3. Change is a highly personal experience
4. Change involves developmental growth
5. Change is best understood in operational terms
6. The focus of facilitation should be on individuals, innovations, and the context

The authors applied these six principles to three diagnostic areas:

1. Innovation Configurations. This area evaluates how teachers are implementing the innovation in the classroom.
2. Stages of Concern. This tool models the concerns of teachers throughout the adoption process. Each stage is described by a type of concern: awareness, informational, personal, management, consequence, collaboration, and refocusing.

3. Level of Use. This scale describes “the behaviors of the users of an innovation through various stages” (Hord et al., 1987, p. 50). Levels include non-use, orientation, preparation, mechanical use, routine, refinement, integration, and renewal.

The Level of Use scale is of particular interest in light of current efforts to blend technology into curriculum and pedagogy (Serow & Callingham, 2011). When Hall et al. (1975) developed the Levels of Use, “integration” referred to a collaborative activity (integrating the innovation with colleagues and other school activities). As explained above, when scholars talk about technology integration today, they are usually referring to integrating technology into pedagogy—learning with technology, not from technology (Hokanson & Hooper, 2004; Mills & Tincher, 2003). To avoid confusion, in this study I will use the term *collaboration* in place of Hall et al.’s term *integration*.

### **Other Adoption Models**

Educational reformers have successfully used the CBAM to facilitate adoption of new curriculum and pedagogical methods, including technology integration (Chamblee & Slough, 2004; Gershner & Snider, 1999; Knezek et al., 2000). Several researchers have used CBAM principles to develop other stage-based adoption models. For example, Hooper and Rieber (1995) outlined a five-step model including the stages familiarization, utilization, integration, reorientation, and evolution. Although similar to CBAM, the model has not been used or researched as extensively as CBAM (Ellsworth, 2000). Moersch (2010) used the CBAM stages to build an adoption model specific to technology use and student-centered learning (Levels of Teaching Innovation, or LoTi). This model is widely used by practitioners as a professional development tool. However, Moersch’s levels conflate general technology use with classroom pedagogy in a way that limits the model’s usability as a descriptive tool for technology adoption

research. Thus, the CBAM is currently the most complete and relevant adoption model we have for researching the teacher's perspective of technology integration in public schools.

### **Knowledge Gaps**

Straub (2009) asserted that a broad view of technology adoption is needed. Each of the models outlined above focuses on a distinct area of adoption but does not provide a holistic view of the teacher's experience. For example, Diffusion of Innovations emphasizes how an innovation is communicated to intended adopters, and TAM and UTAUT focus on how the usability of the innovation affects the adopter. Many researchers have used CBAM to facilitate educational change because of its focus on concerns of teachers throughout the adoption process, but CBAM is not complete; it does not address individual choices or describe the experience of adoption (Straub, 2009) and understanding this experience is vital to implementing change. Fullan (2007) explained, "Neglect of the phenomenology of change—that is, how people actually experience change as distinct from how it might have been intended—is at the heart of the spectacular lack of success of most social reforms" (p. 8). Thus, additional research is needed to paint a holistic picture of technology integration, including teachers' experiences throughout the adoption process.

Other scholars have emphasized the need to research *how* teachers move from one adoption stage to another (Cilesiz, 2011; Hew & Brush, 2007; Hokanson & Hooper, 2004). Although stage-based adoption models are useful for understanding change, most research has focused on discrete stages and has not addressed how teachers transition between stages.

Narrative inquiry is particularly useful for understanding teacher experiences and promoting change. Woods (1993) emphasized the utility of inviting teachers as co-constructors of inquiry, making the research a combination of "their lived experiences" and the researcher's

“conceptual and organizational overview” (p. 160). Such a relationship results in “a sound basis for combining theory and practice, which, in turn, makes for strength in the formulation of policy” (Woods, 1993, p. viii; see also Connelly & Clandinin, 1990; Gill, 2001). Researchers can use narrative inquiry to not only better understand teacher experiences, but to give teachers a voice and build theory that links practice and policy.

Researchers can also use narrative inquiry to address the second skill gap identified above: narrative techniques can help researchers develop a holistic view of the change process. Webster and Mertova (2007) explained, “Narrative inquiry attempts to capture the ‘whole story,’ whereas other methods tend to communicate understandings of studied subjects or phenomena at certain points, but frequently omit the important intervening stages” (p. 5). Researchers can use narrative inquiry to explore little-studied aspects of the change process.

In summary, we need a broad view of teacher technology adoption, a holistic understanding of the teacher’s experience throughout the adoption process, including how teachers move between stages. Narrative and other qualitative descriptive methods enable us to study this in depth by exploring the process from the teacher’s view, illuminating teachers’ interpretations of events throughout the process, and describing how teachers transition between levels of use. Understanding the experience of teachers as they move towards integration will help us better facilitate teacher adoption of learner-centered technology.

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**Chapter 3: Article— Teachers' Adoption of Learner-Centered Technology: Balancing  
Requirements, Evidence, and Student Needs**

Teachers' Adoption of Learner-Centered Technology:  
Balancing Requirements, Evidence,  
and Student Needs

Melissa C. Warr and Richard E. West  
Brigham Young University



### Abstract

A combination of narrative research and thematic analysis was used to investigate teachers' experiences with learner-centered technology and accompanying data. Teachers worked in a state of tension as they tried to meet each student's needs while fulfilling school and district requirements. Most teachers struggled to find clear evidence of the efficacy of learner-centered technology, instead relying on informal classroom observation and within-program data to judge the effectiveness of the product. Additionally, teachers struggled to integrate program data with other student data. Recommendations for better facilitating teacher adoption of learner-centered technology include developing teachers' abilities to evaluate program efficacy and enabling teachers to make evidence-based decisions about program use.

*Keywords:* technology integration, data-driven decision making, elementary education, student-centered instruction

## Teachers' Adoption of Learner-Centered Technology: Balancing Requirements, Evidence, and Student Needs

Scholars have argued that schools must shift to a learner-centered model that assures each child masters the skills needed to succeed in the 21st century (Bransford, Brown, & Cocking, 2000; Guskey & Gates, 1986; Reigeluth, 1994). Bransford et al. (2000) defined learner-centered classrooms as environments where teachers know each student's skills, attitudes, and beliefs and closely monitor each student's academic progress, including identifying and addressing each student's unique skill gaps. Other scholars emphasized that the use of data to inform instruction is a key element of a learner-centered classroom (Bill & Melinda Gates Foundation, 2015; Means, Chen, DeBarger, & Padilla, 2011; Thomas & Huffman, 2011).

Technological tools can provide data that help teachers create learner-centered classrooms. In particular, software can identify each student's skill gaps and suggest diverse approaches to address these gaps (Chung, Delacruz, Dionne, Baker, Lee, & Osmundson, 2007). However, teachers often have data from other sources, such as progress monitoring systems and achievement tests, and are tasked with integrating these sources (Spillane, 2012), and many teachers are already overwhelmed with learning to use technology in the classroom (Ertmer & Ottenbreit-Leftwich, 2010; Norum, Grabinger, & Duffield, 1999; Rogers, 2000).

Although the literature is rich with research on how teachers use data to inform instruction (Goldring & Berends, 2009; Means et al., 2011; Spillane, 2012), as well as studies of technology integration (Ertmer & Ottenbreit-Leftwich, 2012; Hooper & Rieber, 1995; Jonassen, Carr, & Yueh, 1998; Mishra & Koehler, 2006), less is known about teachers' experiences as they attempt to use both learner-centered technology and the data it can provide. Understanding

teachers' experiences as they attempt to integrate technology and accompanying data will enable us to more effectively support teachers as they strive to build learner-centered classrooms.

### **Literature Review**

In this study, we focused on teachers' experiences as they begin using a learner-centered technology program. This topic is based on two major areas of research: technology integration and data-driven decision making. In the following section, we define learner-centered classrooms and learner-centered technology. Next, we summarize research on teacher technology integration. Finally, we describe the importance of data-driven instruction, as well as challenges teachers face when trying to use data to inform instruction.

### **Learner-Centered Classrooms and Technology**

In order to address each student's unique needs, schools must create learner-centered classrooms. Bransford et al. (2000) described learner-centered classrooms as "environments that pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to the educational setting . . . teachers in learner-centered classrooms pay close attention to the individual progress of each student and devise tasks that are appropriate" (pp. 133–134). Thus, teachers who lead learner-centered classrooms use data to identify each student's needs, including gaps in student knowledge, and devise appropriate tasks and activities to address these needs.

Although learner-centered classrooms existed before the current digital culture, technological tools make this type of pedagogy easier to implement with limited resources (Chung et al., 2007). Learner-centered technologies, as we define it here, are technological tools that help teachers meet each student's needs. This can be done through both the program itself and the data the program provides. Chung et al. (2007) described how technology is able "to

make practical many of the ideas central to individualizing instruction” (p. 2). First, technology can streamline assessment, provide immediate feedback, and require active participation.

