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Technology Integration in Context

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TECHNOLOGY INTEGRATION IN CONTEXT

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE GRADUATE SCHOOL OF EDUCATION
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BY

JOANNA MARSHALL

CHICAGO, ILLINOIS

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DEDICATION

For Rodger Bernard Green
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GLOSSARY

**Apple TV/ Air play** – this device allows teachers to project their laptop or I-pad screens on to a screen in the classroom. Students also have the ability to project their screens from the I-pad to the classroom screen.

**Casper Focus** – allows teachers to “focus” students’ I-pad on a specific app, an I-pad classroom management tool

**Comic Book** - an app that allows for the creation of a comic book that provides layouts, caption and text tools. Users can import or draw their own pictures,

**Hover cam** - document camera and software that connects to the teacher laptop. Replaces the overhead projector in the classroom. Can take pictures and video.

**Hudl technique** – an app that allows for the recording of video and slow motion video analysis. Allows for slow motion or frame by frame playback

**Kahoot** – a free game based learning platform that allows the user to create, play or share learning games.

**Noteability** - a note taking app for I-pads that allows students to take notes, high light notes, include drawings and audio or video

**Puffin** – a web browser that allows websites containing Flash animations to run on apple mobile devices.

**Safari** – Internet browser

**Skype** - a free app for video chat or voice calls
Socrative – an app that allows teachers to create assessments that give students immediate feedback in real time

Schoology – A learning management system (LMS) that allows users to create their own pages and share content and resources.

Vernier Lab Quest – a sensor designed to collect data from probes that can create graphs and use wifi or Bluetooth connection to send data to another device wirelessly.
ABSTRACT

This study employed an ecological framework to examine how multiple contextual variables from the state biosphere, district biome, school habitat and classroom niche impact how teachers decide to integrate technology. It was an opportunity to observe how a teacher’s Technological Pedagogical Content Knowledge operates in a classroom in response to the building, district and state contexts. It was conducted in multiple classrooms in one school and with science teachers. It included a self-study component. It provided an opportunity to directly observe the interactions between students and teacher as distinct species in the classroom when technology integration occurred. This allowed me to determine how observing other teacher’s technology integration efforts impacted my own use in my classroom. I hope to provide an emic perspective on technology integration and broaden the definition of effective technology integration.
CHAPTER 1

INTRODUCTION

National Context

Incorporating technology into education is a priority at the national level. In 2010 the Obama Administration crafted a National Educational Technology Plan endorsing a revolution in education through technology and focuses on learning, assessment, teaching, infrastructure and productivity. This document addresses the 21st Century skills of critical thinking, problems solving, collaboration, and multimedia communications in all content areas. It stresses the value of how information technologies can produce flexible classrooms and create opportunities for learning to occur unrestricted, anywhere at anytime. (U.S. Department of Education, 2010).

Schools across the country experiment with technology integration in an attempt to achieve the vision articulated in the national plan. States have attempted a variety of approaches to create more flexible classrooms by integrating technology through one to one technology deployments or through Bring Your Own Device (BYOD) policies. The state of Maine began the Maine Learning Technology Initiative (MLTI) started in 2002 by providing all middle school students and teachers with laptops. The program expanded to high schools in 2009. Currently in Maine there is 100% one to one implementation in middle schools and in 55% of high schools. (http://maine.gov/mlti/about/index.shtml).

Maine is not alone in this endeavor. The Fairfax County Public Schools in Virginia
created a Making Learning Mobile Project in middle schools and created a one to one tablet program. Some school districts have Bring Your Own Device or BYOD policies. The Katy Independent School District in East Texas implemented a BYOD policy in 2011-2012 school year that allowed students and teachers to bring any wireless mobile digital device into the schools for classroom use. From 2011 to 2012 districts using a BYOD program increased by 47 % (Project Tomorrow, Speak up 2012).

Concurrent with the focus of the Obama Administration on technology integration, is the focus on assessment and responding to problems with NCLB. The Obama Administration signed the Every Student Succeeds Act or ESSA in December of 2015 as a reauthorization of the Elementary and Secondary Education Act (ESEA). This new law replaced the NCLB act from 2002. The goal of ESSA was to return control to the states and to reduce the emphasis on assessment but maintains state-wide assessments to show progress and performance of students.

The Act is described as a move toward assessments that are aligned to college and career ready standards along with critical thinking, problem solving and writing. The act is a response to the one fits all approach of NCLB to schools that were not improving test scores. It requires statewide assessments from 3rd to 8th grade and once in high school. It allows for multiple measures of student learning and progress. (U.S. Department of Education, 2015).

