TEACHER PERCEPTIONS OF FACTORS INFLUENCING TECHNOLOGY INTEGRATION IN K-12 SCHOOLS

by

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A thesis submitted in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

in

Instructional Technology and Learning Sciences

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ABSTRACT

Teacher Perceptions of Factors Influencing Technology Integration in K-12 Schools

by

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Utah State University, 2016

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The purpose of this case study was to examine teachers’ perceptions of what factors are most influential to the successful integration of technology. In the Junior High with the highest technology usage in a preexisting statewide technology initiative, data were collected from six teachers and one administrator through interviews and observations. Teachers primarily highlighted factors related to support and product functionality as influential. This study also examines factors such as change management, learning environment, and student motivation to understand the relationship of these factors to teacher perceptions of factors that influence technology integration. Though many influential factors emerged that all seemed highly interrelated, the most common theme that emerged across all factors was that letting teachers show each other how to use the technology to make life easier and improve learning for students may result in higher levels of technology integration.
PUBLIC ABSTRACT

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Advancements in technology often make life easier, make processes easier, and increase efficiency. While this is true as much in the public school system as it is in other aspects of life, technology integration initiatives often struggle in K-12 schools. In its first year of implementation, one statewide technology initiative targeting personalized learning for mathematics resulted in significantly improved proficiency in mathematics for students with high technology usage, but over 90% of students had low usage. This year, which is year two of the initiative, I went into some of the classrooms in the Junior High with the highest technology usage to better understand what facilitates successful technology integration. Data were collected from six teachers and one administrator through interviews and observations. I also looked at factors such as change management, learning environment, and student motivation in order to understand the relationship of these factors to teacher perceptions of factors that influence technology integration. Though many influential factors emerged that all seemed highly interrelated, the most common theme that emerged across all factors was that letting teachers show each other how to use the technology to make life easier and improve learning for students may result in higher levels of technology integration.
ACKNOWLEDGMENTS

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I give special thanks to my wife, friends, and family for their feedback, support, and patience as I tried to balance school, work, and working through this research from its inception to the completion of this final document.

Clarence W. M. Ames
# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABSTRACT</td>
<td>iii</td>
</tr>
<tr>
<td>PUBLIC ABSTRACT</td>
<td>iv</td>
</tr>
<tr>
<td>ACKNOWLEDGMENTS</td>
<td>v</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>viii</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>ix</td>
</tr>
<tr>
<td>CHAPTER</td>
<td></td>
</tr>
<tr>
<td>I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Background</td>
<td>2</td>
</tr>
<tr>
<td>Why Technology Integration?</td>
<td>3</td>
</tr>
<tr>
<td>II. REVIEW OF LITERATURE</td>
<td>6</td>
</tr>
<tr>
<td>III. METHODS</td>
<td>15</td>
</tr>
<tr>
<td>Theoretical Perspective</td>
<td>15</td>
</tr>
<tr>
<td>Study Design</td>
<td>15</td>
</tr>
<tr>
<td>Sample Recruitment</td>
<td>16</td>
</tr>
<tr>
<td>Setting</td>
<td>17</td>
</tr>
<tr>
<td>Study Measures and Data Collection</td>
<td>18</td>
</tr>
<tr>
<td>Data Analysis and Interpretations</td>
<td>21</td>
</tr>
<tr>
<td>Threats to Validity</td>
<td>27</td>
</tr>
<tr>
<td>IV. RESULTS</td>
<td>29</td>
</tr>
<tr>
<td>A School in Transition</td>
<td>29</td>
</tr>
<tr>
<td>Observations</td>
<td>31</td>
</tr>
<tr>
<td>Factors that Influence Technology Integration</td>
<td>44</td>
</tr>
<tr>
<td>The Process for Managing Change</td>
<td>60</td>
</tr>
<tr>
<td>Learning Environment and Student Motivation</td>
<td>63</td>
</tr>
<tr>
<td>Suggestions from Teachers</td>
<td>69</td>
</tr>
<tr>
<td>Discussion</td>
<td>70</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>75</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>80</td>
</tr>
<tr>
<td>Appendix A – Observation Protocol</td>
<td>81</td>
</tr>
</tbody>
</table>
Appendix B – Interview Protocol .................................................................84
Appendix C – Network Display .................................................................86
Appendix D – Mr. Thales’ Email .................................................................87
### LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pseudonyms and Teacher Information</td>
</tr>
<tr>
<td>2</td>
<td>Qualitative Coding Themes</td>
</tr>
</tbody>
</table>
### LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>This clock was on the wall in the classroom of a teacher who regularly told math jokes</td>
<td>22</td>
</tr>
<tr>
<td>2</td>
<td>This is a view of some of the reporting features in ALEKS</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>Dragging one of the codes from the “Code System” panel onto the block of highlighted text assigns that code to the highlighted text</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>Sample relationship: teachers felt prepared to use technology because they had previously had access and opportunities to use technology in their classrooms; the availability of technology was influenced by administration, and the administration thought technology was important because their teachers said it was making a difference (teacher beliefs); this lead to greater access, leading teachers to use it more; ultimately this increased teachers level of preparedness</td>
<td>72</td>
</tr>
</tbody>
</table>
CHAPTER I
INTRODUCTION

As long as I can remember I have loved learning and loved helping others. As a kid though, as much as I loved learning, I generally hated school. I learned from books, from people, and from getting my hands into things and having experiences. Until I got into college, school was just a place where I either sat bored using every ounce of willpower to keep silent and hold still without falling asleep, or got kicked out of class for cracking jokes and distracting others. In retrospect, I suppose I was what must be every teacher’s worst nightmare: a kid with immense potential, who did not give two hoots about grades and had no patience for lectures.

I have since realized that my problems in school stemmed largely from the fact that I have always been overly pragmatic. As an undergraduate studying philosophy and public relations, I was finally able to find the right words to describe my opinions and much to the chagrin of my professors, the thesis statement of my last ever philosophy paper was: “If what we are discussing has no impact in the circumstances we find ourselves in day to day, it is not worth discussing.” Though not universally true, that idea has influenced my philosophical leanings quite a bit. I spent a lot of time pondering the best way to actually make a real difference in “day-to-day circumstances” of people. After 4-5 years in the “real world” after completing my bachelor’s degree, it struck me that the key might be education. Knowledge, I thought, just might be the key to a secure and prosperous future in this little world we live in. So I went back to school.
Background

As a graduate research assistant at Utah State University, I helped evaluate 11 mathematics technology products used by K-12 schools in the 2014-15 school year for personalized learning. Funded by grants from the STEM Action Center, these products are intended to be a supplement for teachers, allowing them to track the needs, understanding, and progress of each individual student. Each product provider recommended a specific level of usage that would be required for the products to positively impact student achievement, and the standards recommended varied by provider. Some standards were measured in time, some related to the number of lessons completed, and others included a combination of mastery and content progress in the curriculum. The STEM Action Center refers to the levels of usage recommended by product providers as “fidelity.”

At the end of the first year’s evaluation, two products demonstrated positive effects on student achievement for students meeting fidelity (Brasiel & Martin, 2015). Though this finding is exciting, on average only 9% of the 150,367 students using the products met fidelity. Another 47,000 students who had access to the product did not use it at all, and the majority of the students barely used the product at all compared to product provider recommendations.

The usage issues in this program are not unique. Statewide, there have been concerns about lack of access to technology that have led to extensive discussions about ways to facilitate technology integration. During a report to the legislature, one legislator framed technology integration as “the creation of 21st century learning environments,”
which led to discussion of what the characteristics of 21st century learning environments are, and how the integration of technology can support 21st century learning. As a result of all of this discussion, the Utah State Board of Education in collaboration with the Utah State Office of Education released *Utah’s Master Plan: Essential Elements for Technology Powered Learning*, which focuses primarily on developing an organized method for planning changes, and building leadership. Specifically they talk about John Kotter’s “Eight Steps to Successful Change” change management model, which include: (1.) Establishing a Sense of Urgency, (2.) Creating the Guiding Coalition, (3.) Developing a Vision and Strategy, (4.) Communicating the Change Vision, (5.) Empowering Employees for Broad-Based Action, (6.) Generating Short-Term Wins, (7.) Consolidating Gains and Producing More Change, and (8.) Anchoring New Approaches in the Culture. In addition, they recommend a focus on communication; technical support; instructional design; infrastructure; project management; digital content, devices, and software; professional development; policy and procedure; procurement; digital content; research and program metrics; and leadership (Utah State Office of Education, 2015). Now that the Utah State Office of Education (USOE) and the Utah State Board of Education (USBE) have clearly identified some factors they see as important for integrating technology and developing 21st century learning environments, it will be interesting to see what factors teachers and administrators perceive as essential for technology-powered learning and assess how those factors relate to the recommendations in the *Essential Elements of Utah’s Master Plan*. 
Why technology integration?

In addition to the positive achievement impacts we found with students who met “fidelity” in last year’s study on personalized learning technology for mathematics, substantial research has shown that successful integration of technology in K-12 schools can have a significant positive impact on student achievement, problem solving skills, and use of technology as a tool for learning (Drayton, Falk, Stroud, Hobbs, & Hammerman, 2010; Shapley, Sheehan, Maloney, & Caranikas-Walker, 2010; Suhr, Hernandez, Grimes, & Warschauer, 2010; Warschauer, 2008; Weston & Bain, 2010). Researchers have also found that access to technology alone is not sufficient to facilitate these positive changes (Cuban, 2009; Warschauer, Cotten, & Ames, 2011; Weston & Bain 2010), which means that just handing every child a computer is not necessarily a great solution. To have a positive impact, technology needs to be integrated in a way that will actually affect learning. In other words, one laptop per child is just a huge waste of money if it means a whole pile of laptops sitting in the corner of the classroom.

It is important to recognize that the implementation of innovative education methods happens at various levels, from district and school administrators, to teachers, parents, and students. Because of this, there are several organizational or process-oriented factors that may hinder the implementation of new technology in schools. For example, in a study of stakeholder perceptions regarding barriers related to implementation of a comprehensive school improvement model, a lack of buy-in was the most frequently cited barrier (Mendenhall, Iachini, & Anderson-Butcher, 2013). Though many researchers have examined what barriers prevent technology from being integrated, more
research is still needed to identify factors that help facilitate technology integration in K-12 schools.
CHAPTER II
REVIEW OF LITERATURE

The review of literature revealed several important areas that provide insight into understanding technology integration in the K-12 public education system in the United States. In the first section of this review, I focus on general studies examining a wide variety of factors that influence technology integration. Second, I summarize articles specifically examining the relationship between teacher readiness (teacher perception of their capabilities and skills required to integrate technology into their classroom instruction) and technology integration. Third, I synthesize articles that explore the relationship between teacher beliefs (teachers’ perception of technology’s influence on student learning and achievement and impact on classroom instruction and learning activities) and technology integration. Next, I summarize literature related to John Kotter’s change management model to determine if it has been shown to promote technology integration in K-12 settings. Finally, I summarize articles related to student motivation and technology integration in 21st century learning environments.

Factors that Influence Integration

A wide variety of factors have strong direct and indirect effects on successful technology integration. The literature examined a wide variety of factors, including teacher variables (e.g. level of education, teaching experience, experience with technology), school variables (e.g. level of technology support, professional development, access to technology), and student variables (e.g. grade level, average number of students per class). Out of all the factors examined, multiple studies concluded
that a teacher’s experience with technology and level of preparedness to use technology had the most direct, significant effect on classroom technology integration (Inan & Lowther, 2010; Ritzhaupt, Dawson, & Cavanaugh, 2012; Tondeur, Valcke, & Van Braak 2008). In addition to teacher readiness/teacher use of technology, these studies identified several other factors that had significant relationships to successful technology integration.

Ritzhaupt et al. (2012) found that the number of years teaching and school level of professional development both had direct, significant effects on technology use or integration at the classroom level and student use of technology, while Inan and Lowther (2010) found that teacher beliefs and computer availability had significant impacts on technology integration. While it is important to consider all of these factors and how they relate to technology integration in the state of Utah, I focused on the two factors found to have the strongest positive relationship with technology integration and increases in student use of technology as a learning tool. Since both of these studies found teacher readiness/use of technology to have the highest statistical significance, I will start with that.