Second, appropriate technology can provide “cost-effective embedded assessments supporting feedback, diagnosis, and selection and delivery of appropriate instructional parcels” (p. 2). In this way, technology can become a key resource for teachers who strive to base instructional decisions on student needs (Ertmer & Ottenbreit-Leftwich, 2010).

### **Teachers and Technology Integration**

Although technology has the potential to help teachers practice learner-centered instruction, research indicates that in order to change learning, technology must be carefully integrated into the classroom. Technology integration changes teaching and learning; it “change[s] how teachers teach, students learn, and administrators operate” (Norum, Grabinger, & Duffield, 1999, p. 188). Mills and Tincher (2003) explained, “Technology integration in classrooms is more about teaching and learning than it is about technology” (p. 382). Hokanson and Hooper (2004) emphasized that technology needs to be “dispersed physically and pedagogically” (p. 249) to reach its potential. Buabeng-Andoh (2012) and Knezek, Christensen, Miyashita, and Ropp (2000) discussed the need for teachers to adjust content and pedagogy to maximize technology use. Each of these examples highlights the importance of pairing the advantages of technologies with changes in pedagogy; however, teachers often struggle integrating technology in this way (Ertmer & Ottenbreit-Leftwich, 2012; Rogers, 2000). Scholars have studied many facets of this issue, including factors that affect integration and the central role of teachers in integration, barriers to integration, and characteristics of exemplary technology-using teachers.

**Factors affecting technology integration.** Technology integration literature is rich with studies analyzing causal factors of technology integration from both the teacher- and organizational-level. Many have modeled how factors such as teacher beliefs, pedagogy, school support, and technology training interact to identify methods to facilitate adoption. For example, O'Dwyer, Russell, and Debell (2004) studied teachers' constructivist beliefs, beliefs about efficacy of technology and organizational-level professional development, leadership, and school policies in their factor analysis of technology adoption. They found 86%–94% of variance in teachers' technology use was within schools, while 6–16% of the variability was between schools. Tondeur, Valcke, and van Braak (2008), Zhao and Frank (2003), and Hsu and Ping-Yin (2013) also found more variance in technology use within schools than across schools. Common to these and other studies is the finding that, although school characteristics are relevant and important, the central driving force to integration is the individual teacher. Zhao and Frank (2003) illustrated this issue well:

To summarize, although there are many possible influences at multiple levels of the educational hierarchy, two factors ultimately determine the degree and types of computer use by teachers: (a) the nature of the uses, and (b) the result of the teacher's analysis of the uses. All other factors contribute to these two. In other words, most factors do not directly influence technology uses in a linear fashion; rather, their influence is mediated or filtered by teachers' perceptions. (p. 817)

Although organizational-level variables impact technology integration, it is the teacher that must mitigate these factors and drive integration efforts.

**Barriers to integration.** Because teachers are central to integration, several researchers have investigated barriers teachers face when integrating technology. Rogers (2000) separated

barriers into those external and internal to teachers. External barriers were grouped in three categories: availability and accessibility, technical and institutional support, and stakeholder development. Barriers related to availability and accessibility included access to useful, relevant, and appropriate hardware and software, and the need for quality software and hardware. Technical and institutional support barriers included user services and media specialists, technical support, lack of funding, and low levels of administration support. Finally, stakeholder development barriers included lack of time for development at the individual and institutional development (Rogers, 2000). Rogers emphasized that these three categories interact and are interdependent with each other, resulting in complex relationships, and successful integration efforts address all three categories simultaneously. She highlighted teacher attitudes and perceptions as the source of internal barriers, observing that the difference between early technology adopters and other teachers was the perceived potential and benefits of technology.

Ertmer and Ottenbreit-Leftwich (2012) similarly separated barriers to technology integration into two categories, namely first-order and second-order barriers. These categories were similar to Rogers' external and internal barriers: first-order barriers described barriers external to teachers, such as resources and training, while second-order barriers focused on teacher beliefs and attitudes about educational technology as well as technological knowledge and skills. Ertmer and Ottenbreit-Leftwich noted that past efforts focused on addressing first-order barriers have not led to more effective technology use in the classroom; some teachers with few resources (high first-order barriers), could achieve high levels of integration, and "teachers with many resources but strong traditional beliefs have been observed to limit their students' technology uses" (Ertmer & Ottenbreit-Leftwich, 2012, p. 177). They explained, "This is not to suggest that a lack of technology resources cannot act as a gatekeeper, but that teachers with

strong beliefs in the pedagogical value of technology have been observed to overcome these barriers” (p. 177).

In addition to identifying barriers to educational technology use, Ertmer and Ottenbreit-Leftwich (2010) discussed factors that help teachers overcome barriers including contextual, cognitive, and affective characteristics. They emphasized that, although teachers need to feel supported in their technology integration efforts, “The best way to bring more teachers on board is not by eliminating more first-order barriers, but by addressing the second-order barriers of attitudes and beliefs . . . One of the conditions necessary for teachers to adopt student-centered technology use is their perception that external factors, or first-order barriers, will not impede their efforts. Thus, systems need to ensure that teachers feel supported by external factors” (pp. 177–179). Ertmer and Ottenbreit-Leftwich suggested cognitive factors can be addressed by assuring teachers have the technological pedagogical content knowledge (TPCK) needed to be successful. Finally, the authors posited developing school culture and vision aligned with learner-centered technology use leads to more effective technology integration, while top-down mandates negatively impact affective factors.

**Exemplary technology-using teachers.** In order to better understand how teachers overcome barriers to technology integration, scholars have researched teachers who have been successful at using technology in the classroom. Several researchers emphasized the constructivist and student-centered beliefs common to exemplary technology-using teachers (Becker, 1994; Ertmer, Gopalakrishnan, & Ross, 2001; Hooper & Rieber, 1995; Jonassen et al., 1998). Scholars have disagreed on whether use of technology merely reflects teachers’ original, underlying pedagogical beliefs (Becker & Riel, 1999; Hatvia & Lesgold, 1996; Miller & Olson, 1994) or can prompt a shift to constructivist practices (Ertmer et al. 2001). Ertmer et al. (2001)

commented, “Our results suggest that although constructivist practices do not depend on the use of technology, technology may both support and facilitate these practices” (Technology: Enabler or Change Agent Section, para. 3). Similarly, Jonassen et al. (1998) emphasized that effective technology users apply technological tools to create constructivist-based lessons.

Other common traits of effective technology-using teachers include a high level of computer competence (Buabeng-Andoh, 2012), high technological self-efficacy (Buabeng-Andoh, 2012; Ertmer et al., 2001; Fullan, 2007; Moersch, 1995), persistence in working around barriers (Ertmer et al., 2001), initiative to pursue professional development opportunities (Ertmer et al., 2001; Norum et al., 1999), and a supportive school environment (Becker, 1994; Buabeng-Andoh, 2012; Ertmer et al., 2001). Becker (1994) also noted successful technology-using teachers adjusted curriculum to accommodate technology use, showed a deeper interest in academic subject matter, and had accumulated more academic credits and degrees than other teachers. Becker observed that technology-focused teachers had more teaching experience than teachers who were less effective at using technology in the classroom; however, more recent research (Buabeng-Andoh, 2012; Ertmer et al., 2001; Hsu & Ping-Yin, 2013) found the opposite was true: teachers with less experience were more likely to successfully integrate technology, perhaps because younger teachers are often more familiar and competent with technology than well-seasoned teachers.

### **Data-driven Decision Making**

Similar to how technology must be carefully integrated into the classroom to change student learning, teachers must learn to use data effectively if it is to enable learner-centered classrooms. Researchers agree that when teachers use data effectively, student achievement and school quality increases (Goldring & Berends, 2009; Means et al., 2011; Spillane, 2012; Thomas



& Huffman, 2011). Effective use of data leads to a more collaborative and professional school culture, drives positive school reform, and results improved educational outcomes (Thomas & Huffman, 2011). Goldring and Berends (2009) claimed effective educators use data to define student needs, set and prioritize goals, plan interventions, and monitor progress. In particular, the use of data is a core element of learner-centered instruction (Bill & Melinda Gates Foundation, 2015; Means et al., 2011; Thomas & Huffman, 2011).

As a result of technological advances, teachers today have access to a multitude of different types of data (Benjamin, 2014; Schifter, Natarajan, Ketelhut, & Kirchgessner, 2014; Spillane, 2012), and it is particularly difficult for teachers to evaluate the quality of data and integrate multiple data sources effectively (Benjamin, 2014). To address this issue, Benjamin called for a shift from “data-driven decision making” to “evidence-based decision making.” He explained:

Using evidence effectively requires that educators become smarter about the relative importance and value of various data . . . selecting high-quality measures, providing meaningful time for teachers to collaborate regarding their data, translating knowledge into strategies for improvement, using action research techniques to determine if strategies deliver continuous improvement, and linking all of this with professional development, evaluation, reward, and recognition. (p. 48)

In order for both data and technology to effectively enable learner-centered classrooms, teachers must develop the capacity to use the tools in an effective, evidence-based way. Understanding teachers’ experiences with data and technology will help us better support teachers throughout the integration process.