As the current administration emphasizes technology integration and annual statewide assessments, the Common Core Standards began to appear. These Common Core standards were developed through state led efforts starting in 2009. This movement started at the state level and was promoted by state governors who were members of the
National Governors Association Center for Best Practices and the Council of Chief State School Officers. It was an attempt to standardize the variety of state standards across the country. They include college and career ready standards and the K-12 standards. By 2015, 42 states had adopted the Common Core State Standards (CCSS) in English / language arts / literacy and math. The state of Illinois adopted the CCSS in 2010. The state of Illinois began to administer online PARCC testing of the English/language arts / literacy and math in the 2014-15 school year. (Common Core State Standards Initiative, 2016).

ESEA and CCSS along with the PARCC testing create a national context in which assessment is prioritized with states having the freedom to select the assessment and other measures of student progress. Both the National Educational Technology Plan and ESEA include assessment with technology. Technology integration in classrooms across the country occurs within a national context that continues to emphasize assessment. In some cases technology is being harnessed to administer assessments.

**Effective Technology Integration**

As information communication technology become common tools in classrooms, the concern for their use in education shifts from availability to the question of how to effectively integrate these tools into instruction and learning. Researchers and organizations rather than those responsible for the integration more typically define the prevailing definition of effective technology integration. Ertmer and Ottenbriet-Leftwich (2010) define effective use as students using computers as a tool to allow them to engage in authentic learning. Kelly (2008) describes good teaching with technology as being used for problem solving, application and analysis not when it is used for having students
practicing basic skills. The Partnership for 21st Century Skills is an organization that promotes the ways in which students should be using technology for communication, collaboration and applying critical thinking to problem solving ([www.p21.org/about-us/our-mission](http://www.p21.org/about-us/our-mission)). The International Society for Technology in Education (ITSE) has also produced National Educational Technology Standards (NETS) for both students and teachers. These standards emphasize inquiry based, collaborative, student-centered uses of technologies. Additionally the standards focus on students as knowledge creators, empowered learners, and digital citizens ([www.iste.org/docs/pdfs/20-14_ISTE_Standards-S_PDF.pdf](http://www.iste.org/docs/pdfs/20-14_ISTE_Standards-S_PDF.pdf)). Hamilton (2007) defines technology integration as when a teacher uses technology to introduce, reinforce, extend, enrich, assess and remediate student learning of curriculum. Researchers and organizations have identified key elements that comprise the construct of effective technology integration. Teachers do not participate in the process of defining effective technology integration. Their voices remain sidelined from this conversation about what constitutes effective technology integration. The role of teacher is that of a faithful implementer of effective technology integration as defined by others. In order for the effective technology integration to occur, teacher voice needs to be brought to the table.

It is important to understand how teachers decide to integrate technology in their classrooms while the national context prioritizes assessment. The goals of effective technology integration seem at odds with standardized testing. How does the externally defined definition of technology integration respond to the assessment context in a classroom? What does effective technology integration look like in practice?
It is necessary to understand the broader forces outside the school walls that may impact how teachers make pedagogical decisions about technology integration within their classroom. There needs to be a more thorough examination of the interplay of school, district and state level contexts on how teachers decide to integrate technology in their classrooms.

Zhao and Frank (2003) propose an ecological metaphor as a way to analyze how technology is used in schools. This framework describes a school as an ecosystem where both computers and teachers are different species while external educational innovations are an invasion of an exotic species. In this framework technology is the invading species and the successful integration depends on how well the technology is compatible with the teaching environment. It describes government institutions as geological forces that shape the landscape of schools and affect technology integration. This model addresses the broader national, state, district, school and classroom contexts.

Applying this model to science teachers engaged in technology integration could provide a more comprehensive understanding of how context impacts teacher use of technology as it includes students and broader contextual components. Hew and Brush (2007) advocate for this type of technology integration study and state, “few studies included other potentially important variables at the school or district level that may be affecting the integration of technology by teachers” (p247). Hew and Brush call for studies that examine technology use in classrooms not just self reported teacher surveys. They call for research that examines “the broader contexts such as decision makers outside the school” (p. 247). Ertmer, Gopalakrishnan and Ross (2001) found in their case study of 17 exemplary technology using teachers that exemplary practice is dependent on
many variables that includes the grade level at which teachers are working at and the institutional constraints teachers experience. It is important to determine how a variety of variables impact technology integration.