**Teacher Readiness**

While the two studies discussed previously used a self-report measure of teacher readiness as a general category, Tondeur, Valcke, and Van Braak (2008) broke teacher readiness into several components. Teacher readiness factors included years of computer experience, gender, traditional teaching beliefs, constructivist teaching beliefs, general computer attitudes, and willingness to change. These factors are particularly interesting
because several of them could also be identified as factors related to “teacher beliefs”, which according to Inan and Lowther (2010) had the second highest direct, significant effect on classroom technology integration. Tondeur, Valcke, and Van Braak (2008) found that differences in teacher readiness accounted for 84% of variance in use of technology as learning tools, and 91% of variance in use of computers as an information tool. Differences in school factors (e.g. availability of software, supportive leadership) explained less than 20 percent of the variance in use of technology. It is interesting to note that teacher factors played such a key role in technology integration.

Gibson, Stringer, Cotten, Simoni, O’Neal and Howell-Moroney (2014) conducted a longitudinal teacher-focused intervention, providing professional development in ten sessions over three years to positively influence teacher readiness. Surveys were collected from 764 students and 60 teachers at 12 time points and the level of participation in the intervention varied between teachers. Using regression analysis, they found an increase in student use of technology for educational purposes in classrooms of teachers who had medium to high levels of participation in the intervention. Though this finding seems to support previous research, across the 12 time points, teacher surveys indicated no significant change in teacher readiness. Hence, teacher readiness may not always be the most significant factor influencing student technology use for education purposes. However, given that teacher readiness is important for technology integration in some contexts (Inan & Lowther, 2010), more research is needed to clarify the role of teacher readiness, and understand how interventions can effectively build teacher readiness.
Teacher Beliefs

According to Inan et al. (2010) and Tondeur et al. (2008), teacher beliefs may be the second most influential factor in relation to successful technology integration. In a longitudinal collective case study, Levin and Wadmany (2008) examined teachers’ beliefs about what factors are related to technology integration. Levin and Wadmany interviewed, surveyed, and observed six teachers in grades four to six, and found that while teaching in a technology-rich environment, teacher’s views of what influences integration shifted significantly over three years. Initially teachers focused on organizational aspects, such as product design, alignment with curriculum, and administrator support. Over time, their views shifted to factors related to classroom practices and their own need for additional learning. The most significant finding was that teacher beliefs are constructed through school experiences, such as teaching and administrator support (Levin & Wadmany, 2008).

In Howley, Wood, and Hough’s 2011 study examining factors related to technology integration, teacher attitude was positively associated with availability of technology, administrator support, and their own level of preparation for technology use in the classroom. These findings corroborate the findings of previous research, since they found that teacher attitudes toward technology (teacher beliefs) and perceived level of preparedness for using technology (teacher readiness) were the two most significant factors related to technology integration in the classroom. If teacher beliefs and teacher readiness are the most significant factors influencing technology integration, and school variables such as administrator support influence teacher beliefs, it is important to
consider these factors when designing an intervention targeting the implementation of technology in K-12 schools. More research is needed to determine how factors that influence teacher beliefs can be mitigated or influenced to facilitate technology integration.

**Change Management**

None of the 29 articles found on the topic of John Kotter’s change management model in the K-12 education system were actual research articles using this model. Though no research was found that used John Kotter’s change management model, Barcelona (2014) published a review of literature examining the current state of education research, and proposed that research supports the use of John Kotter’s model as a guide for effectively facilitating transformative changes in K-12 schools. This article also analyzed the K-12 school system in the State of Maine, suggesting that successful curriculum reform involving integration of technology is taking place in that state. Barcelona (2014) suggests that though John Kotter’s eight steps were not identified as a guideline, the reforms in Maine have employed all of the elements in John Kotter’s model.

In addition, it should be noted that nearly all eight of John Kotter’s steps to successful change are related to stakeholder beliefs and readiness. Establishing a Sense of Urgency, Developing a Vision, Generating Short-Term Wins, Communicating the Change Vision, and Anchoring New Approaches in the Culture are all foundational rooted in influencing beliefs and building on beliefs that already exist. Empowering Employees for Broad-Based Action is about ensuring that stakeholders are ready and
have the things that they need in order to take action. If the literature discussed in this review is correct, it stands to reason that more research is needed to inform how district leaders and administrators target teacher beliefs and teacher readiness for change.

**Technology Integration and 21st Century Learning**

Instructional strategies, student motivation, parent engagement, teacher efficacy and many other factors intertwine to create the learning environment within a classroom. According to a study by Yun-Jo An and Charles Reigeluth (2011), learner centered classrooms promote the development of 21st century learning skills such as problem solving, higher order thinking, collaboration, critical thinking, and metacognitive self-regulation. They also suggest that to meet the needs of the “digital natives” in the information age, learning environments must be technology enhanced (An & Reigeluth, 2011). The term “digital natives” refers to the majority of today’s students, who have had access to computers, tablets, smartphones, and the Internet their whole lives. The two factors discussed most consistently in the literature reviewed as influential to 21st century learning were instructional strategies and motivation.

According to the literature reviewed, instructional strategies can have significant impacts on student learning. Using teacher evaluation systems (TES) that measure planning and preparing for student learning, creating an environment for student learning, teaching for student learning, and professionalism, several studies found strong links between how teachers scored on evaluations and student achievement (Gallagher, 2004; Kane, Taylor, Tyler, & Wooten, 2011; Lavy, 2011). Many of the factors examined in each TES are related to strategies used in instruction. One instructional strategy that has
received much attention over the past decade is the creation of constructivist learning environments. Some instructional strategies typically used in constructivist learning environments include: anchoring learning in a real world context; scaffolding the problem being addressed by providing similar and/or contrasting cases for reference; and encouraging conversation, collaboration, and reflection (Lloyd, 2012). Research suggests that a shift from traditional instructional strategies (e.g. lecture) to more varied strategies (e.g. small group work) is positively correlated with increases in creativity, reasoning skills, and other 21st century skills that are not traditionally measured by standardized assessments (Bietenbeck, 2014). Together, all of this research indicates that carefully chosen instructional strategies are integral to the creation of 21st century learning environments.

Another factor that came up with great frequency in the literature reviewed was student motivation and student engagement. Researchers have shown a strong correlation between increased motivation and increased student achievement. Dweck (2008) found that what a student believes about the potential for their brain to grow and develop through additional effort was linked to increased motivation, engagement, and achievement in math and science. Her studies have found that students’ beliefs about their brains are significantly affected through direct instruction about neuroplasticity (or the brains ability to grow and change) (Dweck, 2008). She has also found that different kinds of feedback can encourage either a growth mindset or a fixed mindset. Growth mindset is encouraged through “process praise,” while “person praise” encourages the development of a fixed mindset (Dweck, 2009). As an example, if a student did well on a
test, saying “Wow, you are so smart!” (person praise) would encourage a fixed mindset. Saying, “Wow! I can tell you studied really hard! Good Work!” (process praise) would encourage a growth mindset. Student engagement and motivation are connected to student learning (An & Reigeluth, 2011; Freeman, et al., 2014; Proctor, Daley, Louick, Leider, & Gardner, 2014). Therefore, 21st century classrooms need to pay attention to ways that teachers can increase student motivation and engagement.

Implications

Based on this review of the literature, there is still a need to research factors related to teacher readiness in order to improve technology integration in K-12 schools. The purpose of my study is to identify factors that teachers perceive to be related to successful integration of technology and creation of 21st century learning environments, examining cases in which personalized learning technologies have been implemented. This study also examines factors shown by prior research to be related to integration of technology such as teacher beliefs, teacher preparedness and administrator support. The information gained from this study will be used to develop strategies for improving technology integration throughout the state.

Research Questions

1. What factors do teachers, administrators, and district leaders perceive as being influential to technology integration?

2. How do teachers and leaders describe the process for managing change in their school or classroom when they received the technology grant?

3. What features of the classroom learning environment support technology integration?
4. What strategies do teachers use to keep students motivated and engaged?
CHAPTER III

METHODS

Theoretical Perspective

As discussed in the opening paragraphs of this paper, my personal philosophical leanings have always been somewhat pragmatic. That is to say, I’m primarily concerned with finding things that make a positive impact in the day-to-day circumstances of individuals, and I believe that the reality of objects and experiences is inseparably connected to one’s consciousness of them (Creswell, 2012). Each person views the world through a unique lens, and what works for one may not work for all. Because of this, it is important for me, as the one collecting and reporting the data, to lay aside any preconceived notions about the case as much as possible (known as bracketing), in order to examine the data collected from participants in its purest form (Moustakas, 1994).

Study Design

Case study research, in a broad sense, attempts to understand what is happening in a real-life, specific bounded system (or case), bounded by time and place (Creswell, 2012). It generally occurs in a naturalistic setting, with the researcher serving as the key instrument for data collection and analysis. Case study research is ideal for understanding phenomenon in the world of education because of the many factors that influence decisions, policies, practices, and outcomes (Merriam, 1998). Technology integration is a particularly complex phenomenon requiring investigation within the specific context of schools. In each case unique stakeholders, leaders, history, availability of technology, beliefs about technology, technical abilities, and support for technology are factors that
need to be considered. To help validate findings, I examined multiple classrooms or “cases” and used triangulation of data to look for themes.

**Sample Recruitment**

Because teaching in a first grade classroom is different than teaching high school seniors, I selected classrooms that were all at a similar grade level. The subject specific period schedule of Junior High classrooms is ideal for observations, because it allows observations of several groups of students taught by the same teacher on the same day. In addition, researchers suggest that cultivation of students’ mathematical interest and engagement early on may increase the likelihood that students will continue taking classes in science, engineering, technology, and mathematics (Bybee & Fuchs, 2006; Bagiati, Yoon, Evangelou, & Ngambeki, 2010; DeJarnette, 2012). The combination of these two factors makes Junior High classrooms an ideal sample for this study.

Initially, I sent letters to Junior High principals whose schools were using math technology products provided by the STEM Action Center grants with high rates of technology usage (as reported by product providers), to find teachers willing to participate. The sample was limited to five schools, as agreed on in my thesis proposal defense, in order to gather a depth of information for this study. Schools were selected for this study only if they had 300 or more students averaging at least 80% fidelity (the standard of usage set by the product provider). Five schools were selected who met the criteria. Out of the five schools initially contacted, two responded. Of the two schools that responded, one school was chosen because it had the second highest level of mathematics technology usage statewide. This made the school a critical case to examine,
because in Brasiel and Martin’s 2015 study, examining the first full year of math
technology implementation in the state, high usage was positively correlated with gains
in student achievement. The standard of mathematics technology usage, in this case,
specifically refers to usage recommendations of the vendors who provided products. This
was measured in time, number of lessons completed, or a combination of mastery and
content progress in the curriculum, depending on the product provider.

Setting

Six teachers and one administrator from the selected school met with me to
discuss the study and provide insight. They indicated that three of the teachers were the
best exemplars for technology integration, and that while they all learned from each
other, these three teachers provided the most instruction and support to their colleagues.
Based on their feedback, these three classrooms were chosen for further observation.
Additional detail is provided about the selected school in the results section. Initial
observations all took place during the first week of April, and follow up observations
took place during the first week of May. One of the teachers ran into scheduling conflicts
due to end of year testing, so observations were only done in two of the three classrooms
initially selected. Teachers were considered for participation without regard to age, level
of education, years of teaching experience, or years of experience with technology.
Pseudonyms are used for all teachers and administrators (see Table 1).
Table 1

*Pseudonyms and Teacher Information*

<table>
<thead>
<tr>
<th>Pseudonym</th>
<th>Role</th>
<th>Grades Taught</th>
</tr>
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<tbody>
<tr>
<td>Mr. Lincoln</td>
<td>Principal</td>
<td>N/A</td>
</tr>
<tr>
<td>Mrs. Mandela</td>
<td>Vice Principal</td>
<td>N/A</td>
</tr>
<tr>
<td>Mr. Pascal</td>
<td>Head of Math Department</td>
<td>7 &amp; 9</td>
</tr>
<tr>
<td>Mr. Thales</td>
<td>Math Teacher</td>
<td>9</td>
</tr>
<tr>
<td>Mrs. Noether</td>
<td>Math Teacher</td>
<td>8</td>
</tr>
<tr>
<td>Mrs. Lovelace</td>
<td>Math Teacher</td>
<td>7</td>
</tr>
</tbody>
</table>

**Study Measures and Data Collection**

Multiple types of data were collected from multiple sources to paint a clear picture of events, attitudes, and circumstances surrounding technology integration in this school. Sources of data included observations, interviews, audio recordings, documents, and photographs. The observation protocol (Appendix A) and interview protocol (Appendix B) contained similar items to allow triangulation. This study consisted of at least eight observations per classroom, half of the observations were conducted while the technology was being used, and the other half were conducted while the technology was not being used. After the first half of the observations were completed, each teacher observed was interviewed.