## **Method**

In this study, we focused on understanding the experiences of teachers adopting learner-centered technology, including how teachers integrate program data with other classroom data sources. Specifically, we sought to understand:

1. How do teachers describe their experiences adopting learner-centered technology programs?
2. How do teachers make decisions about which elements of a program to use and how to use selected elements?
3. How do teachers use program data?

## **Research Paradigm**

We followed a critical realist perspective in this study. Maxwell (2013) described critical realism as a combination of two perspectives. First, the paradigm subscribes to ontological realism, “the belief that there is a real world independent of our perceptions and theories” (Maxwell, 2013, p. 43). Second, critical realism borrows from the epistemological theories of constructivism, describing our understanding of the world as individually constructed based on personal experiences and perspectives. Followers of this theory believe that causal relationships should be “examined in the social world through real open contexts where they interact with one another in often contingent and unpredictable ways” (Roberts, 2014, p. 2). Other tenets of critical realism include the inherent fallibility of our understandings (Roberts, 2014; Scott, 2005) and recognition of human beings as “knowledgeable agents with powers to make a difference and thus have the capacity to monitor their actions and change the practical setting of action” (Scott, 2005, p. 245).

## **Methodology**

A core element of Maxwell's (2013) description of critical realism is the emphasis on two types of relationships: similarity and contiguity. He explained, "Both similarity and its opposite, difference, are matters of likeness or resemblance. Contiguity, on the other hand, is a matter of actual connection, influence, or interaction, or their absence" (p. 54). Maxwell recommended investigating both categorizing and connecting relationships throughout the research process. In this study, we used descriptive and thematic analysis of research interviews to investigate similarity relationships and narrative methods to highlight contiguity relationships.

## **Context**

This study investigated teachers' experiences integrating an elementary school-level online literacy and language program called Imagine Learning. Although some teachers use Imagine Learning simply to deliver content or reinforce skills, this research focused on using Imagine Learning in a more integrated way.

Imagine Learning provides several tools that can facilitate learner-centered instruction. First, the program continuously assesses students' progress and delivers content to address identified needs, including providing some instruction in the student's native language. Additionally, the program provides teachers data about students' progress through several tools, including the Growth Tool, which charts students' performance, and Usage Reports that outline time students spend interacting with the program. Finally, Imagine Learning includes a unique tool called Action Areas that provides teachers with a list of struggling students in a particular skill as well as resources to address these gaps.

## Sampling and Participants

This study sought to understand experiences of teachers given access to Imagine Learning for their classrooms. The sampling process included several stages:

1. We sought schools that had a significant number of teachers using Imagine Learning in their classrooms, including some who were using the accompanying tools and data to inform classroom instruction. To identify these schools, we used Imagine Learning data as well as recommendations from Imagine Learning personnel to identify nine public schools across four states.
2. In order to identify teachers with a variety of experiences, we distributed a survey based on Hall and Hord's (2001) Concerns Based Adoption Method (CBAM) to teachers at these nine schools. The CBAM is an innovation adoption model designed specifically to address educational change, including innovation usage behavior. Hall and Hord (2001) developed the theory in an effort to understand teacher and curriculum change. The model focuses on teacher concerns throughout the change process, including stages teachers experience while adopting an innovation. Specifically, the survey used the CBAM's Levels of Use to identify teachers at different stages in integration, and invited participation in interviews. We administered the survey to about 200 teachers. Seventy-five teachers completed the survey, and 39 were willing to participate in interviews.
3. We selected four schools across two states as final research sites. These were chosen based on survey responses, willingness of teachers to participate in the study, research congruence for this and other studies, and geographical convenience. Because Imagine Learning was originally designed for English Language Learners (ELLs), each school

had a high percentage of students classified as ELLs. All four schools were classified as Title I schools.

Fourteen teachers from the four elementary schools participated in individual research interviews. Teachers varied in teaching experience from second-year teachers to teachers who had more than 20 years of experience. Participants included 11 classroom teachers, one ELL specialist, and two instructional coaches. All teachers had used Imagine Learning for at least one year.

### **Data Collection**

The lead author conducted multiple interviews with most of the participating teachers. Interviews included an initial phone interview (10–15 minutes) focused on basic information about how the teacher used Imagine Learning in her classroom; a full on-site interview (45–90 minutes) focused on the teachers' experiences with educational technology, including their experiences with Imagine Learning; and a follow-up interview (10–15 minutes) to check her interpretations of their experiences. Before each follow-up interview, she sent teachers a narrative summary of her understanding of their experiences. Teachers were invited to edit the narrative, and in the follow-up interview they discussed the veracity of her interpretations as well as any changes they made to the narrative. In addition to the interviews, the lead author spent 30–60 minutes observing each teacher's classroom in order to better understand the setting of their narrative. She recorded actions of students and teachers, such as how the teacher engaged with students while they were working on the program and what types of challenges teachers faced during implementation.

Seven teachers completed all three interviews. Because of scheduling difficulties and time constraints, the other teachers did not participate in all three interviews. Four teachers

completed all but the follow-up interview, while the remaining three participated in only the on-site interview. We kept audio recordings of all interviews.

### **Data Analysis**

We used a computer program to create transcripts of the interviews that linked directly back to the audio recordings. We then analyzed the transcripts with a combination of categorizing and connecting strategies (Maxwell, 2012). We began by applying an experiential narrative analysis as described by Squire (2008). This included a combination of inductive and deductive techniques, such as identifying themes and looking for commonalities and differences across experiences, following Squire's advice and focusing on the "sequencing and progression of themes within interviews, their transformation and resolution, thus . . . foreground[ing] the specifically narrative aspects of texts' meanings" (p. 50). The analysis went through several phases. First, the lead author read each interview, highlighting continuity-based narrative dimensions such as conflict, theme, setting, and relationships. Next, she wrote narrative summaries describing the experiences of eight of the teachers, shared the narratives with those teachers, and conducted follow-up interviews.

After completing the narratives, an additional coding cycle identified common themes across narratives, including concept-driven codes (Kvale & Brinkmann, 2009) of program and requirements, data, making decisions, judgments, and evidence. After coding half of the data, the lead author developed sub-codes of the concept-driven codes, similar to Saldaña's (2016) description of focused coding, and returned to the data as a whole, looking for evidence for and against identified themes.

## **Validity**

Although qualitative researchers often verify trustworthiness by using certain procedures to acquire and analyze data, Maxwell (2012) described a different approach relevant to the critical realist paradigm:

Validity . . . pertains to the accounts or conclusions reached by using a particular method in a particular context for a particular purpose, not to the method itself . . . Any assessment of the “validity” of a study’s conclusions is not simply a matter of determining whether specific procedures have been used, or even how carefully and rigorously they have been applied, but of considering the actual conclusions drawn by using these procedures in this particular context. (pp. 131-132)

We built validity by selecting trustworthiness techniques central to the context, purpose, and findings of this study. First, we used both interviews and classroom observations to gain a more thorough understanding of participants’ lives as teachers. Second, we shared summaries with the teachers, invited them to revise and edit the summaries, and discussed discrepancies and interpretations during follow-up interviews. Third, we monitored personal feelings and their effect on the research, especially for the lead author who was completing an internship with Imagine Learning at the time, but stayed cognizant of personal feelings and biases through a detailed research journal and audit trail shared with the co-author. Finally, we evaluated the theoretical validity of the findings and conclusions by actively identifying evidence for and against each of the themes that presented below.

## **Findings**

Although we began this study looking for how teachers did or did not create learner-centered classrooms, we soon discovered that teachers’ actions already reflected learner-centered

thinking. It was clear that the teachers cared deeply about the progress of each student and used ongoing progress monitoring data to identify struggling students and make instructional decisions. One teacher explained, “We just try to meet the needs of everybody the best we can.” However, in some cases their ability to meet the needs of students was limited by rigid public school systems, curriculum requirements, and a lack of support. These same barriers hindered their efforts to use elements of Imagine Learning that they believed would help them better identify and address student needs.

The teachers tried to balance school requirements and student needs by using tools that they believed demonstrated the most evidence of effectiveness, but the system they worked in left little room for fully implementing learner-centered technology. At most of the schools, teachers were required to have their students use Imagine Learning for 30 minutes each day. However, teachers were not required to use the additional learner-centered tools, such as the Action Areas Tool, or other data provided through the program. Instead, most teachers used the Action Areas Tool and other supplemental resources to check, compare, and make small adjustments in instruction.

Teachers’ experiences with Imagine Learning highlighted the interaction of school requirements, evidence of data validity and program effectiveness, and teachers’ desires to meet each student’s needs. Each of the following sections uses excerpts from teachers’ narrative summaries to describe one of these elements. All teacher and school names are pseudonyms.

### **Teachers Must Fulfill School and District Requirements**

Students' days are packed with instructional blocks, interventions, and assessments. Teachers want to make the most of their instructional time and are frustrated when they feel requirements limit their ability to meet student needs. One teacher explained her students’ busy



schedules: “We have several small groups, three different small groups at three different times throughout the day. Sometimes it's also in the afternoon, our small group. And then they also go to the computer lab twice, sometimes in one day, so it leaves little time for me to teach the skill, so that's why it's hard to get everything in, but I do my best.” Teachers struggled when extra requirements were added to their already-full day. A teacher succinctly explained, “We’re not super fans of programs here.” Sonya’s experience promoting program implementation at Belknap Elementary illustrates one way busy teachers react to extra requirements.

**Belknap Elementary—Sonya: “Teachers felt they could do without it.”** Sonya is an instructional coach at Belknap Elementary, an inner-city school with a high population of English Language Learners (ELLs). Sonya has a positive attitude towards educational technology—she used several programs regularly when she was a classroom teacher, and, as an instructional coach, she has seen evidence of Imagine Learning as well as other programs effectively supporting student learning.

Sonya works primarily with the older grades, though she does support two lower-grade teachers. She said she prefers coaching to classroom teaching because she can reach more kids: “I feel that I can help more students by helping the teachers, versus just helping my classroom. So I reach more. That's [the] main reason [I prefer coaching].”

Belknap Elementary was part of a large Imagine Learning study during the 2014–2015 school year. Sonya’s first exposure to the program was during the summer of 2014, during district training for instructional coaches and a few teachers. She explained, “It was over the summer, during a professional development . . . We were able to see a school on a video that had success . . . it was just a general overview of what it was . . . It seemed like a pretty good program overall. The way that they presented it, it seemed like it would work.”

After the training, Sonya and another instructional coach created a school-wide schedule for using Imagine Learning in the computer lab. Sonya was excited about the program and felt it would be successful, but initial implementation was challenging. She described:

It was rough . . . the teachers felt like it was another task and that it took away from their teaching time, and it was like pulling teeth to get your kids in there, and then the fact that our kids, especially the younger ones, didn't have a lot of computer experience . . . I remember taking a class in there for the first time when I was covering for a teacher. It was a [kindergarten] class. It took me almost the entire 30 minutes to get everyone on. I was like, "Oh my gosh, I don't know how they do this" . . . I will say it was a mess the . . . first half of the year. And teachers just didn't want to deal with it. They felt that they could do without it. [They didn't understand] that it's really differentiating the student's learning based upon what they already know.

Part of Sonya's challenge was that teachers didn't understand what the program was and why she felt it was valuable. Sonya explained, "I think if they would have had the initial training like we did, the overall, this is why the program is in play instead of here's how you use it . . . giving teachers an understanding of it instead of just how to do it." Sonya felt it would be worth it, but she struggled get teacher buy-in.

**Limited instructional time.** As Sonya described, teachers at Belknap Elementary expressed frustration from their early experiences with Imagine Learning. They emphasized that the tension was a result of not understanding why they needed to use the program. They were concerned with time on the program supplanting other instruction. For example, Claudia, a third-grade teacher, explained, "[Students] were on it . . . before we knew what it was . . . it was 45 minutes of your [language arts] block that you had to use for computer time instead of for

guided groups. So we were trying to fit everything in, then you have to bring them to the computer lab.” Sonya agreed. She told me, “The teachers felt like it was another task that took away from their teaching time.” Teachers wanted to meet the needs of students; however, they felt district requirements limited their ability to do so.

**Micromanaging.** Teachers at MacArthur Elementary, a school near Belknap, also responded negatively to initial program implementation, but they were particularly concerned about excessive district requirements and micromanaging. A third-grade teacher explained, “It's very overwhelming, it's very . . . micromanaging. We're told what to do and when to do it and how to do it. It's not our classrooms anymore, Melissa. We're just as much as robots now.” Another McArthur teacher said their new reading curriculum had learner-centered tools, but she felt that she couldn't use them:

We were talking about how [the new tools] would be really helpful, but at the same time being at the bottom of the totem pole, it's a district decision and even though you want to group them this way, if they say “No, you can't use this data, you need to use data from another source,” then it doesn't become useful anymore. You do whatever they want you to do.

Other teachers at McArthur mentioned receiving contradictory information about what they should be doing in the classroom and experiencing frequent changes in curriculum. Although at every school teachers expressed feeling a lack of support or trust, none were as extreme as at MacArthur Elementary.

**Technical challenges.** In addition to the pressures of fitting computer time into their busy schedules, technical problems and lack of training led to teachers being even more frustrated with forced use. For example, a teacher at Belknap was frustrated that she had to keep

her students on the program even when there were technical programs. She explained, “[It] was hard because there was so much concentration on just meeting minutes and when there's faulty equipment . . . it's not really [the student's] fault that he's not on there the entire time.” Other teachers were frustrated when the school didn't provide enough headphones, an integral part of the language development aspect of the program.

**Needing to know why.** Although teachers were continually concerned about the number of programs that used up instructional time, the initial tension from required use dissipated when teachers received training that demonstrated how the tool is designed to deliver instruction tailored to individual student needs. An instructional coach at MacArthur explained, “It originally started last year as something that we had to do and then eventually evolved into something we got to do.”

Teachers at Belknap Elementary noticed a clear change of attitude after a training session. Claudia, the third-grade teacher who described angst over limited instruction time, explained, “After talking about that, then seeing how teachers could use it, [how] I can go in and look and hear and see, just like I would if they were sitting in front of me and we were talking about it. Now instead of just the five kids with me, the whole group was getting that attention . . . with that understanding and developing that understanding, that's how . . . it changed.” When teachers understood why they were asked to implement the program, and particularly how it could meet individual student needs, they became more invested in the program despite frequent technical problems.

### **Teachers Want Evidence that Students Are Learning**

Knowing the reasons behind adopting the technology built teacher buy-in; however, many teachers looked for more solid evidence that the program was meeting student needs.

Finding evidence of the efficacy of a single intervention amid a busy school day is difficult. Many teachers mentioned the difficulties of obtaining evidence of Imagine Learning's efficacy. Gary, an enthusiastic second grade teacher, described his search for proof that the program was an effective use of learning time.

**Hawthorne Elementary—Gary: “How do I know if it’s working?”** Gary loves his students. He is positive, enthusiastic, and quick to celebrate success. He has taught at Hawthorne Elementary for 21 years—two years of second grade, 17 years of kindergarten, and he is now in his second-year teaching first grade. He is results-driven: it is important to him to have evidence that each of his students is learning. And when he sees something is effective, he is all-in.

When the lead author asked Gary if he had used any of the Imagine Learning reports or other intervention tools during the previous school year, he described:

Last year . . . we started getting nervous about if [students were] going to hit their numbers for the end of the year . . . We have this law that if third graders aren't reading at grade level at the end of the year, they have to repeat third grade. So that's why we're very focused . . . I was thinking, “Wait a minute, I don't really know if Imagine Learning is helping, or how do I know? I don't know. Is there a way to figure this out?” So it was shortly after I started questioning that, I'm pretty sure [an Imagine Learning representative] came . . . and he answered that question and said, “Here's how you find out which letters they know, or . . . letter sounds or sight words, things like that. [I thought], "Oh, OK, that's what I needed to see if they're progressing,” so it was good that . . . we were able to see that. But it seemed like Imagine Learning was showing growth

that I didn't see in other areas, in other assessments . . . I didn't know why there was a disconnect there, and to be honest, I haven't looked this year at their progress.

Gary had a specific need: he wanted to know if the program was working, but he didn't know how to find out. A representative came and demonstrated the program's reports as a way to answer Gary's questions. Gary was pleased to learn this. However, when he began exploring the reports, he didn't feel the program was giving him an accurate representation of students' progress, so he never moved forward to using the tools:

There are so many variables, there's whole group, there's small group, there's the computer programs, Imagine Learning, there's homework that they do with their parents, parent involvement. There's so many little variables, how can you isolate Imagine Learning and say, "Oh, here Imagine Learning is making this effect on the students." How could you say any of those variables? It takes all of them together, so I guess I was just asking the question "Is there a way to know how this is affecting the kids?" I was asking our interventionist and maybe the principal. That's when [a representative] came in and showed us how to find the reports.

Despite his difficulty finding evidence, Gary still valued the technology's role in his classroom. He explained,

It sounds like I'm sort of questioning, "Should we really do Imagine Learning?" But there's no way I would stop doing Imagine Learning . . . I just, I'm just one of those people. I like to see the proof. If you can show me it's effective, let's put more time and effort into that and less on something else . . . I like to have the proof but if there isn't any, I have to trust that whoever is presenting things to us, they've checked it out and they know it's a good product or a good program, whatever the item is.