To guide observations, I used a semi-structured observation protocol focusing on three main areas: instructional strategies, motivation, and technology. Each section included a checklist of items and processes, and a section for field notes. The observation checklist was developed based on a combination of the International Society for Technology in Education (ISTE) standards for teachers and students, the Utah State
Board of Education (USBE) Technology Standards, an observation protocol used in the evaluation of mathematics for the National Center for Education Evaluation (NCEE) (Martin, Brasiel, Turner, & Wise, 2012), and the research questions. The technology section was used to look for items one might expect to see in a classroom with high technology integration, and record how frequently technologies were used, and for what duration. While observing cases, I also made notes on what instructional strategies were used to better understand the relationship between instructional strategies and technology integration. The instructional strategies section of the observation protocol was used to record the types of activities students engaged in and for what duration. This helped me understand teacher beliefs about technology and how prepared teachers were to use technology, as well as what kinds of strategies might facilitate the creation of 21st century learning environments. To better understand mindset and motivation in relation to the successful integration of these math technology products, I also made notes on which mindset was reinforced (fixed or growth) and how students were motivated. The motivation section of the observation protocol was used to record how frequently various kinds of feedback were used. Field notes included contextual details not captured in the observation protocol checklist and my reflections about all observations. Photographs were collected to enhance my memory of each situation and provide me with a rich understanding of the unique context of each classroom as I constructed the narrative. For the complete observation protocol, see Appendix A.

For interviews, I followed a semi-structured interview protocol beginning with pre-determined questions based on my research questions. These questions primarily
focused on five areas, including: instructional strategies, strategies used to increase motivation and engagement, strategies for managing changes related to technology integration, teacher beliefs, and teacher preparedness. Based on each participant’s response, additional questions were chosen to provide information and clarification as needed, adapting to the needs and interests of those being interviewed. The core questions of the interview protocol were variations of the research questions and observation protocol of this study. Similarities between the observation protocol and interview protocol facilitated triangulation of data, allowing me to construct a rich, detailed narrative that better captures what was happening in each classroom. Each interview was audio recorded and I took notes during each interview about any meta-verbal or contextual information. All information, including date, place, name of interviewer, name of interviewee, observations, and interviews, were stored securely on Utah State University’s cloud storage through Box.com. For a complete list of questions, see the interview protocol in Appendix B.

At the end of the year there are many disruptions to the regular schedule such as state assessments and field trips. This is also a time of year when student teachers may provide instruction for part of the time. Data collection for this study was influenced by these types of disruptions to the regular schedule. Because of this, I chose to observe two additional teachers a few weeks after observations in the first two classrooms. These additional data helped answer my research questions and provided a broader and deeper understanding of the factors that might be influencing the integration of technology.
The additional teachers were interviewed using the same interview protocol as a guide, however, to better accommodate both of these teachers the interviews were text based and completed electronically by the teacher, rather than orally administered and audio recorded. As I observed the class of the first teacher, she told me that she was called in to teach a seventh period class and had a commitment immediately following the school day so she could not stay to do the interview with me in person; however, she said that she could do the interview while the students were testing if there was a way to do it quietly. I gave her my computer with a copy of the interview protocol pulled up and she typed in her answers. When she was finished, I read through her responses, requested clarification of a few points, and asked a few additional questions. The other teacher had a family emergency right at the end of the day, and said it would be best if I could email her the questions for the interview and conduct the interview over email.

In addition, I emailed the vice principal who attended the first meeting informing her of how well their school was doing in relation to the rest of the state, and asking what factors she thought might be facilitating the integration of technology at such a high level. She responded by email, and I include some of her thoughts and perspectives in chapter four. Despite the change in methodology, data collected from these additional participants confirmed the data from the original teachers.

**Data Analysis and Interpretation**

In qualitative research, the researcher uses inductive and deductive data analysis, recognizing patterns and themes in the data and creating categories based on these observations. Initial analysis and interpretation of data took place in the field as data were
collected. I wrote reflections along with any observations made, and kept a journal
detailing why various images were recorded, as well as any other important items not
captured in the data collected that help me to generate a more comprehensive and
complete representation of the data. Images were primarily used to help me remember
details of what teachers showed me and details of the classroom layout during my
analysis (see figure 1 and figure 2).

Figure 1 – This clock was on the wall in the classroom of a teacher who regularly told
math jokes. I thought it captured his sense of humor quite well.
Figure 2. This is a view of some of the reporting features in ALEKS.

Following recommendations in Creswell’s 2013 book on research design, the initial analysis of collected information took place on two levels. First, I established descriptions about the setting, individuals. Second, I examined the data for consistent themes. To do this, I first transcribed all audio interviews and then loaded all documents (observations, emails, transcriptions, etc.) into a qualitative data analysis program called MaxQDA. As I read through all of the documents, I created new codes for the various ideas captured in the text. When an idea I saw matched something I had seen previously, I would highlight the block of text containing that idea and drag the tab representing the code from the panel on the left of the screen onto the highlighted text (figure 3). This action caused the software to code the highlighted text as whatever code I had selected.
As consistent themes emerged from the data, 10 tentative codes were created to classify text and visual materials into categories. As collected data were re-reviewed, and triangulated, a total of 59 new codes were generated. After reviewing these codes, I summarized them into 18 categories. I did this in MaxQDA by creating a new code which representing each category, and dragging and dropping codes that I wanted placed within that category onto the tab of the category (figure 3). Next, following the same process, I grouped the categories into four general themes which I used to guide the narrative report (Creswell, 2013). Two of the themes were generated from categories that did not group well into the other themes. In every case, I did my best to create names for codes that accurately described the information I collected.
Codes were named using a combination of a priori codes (codes from previous research) and in vivo codes (codes from the words of participants). A priori codes included items about teacher beliefs, teacher readiness, and student motivation. New codes that emerge (emergent codes) were named based on the exact words of participants, or best descriptions of the information being coded. See table 2 for a full list of the final coding structure.

After all data were collected and analyzed I worked to summarize the data. Priority was given to discussion of factors and themes that manifested with the greatest frequency throughout the data. To enhance the reliability of methods and approaches, all a priori codes were clearly defined to ensure that there was not a shift in the meaning of each code with the passage of time (which could have resulted in data from initial studies

Table 2

<table>
<thead>
<tr>
<th>Qualitative Coding Themes</th>
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<tbody>
<tr>
<td>Factors That Influence Technology Integration</td>
</tr>
<tr>
<td>Access (A)</td>
</tr>
<tr>
<td>Administrator Support (A)</td>
</tr>
<tr>
<td>Support from other teachers</td>
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<tr>
<td>Scheduling</td>
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<tr>
<td>Professional Development</td>
</tr>
<tr>
<td>Ease of use/Product functionality</td>
</tr>
<tr>
<td>Teacher Beliefs (A)</td>
</tr>
<tr>
<td>Teacher Preparedness (A)</td>
</tr>
</tbody>
</table>

This table shows the final coding structure on which the narrative was based, a priory codes are designated with an “(A)” next to them.
being incorrectly represented). Transcripts were also double-checked to ensure that no serious mistakes were made during transcription. After coding was complete, all coded segments were exported into a spreadsheet, and using the “Randbetween” function in Excel I assigned each segment a random number. The coded segments were then sorted from smallest to largest based on that number. A second researcher, who has a bachelor’s degree in education and works in K-12 schools, cross-checked a random sample of 15% of the coded segments. I then checked her codes against my own to confirm that she coded items in a similar way (intercoder agreement) to ensure that I represented information correctly. Out of the coded segments sampled, 88% were similarly coded.

Throughout the coding process, additional analysis of information took place based on suggestions from Miles, Huberman, and Saldana’s (2013) book on qualitative data analysis. Interview transcripts and field notes can be cumbersome. Due to the sequential nature of such documents, it can be difficult to get a big picture view of all the data at once to understand how factors are interrelated without creating some kind of visualization. I created network displays to help overcome this challenge. According to Miles, Huberman, and Saldana (2013), for case-oriented research, network displays are ideal for providing the researcher with a concise and comprehensive overview of the data that is easily accessible. Network displays show codes as nodes that are connected by directional links. Rough network displays were created using qualitative data analysis software, MaxQDA, to focus the research and help me better understand the data I had collected. Network displays shifted and evolved over time with the data as additional
information was collected (See Appendix C for a comprehensive network display, created before categorizing codes).

Multiple types of data across several observations and interviews were compared using triangulation to determine if findings were consistent. Observation data, interview data from teachers, and interview data from administrators were compared to find any points of agreement or disagreement, and find patterns. To limit bias, I did my best to represent views and meanings held by participants. To ensure that there were no serious disparities between my interpretations and the actual perspectives of participants, a final write up, using pseudonyms for all participants, was delivered to participants, allowing them to review findings and make edits and suggestions (the process of member checking). This process helped verify accuracy and ensured that participant’s perceptions were correctly represented.

Peer debriefing was also used to enhance the accuracy of information. In this process, a peer who has a PhD in education and works for the United States Department of Education reviewed materials, asked clarifying questions, and provided feedback to ensure clarity. It is important to note that no researcher involved in this study has any personal interest (financial or otherwise) that will be affected by study results.

**Threats to Validity**

One major limitation of any case study design is the sampling approach. Case studies examine one particular manifestation of a phenomenon in a bounded case, with no randomization of sample, which means there is no way to know if the specific things happening in that case will apply to any other case. The case examined in this study was
chosen, in part, because they were ordinary performers last year who are performing on an extraordinary level this year. This “critical case” method of sampling was chosen in part because of its potential to enhance generalizability, but it is still not a guarantee of anything.

A second limitation is the type of data collection. Much of the data collected in this study was self-reported. Self-report measures only have the ability to explain perceptions about what is happening. They do not always reflect things as they actually happen. As discussed earlier, it is difficult if not impossible to discuss “reality” in a way that is totally disconnected from the perceptions of individuals and perceptions can be influenced by beliefs, culture, and many other factors.

Another serious limitation is that the researcher is the primary instrument through which data is collected. My background and past experiences may result in a desire to focus primarily on factors that could be applied generally to facilitate implementation and make positive changes in the system statewide, creating the potential to overlook factors that may be of great significance to specific cases (e.g. teacher pay, gender, etc.). The value I place on “real world” changes may also result in an overly favorable view of individuals who are successfully implementing observable changes. In addition, I may inadvertently focus on changes that I perceive as valuable, while overlooking things that may have great value to others. All of this reiterates the importance of member checking and trying to represent the perspectives of participants above my own perspective.
CHAPTER IV
RESULTS

In this chapter, I will provide an overview of everything I have learned throughout this process. First, to help readers understand the setting, I will provide some additional detail about the school, and provide a composite narrative from a few of my classroom observations. Next I will discuss the themes that emerged from observations and interviews, and how those related to previous research. Finally, I will discuss the implications of everything I have presented and provide recommendations for future work.

A School in Transition

In a family-friendly city with a small-town feel, sandwiched between the mountains on the east, and two larger cities on the north and south, one junior high is making drastic changes to the amount of technology they integrate into their math classes. Based on the data reported monthly by math technology providers for the 2015-2016 school year, this school is consistently among the best in the state when it comes to the integration of math technology.

This has not always been the case. Just last year, the usage of math technology products for personalized learning at this school was sporadic and inconsistent at best, with some teachers using products occasionally, and others trying to avoid them. This year they were awarded over 900 licenses for their math students, and on average 98% of the awarded licenses were used each month, and 89% of those licenses were used for at least 45 minutes a week.
Out of 1,041 schools using math technology products for personalized learning throughout the state, the percentage of licenses used to the level recommended by product providers was only this high in 34 schools, and of those 34 schools, only one other school used the product with about this many students.

The mathematics personalized learning technology program chosen by this school was ALEKS. ALEKS is a Web-based program that adaptively assesses student understanding of mathematics concepts. Based on these assessments the program allows students to access problems in specific topic areas, providing “how to” tutorials and “worked examples” that provide explanations to students about how to do the problems. The program breaks math knowledge into several “topics” or knowledge areas that are displayed as a multicolored pie chart. Students are assessed across all topic areas and the program lets them work on whichever topic they choose. This opportunity to choose the topic gives them at least some level of autonomy, without allowing access to ideas they are not ready for (which can be frustrating and discouraging). As students’ progress, they complete knowledge checks to periodically assess their levels of development and understanding. This data is then available to them and also to their teachers and parents.

This personalized learning feature of ALEKS targets gaps in knowledge and then introduces new concepts. The program allows teacher to build assignments, tests, and quizzes that can be assigned to individual students or entire classes. These assignments and assessments provide each student with their own unique set of problems that address the same content. Basically, the problems are the exact same problems, just with different numbers.
On an unusually beautiful day, early in April, I sat down with six junior high math teachers and the vice principal from this school to hear their perspective on what was happening at their school. After spending some time talking about what they liked, how they were integrating the technology, and what strategies they were using to achieve such high levels of technology usage, they suggested that I make it a priority to spend some time observing the classrooms of Mr. Thales and Mr. Pascal.

Just from this initial conversation a few ideas began to surface repeatedly. Teachers talked most about the importance of having support from and learning from other teachers who were using the products. They also talked quite a bit about the importance of having accesses to technology guaranteed by supportive administrators, and the importance of having a functional, user friendly product that made their job easier, rather than more difficult. Though many unrelated themes also emerged through interviews and observations, these same ideas continued to surface throughout the entire data collection process.

**Observations**

To provide a general feel and overview of what classes looked like I scanned through all of my observation data and combined key elements to generate a rich narrative description of an average class period. For Mr. Pascal and Mr. Thales I provided a description of a class period on a regular day of instruction, as well as a description of a class period on a day with ALEKS, and for Mr. Pascal, I also provided a description of his 7th grade math lab. I used the same methodology to create a narrative description of the classes of Mrs. Lovelace and Mrs. Noether, though I only observed
them while they were using technology, so no description of a regular class day is provided. All observations were coded in conjunction with interviews, and resulting themes will all be discussed together later.

The Classroom of Mr. Thales

On a regular day of instruction. Mr. Thales teaches several 9th grade math classes. As students shuffle into the classroom before the bell rings and find their desks, he talks to students about their weekend camping trips, their sports games, and whatever random other things might be happening in their lives. The desks are in rows facing the front of the room where the interactive digital whiteboard displays the pages of the textbook that they will be working on. Students talk and joke with each other, and in general there is a very laid-back feel to things.

I sat in the back corner of the classroom, as students took their seats and Mr. Thales gave an overview of everything they would be covering in class that day. He started by briefly introducing the new material, and telling them where the assignment for the day was located so that they could get started right away if they wanted to. He then told them about a new extra credit project that they could work on once they completed the in-class assignment. He led with, “This is going to be a 34 paragraph essay,” which resulted in groans from everyone. He continued to lead them on for a few seconds before he said, “I’m just kidding,” and then he asked how many people had part time jobs. Over half of the students raised their hands, then he asked, “how many of you have people the same age as me working alongside you, doing the same thing you are doing?” He then talked about how employers are not going to pay you more just because you need more
money, or you are older, or whatever. Unless you have skills, you will have a hard time making ends meet. The extra credit assignment was to put together some text and images describing an interesting career that made use of mathematics.

Mr. Thales then jumped into the assignment for the day, taught them the concepts, and worked through a few problems. He stood at the board and drew everything using smart markers. In contrast to a whiteboard, when using this technology he could put his finger on one of the shapes he drew and drag it somewhere else, and the actual pages of the workbook were projected onto the board to work from. In this case, having the workbook pages projected was really helpful because they were working on graphing.

Any time he was trying to talk and the class was talking he would say, “I’ll wait” and after about a half a second it would generally go quiet. If it did not, he would call out a few people’s names and they would stop talking and that brought everyone back. After working through two problems he had one kid come up to the board and “teach the class” showing them how to work out a problem. He then said, “We’ll correct this at the end of class,” and he turned them loose and let them work on their assignment.

While the kids worked, he told them a story about when he was in school, and then he told them a story about how his aunt met a guy who was working on a movie script while she was skiing and he wanted to use her name, and she said he could if he made the character intelligent and respectable. So that is who one of the characters in Ghostbusters is based off of. The whole class period he was walking around, working one on one with students and tutoring those who needed a little extra help. The students were also collaborating with each other and teaching each other various concepts.
One of the students got done quite a bit early and he said, “man… we don’t get out of class until 12:35! What am I supposed to do?” and Mr. Thales sarcastically said, “Do you want more problems? I can give you more problems. How many problems do you want?” and the kid said, “500?” Mr. Thales pulled up a program on his computer that can generate assignments and he set it up with 99 “hard” questions, and printed it out and handed it to the student. To my surprise, the student started doing it. And he was moving through it at a pretty serious pace too!

**Teaching with personalized learning technology.** At the beginning of the day, Mr. Thales wheeled a cart full of iPads into his classroom. He has one day a week set aside for using ALEKS, and he uses it in all of his classes. Slightly before class, one student came in and asked if he could print some homework he needed for a different class from his tablet. Mr. Thales said, “Can you just email it to me? Otherwise I’ll have to back out of everything and that’ll take forever.”

As the students entered the classroom, he directed them to grab an iPad. By about two minutes after class officially started, each student was seated with an iPad in front of them, and Mr. Thales said “Okay! You have an in class assignment in ALEKS! It is 100 questions and you have to get it done today! There is no tomorrow!... Just kidding it is only 100 questions for you because you came in late” He said to a student who was just walking in, “for everyone else it is 13 questions. It is gonna be brutal… When you get that done, do ten topics.”

One student said “Thales? This iPad is possessed; how do I fix this?”
“Go get a different one” said Mr. Thales, “no seriously, I have no idea. That is my solution.”

To get things started, Mr. Thales pulled up the ALEKS assignment on his computer at his desk in the back corner of the classroom and walked the class through the first problem. The problem he was working on was projected onto the interactive digital whiteboard at the front of the classroom, and each of the students was working through the same problem, but each person’s problem had different numbers. After Mr. Thales worked through one problem from his desk, he walked up to the front and worked through a few more problems on the interactive digital whiteboard.

After working through a few problems he turned them loose, and went and turned on a mix of indie and 80’s pop music in the background. The environment was fairly open and collaborative and students were working and asking each other questions while Mr. Thales walked around the classroom helping students with their hands raised and the occasional student who just called out to him asking questions. One such student said “Mr. Thales, how do you do this problem?” while he was busy helping a different student a few rows over. He responded by calling to the student sitting next to the one who asked the question and saying “Hey, can you show him how to do this one? I forgot how.”

Another student said, “Thales, this is HARD!” In response, Mr. Thales held up his hand rubbing his thumb and index finger together in tiny circles and said, “you know what this is?”

The student said, “The world’s smallest violin?”
“No,” Mr. Thales said, “it is the world’s smallest record player, playing a violin rendition of my heart bleeds for you.”

The whole time, music was playing in the background and Mr. Thales was walking around helping students, or just checking out what students were doing. Some students had headphones in working by themselves, some students had moved their desks together and were working collaboratively, and the majority of the class fell somewhere between those two extremes.

While he was walking around, he noticed one student who was just surfing the internet looking at memes. He walked up behind him quietly and watched his screen for a minute, kind of smiling and chuckling silently at the silly things the student was looking at. When it got to an image of someone wearing pants pulled up to their armpits, he said “You shopping for new clothes? Those are pretty sweet pants!”

The student jumped a little and quickly switched back to his assignment, and stayed on task for quite a while (I was sitting behind him to the left, so I had a great vantage point to see when he was or was not on task). About 15-20 minutes later, when the student was off task again, Mr. Thales walked by and noticed that he was looking at a post titled “Shout out to all those people with mediocre talents!” and Mr. Thales said “Hey! Is that my website? People with mediocre talents?” and when the student quickly switched tabs again, Mr. Thales said, “No, go back! Let me see that. … That is great. I think I’m going to google that later. Maybe in my free time.” Then in a slightly more serious tone, he added “Maybe you should look at that on your own time too, and do your ALEKS assignment on my time.”
After that the student stayed on task for the rest of the period. For the most part anytime a student started to get off task, he would just say “How are you doing on your assignment? … I just want to make sure you aren’t panicking in the last ten minutes trying to get it done.” This seemed to work quite well, and while it was by no means a quiet math classroom, almost everybody was on task and finished their assignment before the end of the period.

Mr. Thales told me that as long as he gives them an assignment that is due by the end of class, most of the students stay on task pretty well. He said:

I make the assignment long enough so that it will take the kids that would be off task most of the class period to finish that assignment. Sometimes you get a kid who just does not care, and they aren’t going to do the assignment unless their friends that do care are doing the assignment. I think that kind of pulls those kids in. The kids that finish early, those are the ‘A’ students anyway, so they are going to keep working and knock out the topics.

Overall, a day using ALEKS in the classroom of Mr. Thales, really did not look very much different than a regular day in the classroom of Mr. Thales. The students interacted with each other the same way, the teacher instructed in basically the same way, and the class was structured the same way.

According to Mr. Thales though, working with the software has several advantages. He specifically mentioned the instant feedback provided to students, the fact that it allows them multiple attempts to solve problems, the fact that there is no way for students to just copy off of each other since they each have problems with different
The Classroom of Mr. Pascal

On a regular day of instruction. The majority of Mr. Pascal’s classes are 9th grade honors classes. He also has a few regular 9th grade classes, and teaches a 7th grade math lab. His classroom is set up in kind of a pod structure with 9 groups of four desks for 9th and 7th grade.

Before class, a few students came in asking if Mr. Pascal would be around and have his classroom open before or after school the next day. It was clear that he often spends extra time before or after school tutoring students who want a little extra help, and letting them work in his classroom. This particular day, he said, “No, I’ve got meetings tomorrow so I won’t be around, but you can come in early on Friday if you want to.”

As students entered the classroom there was a picture of Chuck Norris projected on the screen at the front of the room. The bell rang and he clicked on his microphone and started talking to the class. After handing out math tests, he said, “Ok! Number 10 on the list of Chuck Norris’ code of ethics!” He read a Chuck Norris quote about the importance of maintaining respect for authority, and then there was a brief discussion about how Chuck Norris is the authority.

As he walked around the classroom he used a small tablet to click through review slides and write things on the interactive digital whiteboard at the front of the room. He was able to draw on the projected image and walk the kids through the problems being reviewed from anywhere in the room, which allowed him to engage with students more.
Mr. Pascal asked, “How do you tell if it is acute or obtuse?”

A few students replied, “Ya just look at it!”

“You’re going to judge it by its looks?” replied Mr. Pascal, “That seems rather shallow. Let me show you a way to figure it out without being so judgmental.”

The classroom was not really structured like a traditional lecture and it was not completely classroom discussion and problem based learning. Mr. Pascal would present an idea and then he would work through a problem with the students. The whole time he was lecturing he was asking questions and lead them through discussion. After working through a problem or two with the class, he let them do a problem on their own and then share their answer and discuss how they got the answer.

As they worked through problems, there was a tiny bit of discussion at each group of tables, but not a ton. I heard things like, “is this one obtuse?” ... “yeah” ... “Really?” ... “Yes!”

After 20-30 minutes, Mr. Pascal changed gears and handed out worksheets, turned all the lights on, and turned the projector off. When everyone had their homework to work on, he went back to his desk for a minute and took roll before resuming walking around the classroom talking with the students, and guiding them through homework problems. As he helped students, I did hear a few math teacher jokes like, “If the angles add up to be more than 180 degrees, it is way too hot to be a triangle!” which generally elicited a mixture of groans and chuckles from students nearby.

Things were not drastically different between the structure of his honors classes and his regular math classes. In regular math class he worked through more example
problems with them, and walked around helping them a lot more, but for the most part only a couple of students in the regular math class had difficulty understanding the material.

7th Grade Math Lab. In addition to his regular math classes, Mr. Pascal teaches a 7th grade math lab. He started his seventh grade class by holding up a pyramid and a cube with the same base and the same height, and asking, “If I fill the pyramid with water and dump it into the cube, how many pyramids full of water will fit into the cube?”

He then demonstrated that the volume of three pyramids will fit into a cube and explained, “You don’t need a new formula to figure out the volume of a pyramid, you can just divide the volume of a cuboid with the same base and the same height, by three!” Then he illustrated the same thing with a cone and a cylinder.