**Available evidence: Observations and program data.** Without the ability to isolate the effects of a single intervention, teachers focused on other forms of evidence, including their own observations and how the program's student data matched other data and observations. For example, one teacher explained, "Daily, I don't know that I can say, Oh, now I see that they're doing better. I don't know that I notice; it's not that obvious . . . But I think, by the time, by the last day of school, you could look back and see how much they've grown, then I notice." Teachers felt the tool was meeting individual student needs because of their observations of student understanding and progress. Teachers said students often sang the songs they learned in the program and connected concepts they learned with classroom lessons. For example, a teacher at Belknap Elementary explained, "At the beginning I was just like, 'Oh, that's time outside of the classroom.' But . . . catching the kids singing the chants to help them remember stuff, that really helps. It exposed them to stuff before I actually taught it so they had some background knowledge when I actually presented something to them, or reinforced it." Another teacher explained, "Something that could be used [to] measure growth [is] important, but anything that is to help students say, 'Hey, I learned that on...' is something that is positive; obviously it is working and the kids are learning."

Similar to Gary's experience, some teachers tried to look for evidence of program efficacy in data provided by the program. Teachers looked at program data to see if it matched what they were seeing in the classroom and other assessments. Teachers who felt the program data matched other data were assured that the program really was working at the individual student level. Teachers who felt the data didn't match usually assumed students were not focused or performing their best on the program.

## Teachers Strive to Meet Student Needs

Perhaps because evidence of an intervention program's efficacy is difficult to come by, teachers frequently cited other reasons they eventually supported the program. These reasons centered on both their own observations and, similar to Gary's experience, trust that administrators who purchased the program had carefully analyzed evidence of efficacy. In the end, teachers felt the program provided a way to meet individual student needs amid a busy school day. For example, Crystal, a teacher at MacArthur Elementary, hand-picked students who she thought would benefit from using the program the most.

**MacArthur Elementary—Crystal: “They need that differentiated help.”** Crystal has taught elementary school for five years. She currently teaches first grade at MacArthur Elementary. Crystal has tried to use a wide variety of educational technology tools in her classroom. She uses educational technology to differentiate instruction and to keep students engaged, or as “just something different to change up the classroom.” She uses a variety of technology programs, including Apple apps. She explained:

[I use] Apple apps or tools to help them, like a magnetic spelling board that you can access through an iPad . . . we have a math app that I've used in the past for kids who are struggling understanding number sense . . . I have three laptops and they stay in my room so then I always have access to them. We use them for Imagine Learning, and we use them for phonics activities or reading activities that the kids are doing.

Crystal is purposeful in how she uses technologies and focuses on what she sees as working best for individual students. During the 2015–2016 school year, Crystal was given Imagine Learning licenses for some of her struggling students. Crystal explained that she uses the tool to differentiate instruction:



When I'm doing a writing lesson or a phonics lesson, I have [some of my students] do Imagine Learning instead or at the beginning of the day in the morning when I have the kids do independent work as they walk in. I have a rotation of kids and they use Imagine Learning in the morning . . . rather than doing the independent work that they are going to have difficulty doing on their own . . . I've actually put more kids on . . . because I thought it would benefit them . . . They have a shorter attention span and they have a harder time focusing in class, and academically they are lower than other kids so they need that differentiated help anyways.

Each of Crystal's students has his or her own schedule with the technology. Most of her students are pulled from whole group activities. One student, however, uses Imagine Learning a little differently:

He's actually not in the morning rotation because he [does Imagine Learning] during intervention time. He'll grab a laptop or an iPad . . . when I'm doing centers. He only has one center every single day, and that's his Imagine Learning. That's about enough time for him . . . that was a personal decision, when everyone else does a center, that's your time to do Imagine Learning . . . That way it frees up the morning where he can do things with the class.

This student uses the tool in a different way from other students because it is what works best for him and his schedule. In this way, Crystal uses Imagine Learning time to meet his specific needs, similar to how she uses it to meet other students' needs.

**Kids get what they need.** Many teachers told me they used the program for the same reasons as Crystal did: they believed it adapted to meet each student's needs. A teacher at Belknap Elementary explained this to her students: "I had fifth graders reading at a first grade

level. I told them . . . what Imagine Learning is doing. We're not just going to go and play games, but it's going to help us close some of those gaps that they're missing.” Teachers emphasized that the program provided differentiated instruction that they couldn’t provide.

**Kids like it and are engaged.** Teachers also used the program because their students enjoyed it. Teachers explained, “The kids do like it,” and “I can see, students enjoy it.” However, beyond students simply enjoying the program, teachers also valued the level of engagement in the learning process that they saw in students working on the program. Gary described, “To see the enthusiasm and their effort is really, I don't know how else you can duplicate that. When we sing in class, they'll participate, but when they're on the computer like that and you hear them, you know, they are all-in!” Some teachers found the program particularly useful for keeping struggling students engaged when they are unable to participate fully in other instructional activities, “I try to get them on . . . while other students are doing centers. These are the students that have issues with centers because they can't read directions because there's a language barrier, so putting them on is a useful way to keep them interactive and learning at the same time.”

### **Teachers Try to Balance Requirements, Evidence, and Student Needs**

Although most of the teachers I spoke with were very supportive of students using Imagine Learning, few teachers used the program’s data or intervention tools in a routine way. In fact, the teacher who was most regular and consistent with using the tools was not a regular classroom teacher; she was an ELL specialist in a school district that used Imagine Learning as a core strategy for ELL instruction. Regular classroom teachers, however, said they didn’t have the instructional time or the flexibility to use program intervention tools regularly. Instead, they used the tools to check individual student progress, verify data gleaned from other sources, and

make small adaptations in their whole-group instruction and intervention time. Jimena, a kindergarten teacher at MacArthur Elementary, explained how she used program data to check other data and make small changes in instruction.

**MacArthur Elementary—Jimena: “You have so much data available.”** Jimena is an ELD kindergarten teacher at MacArthur Elementary. She has taught for nine years, with experience teaching kindergarten and grade two. Jimena grew up near MacArthur and completed her student teaching there.

Jimena cares deeply about each of her students. She does what she can to ensure that each student is successful. She looks at data carefully to ensure each student is getting the support they need. She explained, “I’m a data person, I like to get data.” However, she worries that her students are under too much stress and spend too much time testing. For example, she told me:

I asked “What is a teacher's job?” [They responded], “To test! To give tests!” I'm like, “Oh, no.” It kind of breaks your heart because that's not my job, my job is not to give you a test. It's to teach you how to love learning like reading and working with numbers.

Jimena does her best to utilize the data she has to inform her instruction, but she has to make choices about which sources to use and how to use them. She explained, “You have so much going on in your day and that data is available, but then you also have data you're being asked [to use by] the school . . . you kind of balance that.” Jimena likes looking at the data and thinks it’s important, but she doesn’t have time to use each source in depth. Instead, she uses some data to test her assumptions and the accuracy of other data. She gave me an example of how she does this:

I have one who is still struggling with letter sounds. I can go check, look at Imagine Learning, is this what he is still working on, and yes, sure enough, he is still learning the letters on Imagine Learning. I'll go ahead and double check on it and see if both my observations and what Imagine Learning is teaching them is on point.

When data show students struggling with particular skills, Jimena acts on that information. She described:

We do small groups . . . I'll just quickly pull them over. [I'll ask], "What did you not understand?" We'll work on characters . . . We'll work on that for a whole week and then see where the student is. Then we have an after-school program, and I've sent those students to the after-school program also. Once they meet the benchmark, we switch students. Sometimes I stay after school with students, just for 10 minutes. You don't want to overwhelm the kiddos. I also do a lot of parent letters. I use a website also that I communicate with parents, and it's, "Your child is having a hard time on this," so the parents are aware of what they are lacking and how they can help.

Jimena focuses on individual student needs. She uses data from several sources to identify problems or to check the validity of other data and classroom observations. She works on identified problem areas with students in small groups or after school and communicates progress with parents. She has found a way to effectively use the multitude of data sources available to her.

**Choose and check data.** Jimena described herself as "a data person." Most of the teachers used program data in ways similar to Jimena, though perhaps not as frequently. Teachers turned to program data when they needed more information about an individual student or to check the validity of classroom observations and other data. Imagine Learning data

provided a different perspective on other data and added resources to address individual student problems. A teacher described, “I’ll pull maybe a specific student if say they’re struggling here, so I pull that up as, ‘Where do I begin?’”. The tool also helped beginning teachers check their assumptions about student needs and provided an extra intervention when other interventions were not working. A second-year teacher explained, “With the one student . . . our interventions aren’t working as well, or my interventions from last year, so I’m trying to figure out what I need to do, so what other data besides what I’m used to using. That’s why I went to Imagine Learning.” The program provided an easy resource teachers could turn to when they had questions about specific students.

**Small changes to instruction.** Although teachers did not have much time or space to use data to modify their instruction, they did make small changes to both whole-group instruction and intervention groups. Some teachers taught mini-lessons on skills the data indicated several students were struggling on. For example, a teacher at MacArthur explained, “If [I] saw a majority of the class [was missing something, I did] a quick mini-lesson on I what I saw: ‘I noticed this was happening, let’s go over this, how do we do this?’ . . . Not a full-on lesson, but just a mini-lesson on the side or before.” A teacher at Belknap Elementary explained how she made small modifications to small group instruction to address problems identified through Imagine Learning: “I don’t switch [the groups] around too much. They’re pretty much set, and what changes is whether we’re focusing on a skill or a standard . . . I see these people are really struggling with vocabulary, so let’s review this skill of context clues and making connections in the story . . . They stay in their same groups but what I focus on [changes].” Rather than form new intervention groups based on the program’s intervention tools, teachers often adapted instruction for already-formed small groups.