Next he broke the class into two groups, and half of them got on Chromebooks and worked on homework, and the other half were able to work on math homework for their other classes. On this particular day, no one had any homework for their math classes, because they had just taken a test, so they played a math game with playing cards. The way it works is you deal out four cards face up, and then you flip the next card. The goal is to figure out an equation to make the four cards equal to the number that was flipped.

He walked around observing, and giving any direction needed to both groups. When the two groups switched, a few students had homework to do. He still spent some time walking around helping and observing, but most of his time was spent tutoring and helping those who were working on homework to understand concepts.
Teaching with personalized learning technology. Like Mr. Thales, Mr. Pascal has one day a week set aside for using ALEKS and he uses it with all of his classes. Unlike Mr. Thales, Mr. Pascal uses ALEKS in a computer lab down the hall and around the corner from his regular classroom, and a day using ALEKS looks drastically different from a regular day of mathematics instruction.

As students entered the computer lab, Mr. Pascal directed them to find a computer and get logged into ALEKS. When the bell rang signaling class to begin, he told the class, “Okay! Today we will be working in ALEKS. It has been a few weeks since we have been in the computer lab, so it might start you off with a knowledge check.” Many of the students groaned and it was clear that students thought knowledge checks to be a bit of a nuisance.

From that point forward the computer lab was relatively silent, except for the minimal sounds made by students typing and clicking as they worked through their math problems. Occasionally a student would raise their hand with a question and Mr. Pascal would walk over and chat with them quietly about the problem they were working on. He came over to the instructor’s desk where I was sitting and showed me how he could use the reporting features in ALEKS to monitor what students were doing, and assess needs as they were working. For the entire period, students were working diligently on their topics, filling gaps in their math knowledge, reviewing recently learned topics, and discovering new material.

Mr. Pascal told me that it was really interesting to watch how engaged his students were when he just let them loose to do topics. Occasionally a student would start
to lose focus, but all he had to do was walk over in the general vicinity of that student and
the student would get back on track.

I thought this was particularly interesting since Mr. Thales had talked about how
he had tried to let the kids work independently on topics during the first part of the year,
and it had gone very poorly. At first I thought that maybe it was just a difference between
honors students and regular math students, but when I observed the regular students of
Mr. Pascal in the computer lab, there was no noticeable difference between them and the
honors students.

Mrs. Noether and Mrs. Lovelace.

To gather a bit more information about how ALEKs was being used, I observed
the classrooms of Mrs. Noether and Mrs. Lovelace on days that tests were being
administered. Mrs. Noether’s students were completing their last day on the mandatory
end of year state level assessment in the computer lab, and Mrs. Lovelace was
administering a chapter test in her classroom.

Mrs. Noether. Mrs. Noether was in the computer lab with her students, since the
mandatory state assessments are all computer based. When students completed their state
assessment they jumped right in and started working on topics in ALEKS. All of her
classes were honors classes, and I thought it was interesting that she was using ALEKS in
roughly the same way as Mr. Pascal who also had honors classes. I did notice however
that there seemed to be quite a bit less social pressure related to testing. When I was in
school, if you took a little bit longer on a test than your friends, it was very apparent
because everyone in the class basically had to sit there silently and wait for the last
student who was testing. I remember being the student who was one of the last ones taking the test occasionally, and I found it extremely stressful. It made me feel like I was a bit slow, a bit less adept than my fellow students. Though she did walk around and check on student progress and answer students’ questions if they were done with the sage test, for the most part there was no apparent difference between students working in ALEKS and students who were still testing.

**Mrs. Lovelace.** Mrs. Lovelace started class by saying, “I want you guys to engage your bodies and your brains!” and then she started reading a book. Each time she turned a page, every student would stand up and say: One (stand and put the left hand in the air), Two (right hand in the air), Three (both hands down and sit). The book she was reading was somewhat math related, and talked about how long it would take to count to a trillion. She stopped and said “have any of you ever counted as high as you can? I used to do nerdy things like that. I made it about a half an hour and I was like yeah I’m done.” As she read one student called into question the mathematical correctness of the book, and after some conversation about how you would estimate something like that, she said “I will give any one of you extra credit if you use a computer and map this all out to see if the math is right.”

When the book ended she said “Ok I want you all to get into testing formation!” and the kids all shuffled around and faced different directions. She said “ok remember, if it happens in your head I need to see it on the paper! And what happens if I hear someone talking?”

“They get a zero!”
“Right!”

One student started handing out tests and the teacher’s assistant turned on really good, upbeat piano music on Pandora and the kids got to work. The iPads were at the front of the room in a little cart and when each student finished their test, they would go get an iPad and start working on ALEKS. As students started working on ALEKS, some of them would raise their hand and Mrs. Perkins would come and help them, others took their iPad up to her for help. It looked like most of the time, she told them to click “show worked example” which gives the kids detailed step by step instructions on how to do each problem. Even though the difference between those taking the pencil and paper test and those working in ALEKS was more apparent in this class, I still noticed the same apparent alleviation of test related social pressure in this class that I noticed in Mrs. Noether’s class.

Factors that Influence Technology Integration

The first theme that emerged through my analysis of all of the codes and categories I created from observation and interview data, was related to technology integration. Teachers talked about their motivations for using software, what they liked, what they didn’t like, and what factors helped to facilitate successful integration of technology. Many of the themes that emerged corroborate the findings of previous research, including factors related to product functionality (Levin & Wadmany, 2008) and school level factors such as administrator support (Howley, Wood & Hough, 2011). A few factors I had not seen in the previous literature also emerged, such as the importance of scheduling, and the importance of having support from other teachers. In
this section, I discuss the main factors that teachers perceived as influential to the integration of technology using representative quotes as examples.

**Ease of Use and Product Functionality.**

**Reports.** Teachers really liked the reporting features provided within the program. In general, they used the reporting features to monitor student progress. In general, teachers liked the reporting features of ALEKS because they made grading both easier and much more timely. Teachers were able to target instruction and create review assignments specifically designed to address any gaps that showed up in their student’s understanding. Mr. Thales said:

ALEKS allows you to pull an item report that gives the percentage incorrect/correct and gives details of each question on a test or assignment. I know on a paper test this same item analysis could be done, but with ALEKS it is simply a few mouse clicks, so it actually gets done. I gave a review assignment … then pulled the report … and created a separate 16 question review assignment using the most missed questions that were also on the test and gave that to the kids as an extra review assignment.

Mr. Thales and Mr. Pascal also expressed interest in the potential of the reporting features for understanding what is happening school wide. They indicated that with a little bit more training, and a few more resources, they could use data reporting to improve and refine the instructional strategies of the whole math department to better meet the needs of students.
High quality, targeted, immediate feedback. Teachers seemed to be most impressed with the immediate feedback and targeted instruction ALEKS provided. Mrs. Lovelace expressed satisfaction with the “step by step instructions on how to solve problems if the kids aren't getting it,” and Mr. Pascal said “it has an explain button that gives specific, easy to follow instructions and will provide them with similar example problems so they can follow along. Their explanations are just excellent. They are spot on, very clear, and easy for students to understand.”

All four of the teachers I interviewed also talked about how much better it was to have a way to provide students with some immediate feedback. Mr. Thales said “By the time you get through correcting [a pencil and paper quiz], you’re one or two days out, and it is like ‘okay, what do I do with this now?’ You know? But doing a quiz online… the kids know what their score is right then and there, and you allow them to go back and fix their mistakes.” They all felt that this immediate feedback was helping their students understand concepts faster, and leaving fewer gaps in their understanding of mathematical concepts.

Multiple attempts. Mr. Thales talked to me about his experience incorporating digital learning software at his previous school. He said,

We all had apprehensions of going to a digital textbook and digital assignments. I remember the decision process to give our first chapter test electronically and the apprehensions everyone in the department had about going from a paper test to a digital test. We stressed about not being able to see their work and the ability in a paper test to give partial credit. … I cannot remember which topic it was, but we
were testing on a chapter that was a tough chapter and I offered the kids two attempts in class at the test and I set the program to keep the best score. The kids loved it because they had a chance to fix a simple mistake in class and not have to come in before or after school to re-take a test. I liked it because I did not have to re-mediate with kids that knew their stuff, but instead target those that really needed help.

He said this functionality really changed the attitude of the whole department, because it just made life so much easier for everyone. While previous research has suggested that teacher’s beliefs about technology predict the success of technology integration (Inan et al., 2010; Tondeur et al., 2008) and that many other factors influence teacher beliefs (Howley, Wood & Hough, 2011; Levin & Wadmany, 2008), this comment indicates that an understanding of highly useful product features may be able to completely change teacher’s beliefs about technology throughout an entire math department and influence the integration of technology school wide. It would be interesting to research this idea further to better quantify the impacts of useful features within products on teacher’s beliefs about technology.

“ALEKS Doesn’t Suck.” One of the first things that stood out to me was how frequently the teachers railed against the software they had had previously. It was a theme that emerged the very first time I came to the school and met with all of the math teachers as a group. When I asked what kinds of things might be influencing the successful integration of technology, the administrator said, “I know they all said they
hadn’t had many technical issues with it.” Immediately when she said this, all of the teachers nodded assent.

Mrs. Lovelace said, “My issues have been my issues, not theirs.”

Mr. Thales said, “I had one day where it dumped everyone off, but within a minute they could get back on.”

Another teacher said, “With Cognitive tutor, you would go down there and you couldn’t get on. And you’d spend the whole period and you’d finally get everyone on and then you’d leave, and then the next time you’d go down and spend the whole period getting everyone on and then leave.”

Mr. Pascal responded, “There’s was better chance of the Lakers winning their game than getting it to work.”

“That is so true!” Chimed in Mrs. Lovelace.

The conversation continued this way for a few minutes highlighting frustrations with the previous program including: difficulty for parents; having 15 different skills built into one problem, where if you missed one skill it sent you back to the beginning; long problems; useless feedback for students; and compatibility issues. This theme continued throughout my discussions with the teachers. Mr. Pascal talked about how frustrating it was for students, because if you even enter the unit label for pounds as “Lb” instead of “lbs” for example, “You’d have to re-circle through that problem hitting all those other skills along the way that you’ve done a bazillion times and you’re sick of them… just to hit that one. And then you get to that one skill again… and you make a mistake and it sends you right back. It is like being in an eddy on a river. Stuck. Going
nowhere. All day eddy on the Snake River. Anyway… it was so frustrating.” It seemed that having such a frustrating program the previous year made the teachers really appreciate the capabilities and functionality of ALEKS.

**Support from Other Teachers/Teacher Buy-In**

At the beginning of the year, Mrs. Lovelace did not know that you could create custom quizzes and assignments in ALEKS and she did not really feel like setting her students loose to work on topics that were unrelated to what she was teaching facilitated student success. She had set up her own website, and she had supplemental materials and resources available to students, and she had absolutely hated the math software that had been mandated the previous year. After trying to use ALEKS a couple times, she did not feel like it was any more helpful than the previous years’ software, so she decided to stick with her own supplemental resources. “I said, if it is aligned with what I’m doing currently, then I’m not going to waste my time doing this.” Said Mrs. Lovelace, “I had researched and found links myself that were supplementary that the kids could go onto at home to figure out. I had expressed my frustration and then after second term I did not use it at all.” At some point Mr. Thales and Mr. Pascal talked to her and said, “Mrs. Noether, this is exactly what you are talking about!” and Mr. Thales showed her how to set up quizzes and assignments that align with what you are teaching. “I have totally whole hog jumped in this term, using it more like what Mr. Thales designed and I have absolutely loved it. I just did not have any idea… It was too new to me and so it was just frustrating.” This seems to indicate that teachers can be extremely influential when it comes to helping each other develop an understanding of how technology can be
integrated in ways enhance and support instruction, improving things for both the students and the teacher.

When asked about why he used ALEKS, Mr. Pascal said, “There are a couple of teachers who highly recommended ALEKS to me based on their experience last year.” He also highlighted how important it was to have support from and learn from other teachers. “Mr. Nash went to something over the summer that taught you how to get it set up, how to get the kids signed up, how to get their passwords and user names, and get their accounts set up,” he said. “Then Mr. Thales had experience with Digits, and there is some overlap with Digits… so more or less Mr. Thales just kind of guided us through.” He said that they are all learning from each other as they try out new elements of the program. “I do things kind of different than I did first term. First term was just jump on and go. And then we’ve kind of evolved a little bit, but it has been primarily on our own.”

All of the teachers indicated that they had all sat down together as a math department at the beginning of the year to discuss math technology, and made the decision as a department to use ALEKS an hour a week. Nearly all of the teachers indicated that part of their motivation for using the software, and part of why it was working so well, is that they had made the decision as a department. The vice principal, Mrs. Mandela, also indicated that the successful integration of technology at their school was largely due to the efforts of the amazing teachers in the math department.
**Administrator Support**

Mrs. Mandela also said that principal’s vision for improving student outcomes in mathematics played a significant role. She said:

He had a clear and definitive idea on the importance of training, clear articulation and dissemination of academic goals, and building the appropriate infrastructure involving computer labs and other technology, including ALEKS, to help drive the efforts to reach the math goals. He has also been very effective at helping the Math Department understand the goal and provide the necessary support to achieve the goal. As a result, the individual teachers have seen how effective ALEKS can be to help students learn, and now they have created ALEKS lessons to support our Credit Recovery Program and a summer bridge program for students to practice math skills during the summer.

Her comments focused primarily on the importance of setting clear goals, communicating those goals effectively to your teachers, and ensuring adequate infrastructure to support the desired changes. While this comment was directly talking about administrator support, it also confirms the idea that successful management of change often uses elements identified in John Kotter’s change management model even when administrators are not aware that the model exists (Barcelona, 2014). This is important because it is possible that providing these guidelines to schools and districts who are struggling to integrate technology may positively influence their rate of success. This would be an excellent area on which to conduct further research.
Mrs. Lovelace, Mrs. Noether, and Mr. Pascal also talked about the importance of administrator support, noting that the principal had asked each of them to commit to using ALEKS one hour a week. “By doing that,” said Mr. Pascal, “the principal then had to commit to making sure that we had lab space. And that has always been an issue. But he committed and has kind of given us some priority lab time.”

Mrs. Noether said, “Last year Mr. Pascal who is the department head, and Mr. Lincoln who is the principal just said ‘we are going to try to do an hour of technology a week.’ And so we planned around that.”

While everything in this section confirms prior research on the importance of administrator support (Howley, Wood & Hough, 2011; Levin & Wadmany, 2008), it also highlights a few specific kinds of administrator support that teachers found especially important. The most prevalent comments about administrator support were related to ensuring that lab time was scheduled in advance, and ensuring that teachers had access. This is important because it may provide administrators with a few areas on which attention can be focused in order to support teachers in successfully integrating technology into their curriculum. Additional research is needed to determine how these findings might generalize to other classrooms.

Scheduled in Advance

Mrs. Noether and Mr. Pascal mentioned that one of the reasons they were successful is they planned and scheduled their technology usage in advance. “The biggest thing was having a day scheduled each week where I was assigned the iPads,” said Mrs. Noether. “Since I knew they were scheduled, I planned them into my calendar. It helped
me to manage my time before and after, since I knew I would be using iPads every Friday.”

“**I built my calendar around it,**” said Mr. Pascal. “It is like everything else in your life, if you think ‘oh I’ll do that in my free time’ then you never get to it. You’ve got to build it in. If you want to work out at the gym every day, you don’t do it if you’ve got extra time, you have to build it in. It is just the way it is. It is probably the only way you can get it done.”

From the beginning of the year, they knew they would have access to the technology. Working together as a department they were able to plan out and coordinate their lab times from the beginning of the year, and they knew they would have the administration making sure they were actually able to use the labs during those times.

**Access**

In order to plan the use of technology into curriculum, teachers need to be confident that they will have access to the technology when they need to use it. “**We have one lab that is been set apart just for the math and science, and science has two sets of their own laptops so really it is just for math,**” said Mr. Pascal. “**We have administrators that have made sure we have as much lab time as possible. Our STS does an excellent job of keeping the computer labs functional. I have never had a day in the past 2 years that the lab was down.**”

Mr. Thales and Mr. Pascal also talked about how much more they would be able to do with the software if they each had a classroom set of Chromebooks. Mr. Pascal said:
The problem is the district does not approve of Chromebooks because it is another platform and they want to limit the number of devices that they have to service…. But you don’t have to service Chromebook, they are like a calculator! If it dies, you throw it away and buy a new one! Really, they are like $150 dollars and these calculators are like $110. So basically we are behind the times. Chromebooks just have an internet browser, so kids cannot get on and download things. All we want is access to the internet, and that is all you can do on a Chromebook. You cannot access other things. As far as other classes, Chromebooks would still work because these kids all have office 365 accounts. So they can do everything on the Cloud. Mr. Thales and I are hoping we can pick up one classroom set and then the two of us can share and swap. Then we would do some of these other creative things we talked about.

They expressed that greater access to technology would allow them to more fully integrate the technology into classroom instruction, and help facilitate the use of product features that they have not yet used to their full potential.

**Professional Development**

In general teachers said that after the initial training, there was not very much professional development provided and they had to just figure things out. “We went to one class and learned how to set up our students in the program,” said Mrs. Lovelace. “It was useful because I did not know how to do that and that obviously would have taken me a long time and I probably would have given up. However, I definitely needed more info on the program itself and how it can be used.”
Though a representative from ALEKS was sent out part way through the year, to answer questions and everyone was excited to learn more about the program Mr. Thales and Mr. Pascal both indicated that they did not get anything very useful from that meeting. “We did have a lady come from ALEKS and we had questions for her, and she couldn’t answer any of them. For every one of them, she was like ‘oh, I’ll ask,’” Mr. Pascal said. He also said that she did not actually get back to them with answers to their questions.

“Basically you need somebody that uses it,” Mr. Thales said. “Ya know, a former teacher, or somebody that knows the program and uses the program, rather than salespeople that are in charge of multiple programs that they are selling for the company.”

Echoing this call for professional development from people who know how to use the program, Mrs. Lovelace said, “I do think I need to tweak what I am doing. I rely heavily on our other teachers to hear what they are doing and how well they like it.”

Despite the fact that all of these teachers rely on each other for support, there are really no formal opportunities for collaboration. “I see Mr. Thales between classes all the time and before school and after school,” said Mr. Pascal. “Just that kind of stuff… We were supposed to be doing professional learning communities, but basically they give us one hour a month, and… that is not a professional learning community, that does not work.”

While some of the research I reviewed indicated that professional development didn’t significantly impact teacher’s perceptions about technology in general (Gibson et
al., 2014), research also indicated that school level professional development did significantly impact how well technology was integrated into the classroom (Ritzhaupt et al., 2012). It may be that having more professional development at the school level impacts how technology is used in the classroom because it facilitates collaboration among teachers who are in similar situations, using similar technologies. This type of school-level collaboration would allow teachers to support each other in finding and understanding useful product features, which may impact technology integration by influencing teacher beliefs.

**Teacher Beliefs**

Though no one mentioned this explicitly, it was clear to me that these teacher’s beliefs about technology heavily influenced how much they integrated technology into their instruction. They all expressed how important teaching with technology was in preparing their students for success, and they also discussed how technology could be used to make the education process easier and better. “Our whole world is surrounded with technology,” said Mrs. Noether. “It will continue to increase as well. [Students] need to be proficient using technology if they want to be successful in their lives… and not with just social media,” she added.

Mr. Pascal talked a little bit about some schools that are innovating with technology, and his vision for technology in K-12 classrooms. He said:

“I picture programs like ALEKS… changing the primary function of a classroom teacher…there are some schools set up where kids come to the school to access ALEKS and they basically learn their mathematic skills from the program and
then the time in the classroom is spent in small learning groups where it is more of a collaborative atmosphere instead of a skill based thing. And they can do this at their own speed. I mean right now every student has to go at the same speed. There are some good things to that… but why? That does not make sense. In [the same] class I have some kids who are at 400 skills right now and some that are around 200. They are miles apart, and at the end of the year they will all be going on to the next grade level. But how can you want this kid who does not have the skills to move on to the next class? So I see schools changing what teachers do where the teacher facilitates group work and collaboration and remediation.”

Confirming the research of Levin and Wadmany (2008), almost universally, teachers at this school reported that their beliefs about technology’s usefulness as a learning tool were heavily influenced and even constructed by school experiences and factors like administrator support, availability of technology, and support from other teachers. “The reasons for my usage of ALEKS are really a product of the experiences we had as a math department implementing Digits, a digital textbook, after using traditional textbooks at my last school,” said Mr. Thales. He talked about how, as a math department they had supported each other and worked through challenges and really come to appreciate all that the technology could do.

Teacher Readiness

When asked about what changes they needed to make to integrate this new technology into their curriculum, Mr. Thales and Mrs. Lovelace both indicated that it was not a big change from what they had been incorporating previously. Mrs. Lovelace said,
“I did not really have to change anything because I was already using the computer once a week in my class.” All she did was adjust the activity the students were doing during their time on the computer. “This year I just transitioned to using ALEKS,” she said. “My practice problems and instructional videos are on my website and they can do those at home for extra practice. It is totally up to them.”

Since Mr. Thales had been using a similar product at his previous school, it was not much of a change for him either. “I used an online textbook for two years up north, and ALEKS is almost the exact same format except ALEKS also has the topics and learn at your own pace pathway, which I like,” he said. “For the last two years I had Chromebooks in my classroom about twice a week, if not three days a week.”

Mrs. Noether was part of the reason that ALEKS was chosen, because she had already used it and had good things to say about it. “I’m the only one who used it last year,” she said. “The reason I chose ALEKS was because we could do it on the iPads and I had scheduled the iPads, not the computer lab, because the lab was so full. So that is why I started it. It is nice, because I have four honors classes and I feel like a lot of my kids get what we are doing so fast that they get bored. So it is nice for them to be able to go in and pick what they want and go at their own speed.” She also indicated that though she plans to use a few more features of the program in the future, this year she used it basically the same way that she did last year. “I haven’t made it too much different than I did last year,” she said, “but I like the idea of making those assessments, kind of like how Mr. Thales does, with a little bit of learning at your own pace and a little bit of what we are learning in class. Usually I will just say that the green pie piece is what we are
working on in class if you want more practice. If you’re bored, you can do anything. And I like that with the knowledge checks, anything they click on, they should be ready to learn, so I don’t have to worry about ‘This is way too hard for you’ I can just let them work on it.”

Though the decision to use ALEKS was driven by the principal, these teachers were clearly prepared to use the technology, and ready to integrate it into their curriculum. In addition to the factors other factors that teachers perceived to be influential, these comments support the findings of previous research which suggest that a teacher’s level of preparedness may influence technology integration (Inan & Lowther, 2010; Ritzhaupt, Dawson, & Cavanaugh, 2012; Tondeur, Valcke, & Van Braak 2008).

Like teacher beliefs, most of the teacher’s readiness to use technology seemed to be built through and influenced by interaction with other teachers who already knew what they were doing. In a few cases, it seemed that teachers who already knew what they were doing built their own readiness through independent research and trial and error. This, along with teacher comments about the effectiveness of provided professional development seems to support the idea that current strategies being used for professional development may not significantly impact teacher readiness (Gibson et al., 2014). It may be that other types of professional development would impact teacher beliefs and teacher readiness. These teachers indicated that they wanted opportunities to work with individuals who actually used the program in classrooms similar to their own. More research is needed to determine if the kind of professional development these teachers
were asking for would influence teacher perceptions and better facilitate successful integration of technology.

**The Process for Managing Change**

When I asked teachers and administrators about the process for managing change, Mr. Pascal and Mrs. Noether talked about scheduling the use of computer labs from the beginning of the year, and Mr. Thales and Mrs. Lovelace said that there were really no challenges related to the change.

Mr. Pascal said, “You can see from the calendar, I just went in and put computer lab in every week… that is where I started was with the computer lab, and then I built around it. I just blocked it out so basically I have four days a week to do my other stuff.”

Mrs. Lovelace said, “I did not really have to change anything because I was already using the computer once a week in my class. I just modified to using it on test day so once they finished the test they could get on and use [it].”

Mr. Thales said “You always have review days packed into your schedule or your calendar. Really it is just more of a review day.”