## Discussion

These teachers' experiences illustrate the complex environment teachers must navigate as they integrate learner-centered technology into their classrooms. The three elements discussed in this article (requirements, evidence, and meeting student needs) are not the only elements that influence teachers' use of learner-centered technology. For example, teachers' beliefs about education and educational technology also impact their use of these tools (see Ertmer & Ottenbreit-Leftwich, 2010). However, when teachers are required to implement a program, beliefs may take a back seat to the more pressing issues of school requirements and evidence that required practices are meeting student needs. When requirements, evidence, and student needs do not align, teachers work in a state of tension and are unable to move beyond a static, mechanical use of learner-centered technology. If schools are to meet the needs of every learner, administrators and policy makers must find a way to resolve this tension. The solution is two-fold: teachers must increase their capacity to evaluate programs and methods based on evidence, and administrators must allow teachers to make major instructional decisions.

First, we must increase teachers' capacities to make evidence-based decisions about the programs and tools they use in their classrooms. Although several teachers in this study attempted to find evidence of program efficacy, most focused their evaluations on informal observations or within-program data. Other researchers have discussed similar issues, particularly with regards to using evidence and data to drive instruction. Means et al. (2011) found teachers were more likely to use data appropriately when they received training in data analysis and interpretation skills. Benjamin (2014) similarly emphasized that teachers need ongoing professional development if they are to base instructional practices on evidence.

Moreover, teachers need to learn to think beyond their classroom and have a say in school-wide programs and policies (Thomas & Huffman, 2011).

In addition to increasing teachers' capacity to interpret and evaluate evidence, teachers must be encouraged to make decisions about programs used in their schools and classrooms. Papola-Ellis (2014) asserted that when teachers are not given the opportunity to make instructional decisions, they can develop a "learned dependency" on external decision making (p. 166). If teachers are to meet the needs of each student in their classroom, they must be empowered to make deliberate instructional decisions at both a school and individual classroom level. Increasing teachers' capacity and opportunity to make evidence-based decisions will help resolve the tension resulting from the misalignment of requirements, evidence, and student needs.

Teachers care about students. They do their best to promote learner-centered classrooms. However, outside requirements often limit their ability to make the decisions they feel are best for their students. In order for teachers to integrate learner-centered technology and use data provided by these programs to drive instruction, they must develop the ability to critically evaluate the efficacy of these tools and have the flexibility to integrate the tools they find effective. Wayman (2005) summarized it well: "In short, research suggests that teachers are in favor of solutions that help improve the education of the children they teach" (p. 298).

### **Conclusion**

In this study, we investigated teachers' experiences integrating learner-centered technology using descriptive, thematic, and narrative techniques. Through interviews, observations, and surveys, we found teachers struggled to balance district- and school-level requirements. In particular, they looked for evidence that instructional tools and methods were

meeting student needs. However, it was difficult to find evidence of the efficacy of a single intervention when multiple programs were implemented simultaneously, and most teachers did not have the analytic skills or decision-making power to make evidence-based instructional decisions.

### **Limitations**

This study focused on teachers' experiences with Imagine Learning, an elementary school language and literacy program. Three of the four schools included in this study participated in a multi-school research study the previous school year, and some of the tension surrounding the program may have stemmed from their experience in this study. However, this type of mandated program use is not uncommon, and it is important to understand teachers' experiences when a program is introduced in this way.

### **Implications for Research and Practice**

Introducing new types of technologies into a school can be a difficult and complex task. The experiences of the teachers in this study demonstrate the importance of including teachers in the decision-making process. Tension resulting from the conflict between student needs, school requirements, and evidence of efficacy may be diminished if teachers have a central role in the decision-making process. Future research should investigate how major curriculum decisions are made at the school and district level and explore methods of involving teachers in the process. Additional research into teachers' capacities for evidence-based decision making, including designing methods for developing these skills for both pre-service and in-service teachers, will help teachers, administrators, and policy-makers feel confident in teachers' abilities to make decisions that meet individual student needs.



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## Chapter 4: Conclusion

Completing this thesis was challenging. As is common in qualitative research, I often felt my research was taking me in a different direction than I had planned (Hatch, 2002; Maxwell, 2012). Nevertheless, I believe my work has illuminated important aspects of teacher technology adoption. In particular, I found that in the present volatile educational context, the Concerns Based Adoption Method (the original focus for my study) does not provide an adequate explanation as to how teachers progress through the adoption process. We need other methods to explore tensions in the educational system.

Throughout my research, I adapted my methods to accommodate new directions while frequently returning to the philosophical core of my work. For example, my original sampling method did not work as well as I had hoped. I wanted to identify high and low users of Imagine Learning at each school. However, teacher use was so deeply embedded in school context that it was difficult to find teachers with drastically different experiences within the same school. Each teacher experienced the adoption process in a slightly different way, but the largest differences I observed were at the school-level, similar to the findings of Hsu and Ping-Yin (2013). These discoveries turned my attention to the tension between cultural, educational, school, and individual plot lines. I tried to follow Clandinin, Murphy, Huber, and Orr's (2009) advice, and look deeper into the tensions:

As we turned our attention to the powerful ways that attending to tensions could help us think about narrative inquiry as relational inquiry, we began to see the interconnected ways that tensions opened up possibilities. Thinking metaphorically brought to mind geodes, rocks that appear grey and plain on the outside. On closer exploration, however, what becomes visible as you gaze through the cracks into the interior are the multicolors,

maybe sparkles of quartz and amethyst, maybe veins of gold or red. By looking into the cracks more deeply, more becomes visible. Thinking metaphorically, tensions could be seen as marking the cracks or fissures in what might, at first glance, be a smooth story. Beginning to attend to the cracks creates the possible spaces for inquiry. It is in the cracks where inquiry spaces are made possible, that is, where there is possibility for retelling lives. (p. 84)

I experienced this phenomenon during my first interview with Danelle (pseudonym), an English Language Development teacher. As Danelle told me about her teaching experiences, I sensed a fissure underneath a mostly-smooth story about moving to a new school. When we both seemed to feel comfortable in our relationship, I asked her more about that school. Her descriptions of not feeling respected, supported, or successful helped me understand her personal story and how her experiences at the school created tension that wasn't resolved until she moved to a school where she did feel respected and successful. This also gave me insight into her experiences with Imagine Learning. It was critical that she felt successful when she used the program; if she didn't, she adjusted her methods. Her experiences were different from other teachers I interviewed because she was at a school that did respect her decisions and allowed her the space to try new ways of using the program. Understanding Danelle's story helped me better understand the stories of other teachers I met with.

As I continued my research, I found it was overwhelming and extremely difficult to build as deep of a relationship as I had with Danelle with all the teachers I interviewed. I completed 13 of my full interviews in three days. Each night, I returned to my hotel room exhausted from interviews and observations. I reflected on my day, on each interview and observation, and recorded my impressions in my research journal, then fell into bed to try to get some sleep before



starting the process all over again. Some interviews were better than others. All provided insight into teachers' experiences with Imagine Learning, but only some provided enough detail to build a rich narrative. Additionally, limited time made it difficult to do a deep analysis of every interview.

I continued to do my best to analyze each interview in depth, but my deadline was quickly approaching and I was still far from completing each narrative and follow-up interview. I had completed eight full narrative summaries and follow-up interviews as well as drafted three additional narratives. Although all the final narrative texts were not complete, my research was providing important insight into teachers' experiences integrating Imagine Learning into their classrooms. In particular, I noticed significant themes centered on teacher's reasons for using different elements of the program, including how they determined what was and was not effective. I realized this finding had important implications for policy and practice. I decided to turn my attention temporarily away from the narratives to focus on these ideas. I copied my analysis file, removed all the codes, and did a new analysis focusing on programs, requirements, evidence, judgments, and decisions. This analysis resulted in the article presented in Chapter 3.

Although the article presented in Chapter 3 contains narrative elements, I do not present it as a narrative article. I do, however, have plans to continue my narrative analysis and write an additional article focusing on teacher identities and technology. It will use narrative to explore how teachers' professional-life stories accommodate personalized learning technology.

Specifically, I will address:

1. What feelings do teachers have about technology, particularly programs that deliver instruction?
2. What tensions result?

3. How do they resolve these tensions?

I also plan to complete a third article that explains why Hall and Hord's (2001) Concerns Based Adoption Method did not fit this particular context and what that means for future research on teacher technology adoption.