If I had not been looking for it, I probably would not have noticed the role that some of the elements of John Kotter’s change model played in the successful integration of technology. I did not notice evidence of: Creating the Guiding Coalition; Generating Short-Term Wins; Consolidating Gains and Producing More Change; or Anchoring New Approaches in the Culture. It did seem like at least two of these things happened organically without being intentionally implemented by administration, namely: teachers all looked to Mr. Thales and Mr. Pascal for advice and guidance (so they would be the
“guiding coalition”), and teachers seemed to be anchoring new approaches into the
culture of the department by showing each other what was working and sharing success
stories with each other.

Without consciously adopting the change model though, it seemed like the
administration had done at least four of the steps, namely: Establishing a Sense of
Urgency; Developing a Vision and Strategy; Communicating the Change Vision; and
Empowering Employees for Broad-Based Action. I have already talked a little bit about
how the administration had gone about “Communicating the Change Vision” in the
section titled “Administrator Support” so here I will focus on the other three.

**Establishing a Sense of Urgency**

The teachers talked about how the principal had created a sense of urgency by
communicating that if they signed up and got licenses for ALEKS, they were committing
to use the software at least an hour a week. For at least some teachers, this commitment
seemed to be very influential in their initial decision to use the product.

**Developing a Vision and Strategy**

There was also evidence that the principal had developed a vision and strategy,
and done a good job of communicating the change vision to the teachers in the math
department. Mrs. Mandela said:

“When I began last summer Mr. Lincoln had told me his plans for improving
math scores, as outlined in the School Improvement Plan that was developed with
our Community Council. Because of the plan and targeted focus, Lincoln had a
clear and definitive idea on the importance of training, clear articulation and
dissemination of academic goals, and building the appropriate infrastructure involving computer labs and other technology, including ALEKS, to help drive the efforts to reach the math goals. He has also been very effective at helping the Math Department understand the goal and provide the necessary support to achieve the goal. As a result, the individual teachers have seen how effective ALEKS can be to help students learn.”

**Empowering Employees for Broad Based Action**

The administration also empowered employees for broad based action. “During department meetings,” added Mrs. Mandela, “we also discussed throughout the year how teachers were using the software. This was very beneficial because a couple of math teachers were able to help others customize the ALEKS lessons to make the program more effective. This level of individual teacher leadership among the group was also key to successfully implementing the program. Teachers also participated in the webinars and other training offered by ALEKS during the year.” These efforts were targeted to empower teachers with the knowledge necessary to customize ALEKS and implement it in whatever way they thought would work best in their individual classrooms.

Based on comments from teachers and administrators, it seems that at least four or five of the points listed in John Kotter’s change model influenced the success of technology integration at this school. It is possible that the elements that were not evident from interviews and observations were also influential, but since I didn’t ask specifically about each element it is difficult to know. Though more research is needed, these findings suggest that it may be worthwhile for administrators to at least consider Establishing a
Sense of Urgency, Developing a Vision and Strategy, Communicating the Change Vision, and Empowering Employees for Broad-Based Action, and Establishing the Guiding Coalition in their efforts to integrate integration in K-12 classrooms.

**Learning Environment and Student Motivation**

These teachers all talked quite a bit about how important it is for students to have be in an environment that helps to keep them motivated and encourages learning. “It is only effective if the students buy into it,” said Mr. Thales. Though the instructional styles varied from teacher to teacher, and each classroom environment was slightly different, there was quite a bit of overlap in how they encouraged student motivation and engagement.

**Process vs. Person Praise**

During my observations, I noticed that all four of these math teachers used “process praise” more than “person praise.” In fact, I only heard three instances of person-oriented feedback in all of my observations, while process oriented feedback was almost continuous. For example, a student showed Mr. Thales a grid drawing he had completed, scaling up a smaller image, and Mr. Thales said, “I can tell you worked really hard on this part over here, it looks really good! … It looks like you got a bit lazy on this part though, am I right?”

According to Carol Dweck (2009) this type of process oriented feedback can have significant impacts on both student motivation, and the learning environment in general. When I first heard the consistent process oriented feedback across all four math classes I observed, I thought, “Oh, they must know about Dweck’s research.” When I asked
teachers about it however, I was surprised to find that they did not know about Dweck’s research.

“It is intentional, but I did not know the differences,” said Mr. Thales. “There’s a study... I think it was from the University of Pennsylvania, that is called the grit factor. At least once a year, I go through that with my kids, because a lot of these kids don’t think they are cut out for college. And they need to know it is not so much how smart you are or how dumb you are, it is a matter of how much you’re willing to work for it.”

Mr. Thales also talked about how the mentality that goes along with this type of feedback influences the environment of his classroom. “The kids that struggle,” said Mr. Thales, “you’re trying to build confidence, which is why I probably do it. Usually they don’t have a backbone enough to try something on their own because they are afraid they’ll get it wrong. So I usually point out “nice job on this” which is probably where it stems from. I mean, you get a lot of kids coming in on the low end that are afraid to ask a question in class because they are afraid it might be incorrect and that sort of thing. Usually my classroom is more open, it is not like ‘alright be quiet!’ It is pretty loose.”

It was interesting that each classroom I observed had a very process oriented environment which encouraged trial and error, even though the teachers were not familiar with research on this subject, and I did not notice any particular instructional strategies that remained consistent between all classrooms. It would be interesting to do additional research on how process oriented feedback in mathematics classrooms may relate to the integration of technology.
**Shorter Increments Would Be Better**

Across the board, teachers indicated that sitting the students down and expecting them to work silently by themselves on the computer for 50 minutes straight was less than ideal. Unfortunately, when you have one 50-minute period a week scheduled with the technology, and you are supposed to use it an hour a week, your options are limited. While Mr. Pascal and Mrs. Noether were able to have some success with their honors classes working independently for 50 minutes at a time, they both said it would be ideal if they could use the program differently. “Four of my classes are Honors, and they have a lot more endurance than my two regular classes,” said Mrs. Noether. “It would be better if we could use it in a couple 20 minute increments, but our technology does not allow us to because we have too many people trying to sign up for labs.”

Mrs. Lovelace said, “I don’t use it very long. I found my students were getting off task, so giving them the entire period without a purpose just to work on the computer—was not working for me.”

Mr. Thales said that he tried to do the 50 minutes straight on topics with his classes, and it was a disaster. “Mid-year is probably when I got most things figured out with it,” he said, “November or December-ish. But the first of the year was just… ‘okay this isn’t working.’ The hour a week was not working because they were screwing around in class so [I had to] try to figure out something different. So we did numbers of topics and burned out on that, and then I found out how to build assignments, so I built some assignments, and [tried] the combination of assignments and topics… and that works the best. The topics fills the holes from prior years, and in the assignments the problems are
usually structured a little bit differently than what they see in their textbook. So it is the same skills, and same concepts, but just a different approach to it. That is the other reason why I think you’d be kinda crazy not to use it.”

**Grades, Rewards, Deadlines, and Peers**

Mr. Thales said repeatedly that with his classes it is all about setting a due date at the tip of their nose instead of sometime the next day, or later in the week. He makes his assignments short enough that even students who work slowly can finish the assignment in class, but long enough that it will keep kids who would otherwise get distracted on task. “…kids will screw around if given the chance, and [as you saw] they were nose to the grindstone all period, because it was due. They couldn’t take it home tonight, and that was the difference,” said Mr. Thales. “In 9th grade they are more concerned about their grades because it is now high school graduation, so you’ve got that playing in your court too.”

Mrs. Noether and Mr. Pascal both grade their students on whether they get an average of 10 topics done each week. “They have to get at least ten done to get full points on their grade,” said Mrs. Noether. While this strategy is a little bit different than that of Mr. Thales, the students still have a deadline that is right at the tip of their nose, and they have to get things done to earn their grade. Mr. Pascal uses the same basic principles with a slightly different grading structure. “Their goal is 10 skills per week, but the kids that are farther advanced are getting harder problems, or problems we haven’t studied in class yet, so for them to do 10 topics is maybe more of a punishment,” he said. “So if they hit
500 topics OR 10 skills per week, they got 100%. So those kids that are really advanced aren’t getting penalized for it.”

Mrs. Lovelace says that she gives her students the chance to use ALEKS at home to improve their grades. “If they did test corrections – 85% of my students did – they can replace their cumulative test score with the one on ALEKS,” she said. “I feel replacing their test score is a great incentive.”

Mr. Thales and Mrs. Noether also talked about the impact that peers can have on students’ motivation. “Sometimes I’ll say ‘look, somebody’s at 16 topics already!’ and it kind of helps them to try to do more,” said Mrs. Noether.

Mr. Thales said, “I make assignments that that they should be able to finish that are due at the end of class, and sometimes start correcting them in class. So then usually if you have two friends, one is usually more interested in finishing by the time it is graded. So the other one has somebody that is interested in finishing that they want to talk to, but it kind of reins it in that way. If you have due dates the next day, the kid that is smart enough to finish in class is just going to go home and do it real quick, and the kid that needs to be doing it in class is going to sit and visit because their friend is. It is just the way you structure the assignments and the due dates,” he said, “because kids will visit, ya know? They’ll talk about anything; they are like adults.”

The teachers also talked about using rewards as motivation, things like suckers for those who have completed the highest number of topics, or a Pi day party if the whole class is able to reach a certain goal. Mr. Thales pointed out that this strategy did not seem to work as well for him in this school as it had at his previous school. “In this school I
think the kids are pretty well off,” he said. “We offered them a pizza party if they knock out 500 of the 589 by the end of the year and the kids were like ‘pssh… it is not here and now… and it’s pizza, who cares? I get pizza every…” Whereas at my last school… you hang donuts in front of them and they do just about anything.”

**Variety**

Teachers also talked about the fact that students seemed to be motivated a little bit by the variety. Mr. Thales said that he prefers to use mathematics software in his classroom twice a week because the variety keeps students engaged and teaches them concepts in different ways. “Any more than that and it gets to be overkill, and the kids get tired of it,” he said. “Two days a week, tied it to what you’re learning in the chapter already is usually pretty good.”

Mrs. Lovelace had the most to say on this subject. “The more varied we are in our instruction- the better our chance of their learning it is,” she said. “I want to ensure my students have as many ways to learn the math as I can give them.” She talked about using practice problems, instructional videos, web resources, and personalized learning technology to provide as much variety as possible and ensure that her students gain a deep understanding of the material.

**Teacher Presence**

Mr. Pascal said that his physical presence also seemed to be a significant factor in keeping students motivated and engaged. “I’ll pull up reports in the middle of class and I can see ‘Oh this kid has only done one skill’ and then I can go hover over his desk and help him with a problem or two,” he said, “but mostly make sure that my presence is
there, because maybe he has just lost focus. I can use this report to see what kids I need to be around. In the [traditional] classroom, you cannot just look at a report like this and see ‘oh he’s with it, and he’s not…’ It is not that easy. So that is a nice thing.”

When I was observing the classes of Mr. Thales, I noticed that he also used his presence to help his students get on task if they were getting side tracked. A few times a small group of students would veer from conversations about the math they were working on into conversations about any number of other things, and Mr. Thales would walk by and jokingly find a way to tie their conversation back into the assignment, and encourage them to get their work done. It seemed to be effective.

**Suggestions from Teachers**

These teachers were all helpful and cooperative. They wanted as much information as I had to offer about effective ways to use the program, and they were excited to share their own experiences in the hopes that it might make technology integration easier for other teachers going forward. They really wanted to see additional research done on the use of personalized learning technology for mathematics because they wanted to know the most effective way to use the program so they could make changes accordingly. Even though they had higher usage levels than almost any other school in the state, the teachers all agreed that there was more they could be doing with the program if they just knew a bit more and had additional resources.

Mr. Pascal talked about the additional capabilities that would be available if they were using one of the textbooks that aligned with the software they have chosen. “You can actually link the assignments to the textbook if you have that textbook. What I have
to do is get all of these skills put into categories, and I can pull out a problem and build an assignment,” he said. “If you were using their textbooks, instead of you having to go through and pick them out like this, you could just say ‘Let’s go to chapter five, sections two, three and four and build an assignment based on that.’ …So it makes it a little quicker. The problems will still look the same, it is just aligned to their book.”

Mr. Thales is really interested in exploring the potential of the reporting capabilities built into the software to improve student outcomes. He said:

“Mr. Pascal and I have talked about testing in ALEKS for chapter tests, but we just don’t have the computers to do it. I feel like if we did, that is what we would be doing. If I was using it for testing [I could] do an analysis report on the questions and build review assignments based on those reports. Schools pay money to have someone come in and pour over data like that when its paper and pencil. In one district up north they get a grant and the school pays $5,000 of the salary and the government pays the rest and they get somebody who comes in and all they do is look at test data from chapter tests in the department. They say, ‘Okay, the scores are better on this question with this teacher versus this teacher, so let’s figure out what’s going on’ all their job is, is to look at data given to them within a department or within a grade level on tests. With ALEKS I could pull that data and add it up in twenty to thirty seconds.”