My hope is that this research into teacher technology adoption will help administrators and policy-makers better support teachers in their efforts to meet the needs of each of their students. My experiences with teachers have shown me that most teachers just want what is best for their students. They live in a "tension-filled midst" (Clandinin et al. 2009, p. 81), and simply want to resolve conflicts when their individual stories bump up against school context and organized reform (Craig, 2009). By coming to a more complete understanding of these tensions, we can work together to find resolution through educational transformation.

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## APPENDIX A. Level of Use Definitions

Level	Hall & Hord (2001) Definition	Blended IL Criteria
0: Nonuse	State in which the user has little or no knowledge of the innovation, no involvement with the innovation, and is doing nothing toward becoming involved	Teacher does not use reports or Action Areas. (May use usage reports)
I: Orientation	State in which the user has recently acquired or is acquiring information about the innovation and/or has recently explored or is exploring its value orientation and its demands upon user and user system.	Teacher is learning about reports and the Action Areas tool, possibly through school-wide training sessions. Teacher may have explored the reports and Action Area, but isn't using the information.
II: Preparation	State in which the user is preparing for first use of the innovation.	Teacher is making plans to use reports and the Action Areas.
III: Mechanical use	State in which the user focuses most effort on the short-term, day-to-day use of the innovation with little time for reflection. Changes in use are made more to meet user needs than client needs. The user is primarily engaged in a stepwise attempt to master the tasks required to use the innovation, often resulting in disjointed and superficial use.	Teacher is beginning to use reports and Action Areas to individualize instruction, such as forming intervention groups for certain skills, identifying skills that many students are struggling with and adjusting curriculum accordingly, and working with individual students on trouble areas. Use is disjointed and superficial.
IVA: Routine	Use of the innovation is stabilized. Few if any changes are being made in ongoing use. Little preparation or thought is being given to improving innovation use or its consequences.	Teacher consistently uses reports and Action Areas to inform classroom instruction and adjust curriculum and pedagogy.

IVB: Refinement	State in which the user varies the use of the innovation to increase the impact on clients within immediate sphere of influence. Variations are based on knowledge of both short- and long-term consequences for clients.	Teacher is experimenting with using reports and Action Areas in different and unique ways to improve student learning, such as showing individual students growth reports and skill gaps.
V: Collaboration*  *Originally “Integration”	State in which the user is combining own efforts to use the innovation with related activities of colleagues to achieve a collective impact on clients within their common sphere of influence	Teacher is coordinating with other teachers to address student skill gaps-- such as coordinating intervention groups to include kids from multiple classes or extending specific Imagine Learning activities with multi-class projects.
VI: Renewal	State in which the user reevaluates the quality of use of the innovation, seeks major modifications of or alternatives to present innovation to achieve increased impact on clients, examines new developments in the field, and explores new goals for self and the system	Teacher has successfully used IL in an integrated way but is looking for a different innovation to improve learning outcomes.

## APPENDIX B: Level of Use Survey

1. Which Imagine Learning tools are you using with your students? (please check all that apply)

- A. I don't currently use Imagine Learning with my students.
- B. My students use the program.
- C. I use the Usage Reports
- D. I use Imagine Learning activities with my whole class.
- E. I use Imagine Learning activities with small groups.
- F. I print supplemental worksheets from Imagine Learning
- G. I use the Action Areas Tools
- H. I use the Intervention Tools
- I. I use the Growth Tool
- J. I use other Imagine Learning tools (please describe).

2. If #1 is only A: Have you set a date to start using Imagine Learning?

YES: Basic IL Level II

NO → 2B: Are you currently looking for more information about Imagine Learning?

NO: Basic IL Level 0.

YES: Basic IL Level I.

3. If #1 is only B and/or C: Have you decided to set a date to start using other Imagine Learning tools, such as reports and/or intervention tools?

YES: Blended IL Level II

NO → 3B: Are you currently looking for more information about Imagine Learning reports and intervention tools?

NO: Blended IL Level 0.

YES: Blended IL Level I.

4. If #1 includes any of D-J: How do you use Imagine Learning tools, such as reports and/or intervention tools?

4A Are you making changes in how you are using Imagine Learning reports and/or intervention tools?

YES → 4B: Please describe what types of changes you are making.

4C: Are you coordinating your use with other teachers? Please explain.

4D: Are you planning on making major modifications or replacing Imagine Learning? Please explain.

if 4B is user-oriented: Blended Imagine Learning Level III.

if 4B is impact oriented, 4C is YES, and 4D is NO: Blended IL Level V.

if 4B is impact oriented, 4C is YES, and 4D is YES: Blended IL Level VI

if 4B is impact oriented, 4C is NO, 4D is YES: Blended IL Level VI

if 4B is impact oriented, 4C is NO, 4D is NO: Blended IL Level IVB

NO → Level IVA

5. Would you be willing to participate in further research about technology adoption?

YES → 5B: Please enter your name, email, and/or phone number.

\*based on Hall and Hord, 2001

## APPENDIX C. Interview Protocol

### **Initial Interview (online or on phone, 10-15 minutes, semi-structured):**

- Do you have any questions or concerns about the study?
- Briefly tell me about how you use Imagine Learning with your students.
- How long have you used Imagine Learning?
- What other technology or computer programs do your students use at school or as part of homework?

### **On-site Interview (45 - 75 min, semi-structured):**

- Tell me about your experience with Imagine Learning, from when you first heard about it until today.
- The researcher will show the participant cards outlining the CBAM Levels of Use in a random order.
- Do you see yourself in any of these levels? Did you experience any of them?
- When did you move between levels? What was happening then? Why did you change?

### **Follow-up Interview (online or on phone, 10-15 minutes, semi-structured):**

- Before the interview, the participant will receive a narrative summary of his or her experiences.
- What was inaccurate in the narrative?
- What parts of the narrative seem the most true?
- What parts of the narrative seem the least true?
- What else would you add to the narrative?



#### APPENDIX D. Visual Analysis Process

I used the visual analysis tools provided by MaxQDA to assist in understanding teachers' experiences. After completing thematic coding, I used the MaxMaps tool to understand the relationships between themes. Figure 1 outlines the first step in this analysis. Each tag-shaped item is a code from the analysis. The parent codes are Student Needs, Requirements, and Evidence. The thickness of the lines represents the relative frequency of each subcode to its parent code. I manually adjusted directions of arrows as I analyzed relationships among the codes. Finally, I wrote a summary statement for the relationships I saw within each code group as well as the relationships among the parent codes.

After creating the base, I looked carefully for evidence against the themes and relationships I identified. I used MaxQDA's memo feature to write memos highlighting evidence I observed that challenged the model. I used the red exclamation point icon to designate negative case memos. I placed these memos into the map and considered how it affected the identified relationships (see Figure 2). I adjusted my map to accommodate these cases.

Finally, I identified salient quotes that highlighted the themes and relationships. I placed these quotes on the map where I felt they best explained a relationship (see Figure 3). I included the summarized statements and most of the quotes in the final article.

## How do teachers describe their experiences adopting Imagine Learning?

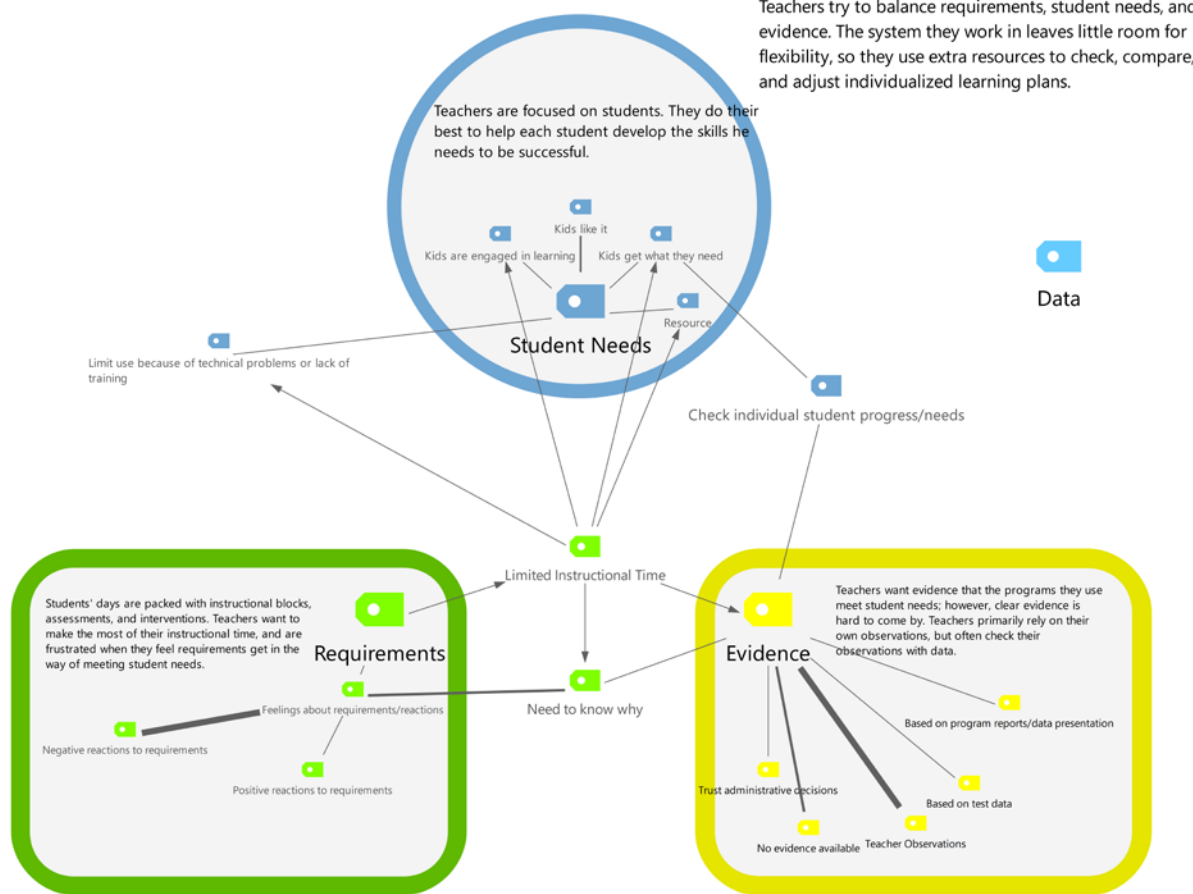


Figure 1. Exploring code relationships using MaxMaps.