**Discussion**

At the end of the year, these teachers shared their school’s final State SAGE Assessment score for grade level proficiency in mathematics with me because they were
so excited about the improvements. Since the SAGE assessment was first introduced, their school has hovered right around the same score, which is basically the same as the district average. This year, while the district average was still about the same, the proficiency score at this school jumped about 20%. Though teachers don’t attribute these gains to technology alone, they believed that using functional technology with support from administrators and other teachers played a big part in achieving these gains.

The main factors that teachers perceived as being influential to the successful integration of technology were: ease of use and product functionality; support from other teachers; administrator support; building it into the calendar from day one; access to technology; and professional development. Though teacher readiness and teacher beliefs were not discussed explicitly, based on their comments it seems clear to me that these factors also had a significant influence on how much they used the technology.

Many of these were so intertwined in the qualitative data that it was often difficult to separate them into clear and distinct stand-alone factors. For example, teachers made it clear that planning time to use from the beginning of the year was very important, and it was equally clear that they would not plan technology use into their schedules if they were not certain that they would have access to the technology when they needed it. In order to feel secure in their ability to access technology, they needed to feel sure that the school’s administrators were on their side and would ensure they had the necessary resources.

As another example: Teachers mentioned that the professional development they received in relation to the software was minimal and insufficient, and they relied mostly
on support from other teachers to figure out how to use the program. It was also clear that while they had discovered quite a bit through trial and error, at least one teacher had received some professional development that allowed them to help the other teachers.

It also seemed that many of the factors teachers identified as influential were bi-directionally intertwined with the teachers’ beliefs about technology, and how prepared they were to integrate technology into the classroom. I have diagramed the direction of the relationships of these factors based on the direction indicated by the teachers (see Figure 4) and I have written a sample relationship as the caption.

*Figure 4.* Sample relationship: teachers felt prepared to use technology because they had previously had access and opportunities to use technology in their classrooms; the availability of technology was influenced by administration, and the administration thought technology was important because their teachers said it was making a difference (teacher beliefs); this lead to greater access, leading teachers to use it more; ultimately this increased teachers level of preparedness.
While teachers indicated that learning environment and student motivation was affected by many of the other factors listed, they did not perceive either of these two factors as influential to the successful integration of technology. While change management strategies also had at least some influence on the technology integration process, teachers focused primarily on factors that were more visceral, day-to-day issues like access and product functionality. Change management strategies related to the integration of technology were only ever discussed by the vice principal, while if the teachers did refer to any of the elements involved in the processes used to manage change at the administrative level, they lumped it into the same category as administrator support.

None of the literature that I reviewed about technology integration made any reference to Professional Learning Communities (PLCs) or the influence of teachers on other teachers. I found this of particular significance because teacher support was the factor most frequently mentioned by teachers as influential to their successful integration of technology. It would be interesting to cross-reference everything these teachers said with existing literature on PLCs, and design a study that measures the effect of a well-organized PLC on technology integration. When I emailed Mr. Thales in the process of member checking to ask if I had represented things correctly, he responded vehemently in the affirmative with a lengthy email highlighting the importance of teacher to teacher discussion. He reaffirmed that teachers are often viewed as the most credible source of information by other teachers, and have the best understanding of how to answer questions of other teachers who are going through the same issues. He indicated that the
teachers who have the most credibility are the ones at your own school or in your own
district who are successful, and those who are working with students of similar
demographics, or even more difficult demographics, who are successful. He thinks it is
crazy that there is nothing in place to facilitate collaboration or examine the practices of
schools that are outperforming everyone else. I have included a de-identified copy of his
email in Appendix D.

While this study has been extremely informative, the relationships between all of
these factors are complicated and it is impossible to determine the correlational
coefficient without additional research including quantitative data collection and analysis.
I hope to use these preliminary data to develop a brief survey that will be sent out to
teachers for the 2016-17 school year, which will provide a much larger sample for
statistical analysis. The information collected from that survey, combined with the
information collected in this study, will be used to help district leaders throughout the
state develop plans to facilitate the successful integration of technology into K-12
classrooms.
References


APPENDICES
Appendix A – Observation Protocol

Observation Protocol

Teacher Name:

School:

Date:

Observer:

**Instructional Variables**

<table>
<thead>
<tr>
<th>Instructional Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. # of minutes spent on each of the following tasks</td>
</tr>
<tr>
<td>- Teacher-directed lecture</td>
</tr>
<tr>
<td>- Class discussion</td>
</tr>
<tr>
<td>- Small group activities</td>
</tr>
<tr>
<td>- Paired student activities</td>
</tr>
<tr>
<td>- Student independent work time</td>
</tr>
<tr>
<td>- Homework review</td>
</tr>
<tr>
<td>- Test/Chapter/unit review</td>
</tr>
<tr>
<td>- In-class quiz or test</td>
</tr>
<tr>
<td>- Student discipline/interruptions</td>
</tr>
<tr>
<td>- Other _____________________</td>
</tr>
</tbody>
</table>

2. How often did students do the following?
   - Answer each other’s questions
   - Make connections to previous lessons
   - Introduce more than one way to approach a problem
   - Take turns answering teacher questions
   - Collaborate to solve problems

3. Pedagogy:
   ----------------------x----------------------
   sage on                     guide on
   the stage                   the side

Notes:

4. Did the teacher do any of the following:
   - Encourage curiosity/creativity
   - Expect complex thinking
   - Connect new concepts to things students already know
   - Connect concepts to the real world
   - Establish routines
   - Use alternative strategies if students don’t understand material
   - Provide encouragement
• Notes about instructional strategies:

• Notes about the classroom culture and learning environment:

**Motivation**

<table>
<thead>
<tr>
<th>Motivation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Make a tally mark each time you hear person centered feedback:</td>
</tr>
<tr>
<td>2. Make a tally mark each time you hear process oriented feedback:</td>
</tr>
</tbody>
</table>

• What strategies are used to keep the students motivated and engaged?

• How is growth mindset or fixed mindset reinforced?
## Technology

<table>
<thead>
<tr>
<th>Technology:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Number of devices per student (e.g. 4:1)</th>
<th>Interactive Digital Whiteboard (Y/N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital display devices (Y/N)</td>
<td>Mobile devices (Y/N)</td>
</tr>
<tr>
<td>Document camera (Y/N)</td>
<td>Wireless access (Y/N)</td>
</tr>
<tr>
<td>Audio amplification system (Y/N)</td>
<td></td>
</tr>
<tr>
<td>Scanner (Y/N)</td>
<td></td>
</tr>
<tr>
<td>Printer (Y/N)</td>
<td></td>
</tr>
<tr>
<td>Student access to digital resources</td>
<td>Notes:</td>
</tr>
<tr>
<td>Student access to the Internet</td>
<td>Notes:</td>
</tr>
</tbody>
</table>

### How many times were classroom technologies used? For what duration?

<table>
<thead>
<tr>
<th>Student devices</th>
<th>Interactive Digital Whiteboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital display devices</td>
<td>Mobile devices</td>
</tr>
<tr>
<td>Document camera</td>
<td>Wireless internet</td>
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<tr>
<td>Audio amplification system</td>
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<tr>
<td>Scanner</td>
<td></td>
</tr>
<tr>
<td>Printer</td>
<td></td>
</tr>
</tbody>
</table>

Notes: How is technology integrated into classroom instruction?
Appendix B – Interview Protocol

Interview Protocol

Time of interview:

Date:

Place:

Interviewer:

Interviewee:

Questions:

**Teacher Beliefs**
1. Do you think technology enhanced learning can better prepare students for the 21st century? Explain your viewpoint.
2. What is motivating you to use technology the amount you do?
3. What is motivating you to use the math software the amount you do?

**Teacher Preparedness**
4. Do you know how much usage the product provider recommends? How much do you think the product should be used per week?
5. How much professional development did you receive related to this software? How long was it? Was it useful? Why or why not?
6. How are you using software?
7. How do you know when to use software?

**Instructional Strategies**
8. What are some ways you have helped students view technology as a learning tool?
9. How do you incorporate technology into your instruction?
10. What did you do to incorporate software into your instruction?
11. What are some ways that you have been able to use technology to enhance student learning?
12. Do you encourage collaboration and creative thinking? If so, how?

**Motivation Strategies**
13. How are students using software?
14. How often do you check student progress?
15. Do students use this software at home?
16. What strategies do you use to motivate and encourage students?
17. What strategies do you use to keep students engaged?

**Change Management**

18. In your school or classroom, what strategies were used to manage this change to your instruction?

19. What instructional or management strategies do you use to integrate technology in your classroom?
Appendix C – Network Display
Appendix D – Mr. Thales’ Email

…You also talked about how setting time aside for a department to meet would possibly lead to higher use of technology and integration. At [my last school] we did meet once per week for just over an hour during a late start day that was set aside for the sole purpose of PLC time, Professional Learning Communities. It was a district decision that this time was untouchable by administrators to schedule faculty meetings or any other type of activity. It was specifically set aside for departments to meet together by subject. For example the math department met together in a math classroom, the English dept. met together in an English room, etc. As a math department we used this time to go over schedules and pacing, but this is when we built tests and quizzes in Digits [the math technology we used] together. During this time we would also discuss the concepts we had been teaching within the current chapter and strategies that worked. We would also use this time to look at test and quiz data to see where students were struggling and how to effectively re-mediate those concepts within the school day. Without this built in the schedule we are doing what we do at [my current school], which is: the level of integration depends upon specific teachers within each grade level. It seems 9th grade (Mr. Pascal and I) are far more integrated than the other grade levels when it comes to building chapter tests and retake tests etc. and that is dependent upon: our willingness to work together; the proximity of our rooms next to each other because it gives us time to talk; his knowledge of how the school and district support technology; and my prior experience with math technology. Without our classroom proximity we wouldn't be where we are in terms of integration as shown by our other teachers and their level of
integration.

It seems the common factor in your paper and what I experience in the trenches is that teachers have the biggest influence on other teachers when it comes to changing curriculum and instructional strategies. I know I think of "district" and "university people" as being "out of touch" with reality in the classroom because a lot of what I have heard in the past on instructional strategies seems to fit in a "lab environment" where the kids in examples are more like "honors" kids that I don't deal with. I would also say that I take the opinions and ideas of those in my department much more seriously than if they were someone from a different school, unless said school is showing significant success in end of year test scores. Basically, I want to hear ideas from people where test scores are high for the school's demographic. For example, I would expect a more affluent school’s test scores to be higher than that of a less affluent school. I would also say that a less affluent school with test scores that are maybe 5 to 10 points higher than the state average is doing just as much in instructional effectiveness as a school like ours were the students are performing higher than 10 to 20 percent above the state average. Those are the teachers I would listen to.

One of the questions I have asked when I interviewed for this district and have also asked our district math person since being hired is, "Do we ever get to talk to teachers at schools that are showing higher success rates in end of year testing so we can implement changes in our instruction?" The answer is no. We have schools a [couple Junior High Schools] that do really well, and [others] with the same demographic that are under-performing. Anyone can pull SAGE results from the State Office of Education
website to see this. Yet nothing is done to find out what [the high performer] is doing differently unless teachers happen to know another teacher and ask questions on their own, which doesn't happen as far as I know. I am hoping your paper will maybe change this as a side effect of its primary purpose of how to integrate technology, since our school showed significant increases from the prior year. I think this idea shows up within our department when Mrs. Lovelace has found out what Mr. Pascal and I are doing with assignments that actually works for kids and now she has done a 180 degree turn in her opinion of the software.

Thanks again for doing what you have done. I really hope more discussion about learning from teachers in successful schools within the state and individual districts develops from this. At [my previous school] I would have liked to see what [the top performer in the district] was doing since they were very successful with a similar demographic, and at the beginning of the last school year I wanted to look at what [the top performer in this district] was doing because of the similarity of demographics. Unfortunately nothing like this takes place, which seems crazy. Mr. Thales and I just happened to find something that worked this year and plan on tweaking a little next year to try and improve a few things from last year.