# How do teachers describe their experiences adopting Imagine Learning?

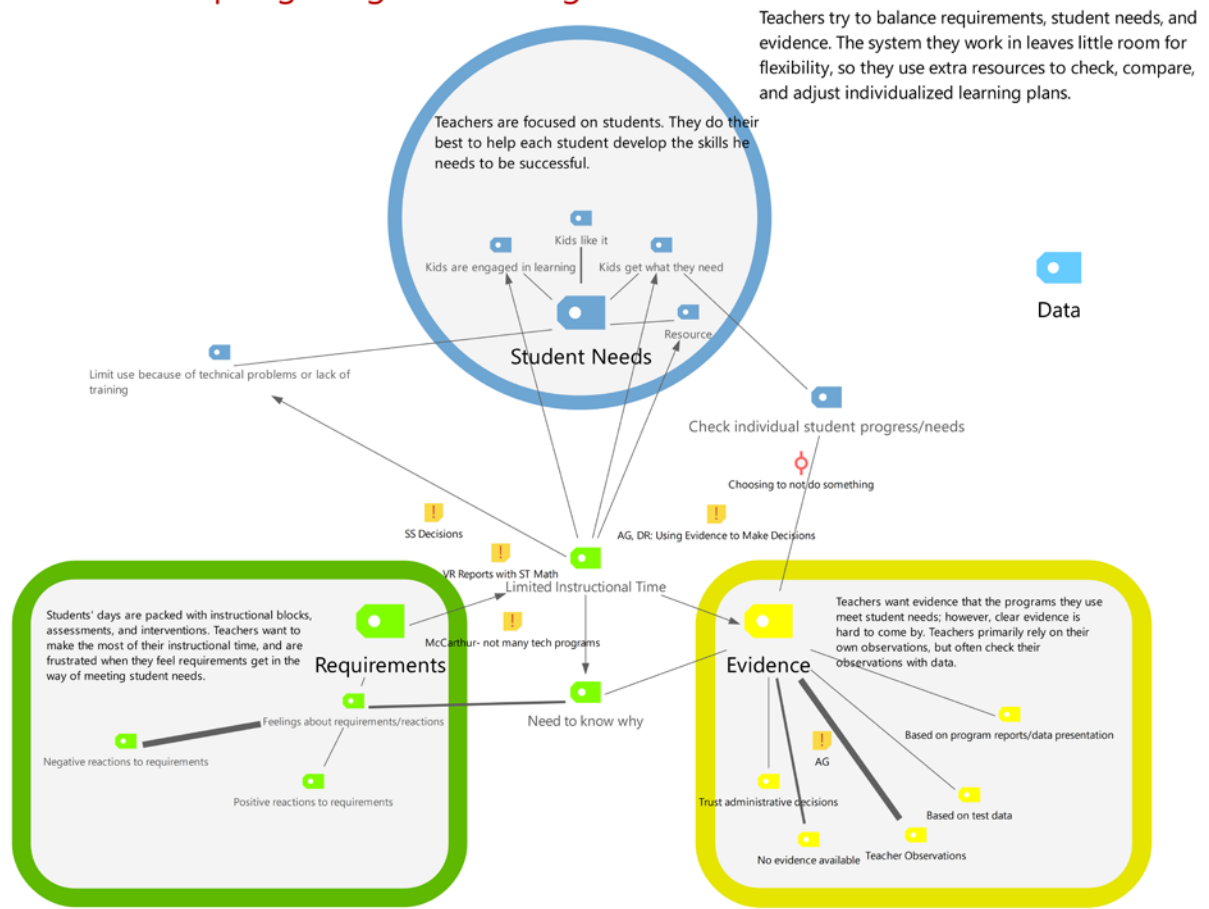


Figure 2. Negative case analysis using MaxMaps.

# How do teachers describe their experiences adopting Imagine Learning?

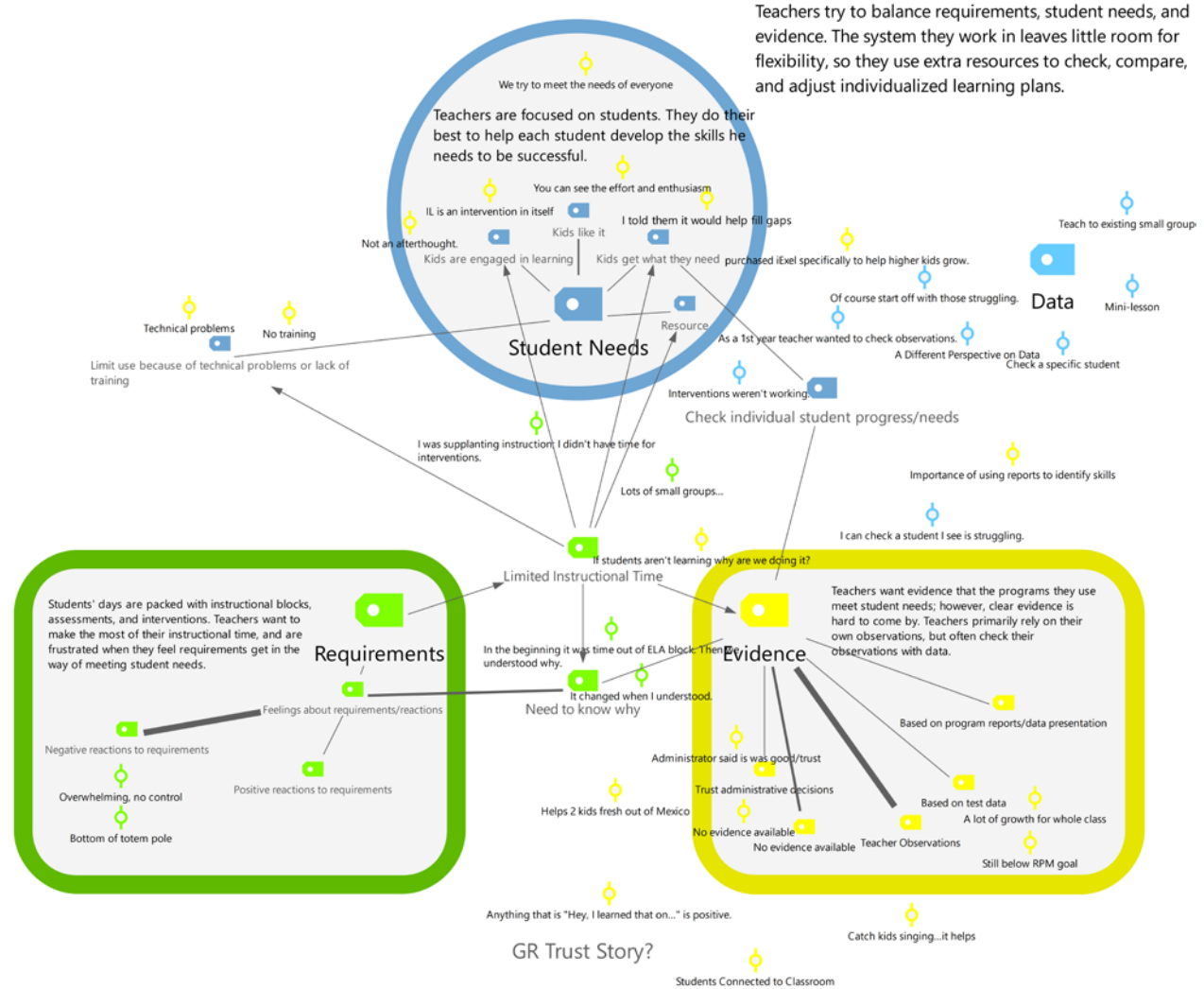


Figure 3. Exploring thematic relationships by adding quotes to MaxMaps.