This study addressed these issues by looking at a district that has mandated goals of increasing standardized test scores, increasing AP enrollment, increasing passing AP scores and decreasing the number of students receiving grades of D’s or F’s. These goals are required by the six high schools that comprise the district and have to be incorporated by teachers when they create their goals as part of their evaluation process. Over the past five years there has been an increase in the number of pilot programs of 1 to 1 iPad use in classrooms throughout the district. For the 2015/2016 school year all students in this district had an iPad. This study provided a unique opportunity to examine how these district initiatives in concert with the state context and current standardized assessment context impacted the decisions science teachers made about technology integration in their classrooms.

Methods

The purpose of this study was to provide an understanding of how the state, district and building contextual factors impacted science teachers’ decision-making process about technology integration. It sought to produce a rich thick description of technology integration as it happens in a variety of classroom contexts. It provided me with an opportunity to examine my own process of technology integration with my special education and ELL students. It sought to give voice to teachers and provide them with an opportunity to define effective technology integration for their specific context.
The emic perspective of teachers engaged in the process of technology integration was the focus.

**Research Questions**

1. How do teachers navigate a variety of contexts when making decisions about how to integrate technology in their instructional practices?
   
   A) How are teachers integrating technology in their classrooms?
   
   B) How do the state, district, school, and classroom contexts impact teacher decisions about technology integration?
   
   C) How does a teacher’s knowledge (TPCK) inform and shape their technology practices and decisions?

1. How do I navigate a variety of contexts when making decisions about how to integrate technology in my instructional practice?

   A) How do I integrate technology in my classroom?

   B) How do the state, district, school, and classroom contexts impact my decisions about technology integration?

   C) How does my knowledge (TPCK) inform and shape my technology practices and decisions?

2. How does the process of studying technology integration practices of other teachers influence my own classroom decisions about technology integration?

**Design**

The study was a multi-case study of four science teachers who were in the process of integrating technology with a self-study component as I explored my own use of technology and how it was impacted by conducting this study. Case study was an
appropriate approach to the topic of technology integration in science classrooms and has been used in previous studies on this topic. According to Yin (2014), “case study research arises out of a desire to understand complex social phenomena (p.4). Since this study attempted to understand the interaction among state policies, district level initiatives, building level decisions and classroom context, case study provided a method of understanding this process. One purpose of self-study is to improve classroom practice, (Allendar, 2005), as it positions the teacher as knowledge creator. (Clarke and Erickson, 2004). The self-study component presented me with an opportunity to investigate my own use of technology in my classroom. It allowed me to determine how observations of other teachers’ use of technology modified and improved my own practice.

The participants were in a Suburban middle class school district that could be described as technologically rich. Teachers have access to computer labs, computer laptop carts and the district provides iPads to students and teachers. Teachers all have a district issued personal laptop. There is an internal university run by the district that provides classes for teachers to integrate iPads into their classrooms. Currently two courses are offered, Teaching with iPads 1 and Teaching with iPads 2, both taught by teachers in the district.

Teachers were observed using technology with their students and interviewed about how they decided to use the technology. Concurrent with the observation and interview process, I kept a research journal about my own technology integration practices with my own students. This study allowed me to understand how observations of my peers impacted my own choices in technology integration. Documents were collected from the Illinois State board of Education, the district website and emails.
These data sources of observation in classrooms, interviews, document analysis and a research journal allowed for triangulation. The data was open coded by with each teacher as a case, then subjected to cross case analysis for emerging themes between and across cases.

In this study my role was that of a participant observer since I observed other teachers and investigated my own process of technology integration with my students. Yin (2014) describes an advantage of research as participant observer as providing “the ability to perceive reality from the viewpoint of someone “inside” a case” (p117). Another advantage is that as participant observer and as a colleague of the teachers participating there is a level of trust and teachers may feel more willing to confide in me since we are “in the trenches” together. However this could also be a potential source of bias as well since it meant I was wary of teachers wanting to vent their frustrations about barriers to technology integration. An additional potential downside to this position is that “the participant observer may not have sufficient time to take notes or to raise questions about events from different perspectives as a good observer might”(p.117).

I have a positive approach to technology. All of my students have their own iPads. I have already begun to incorporate iPad apps, on line simulations, and use the website Schoology to deliver content to my students. I also have access to laptop carts, computer labs and have done collaborative projects with my students using I-movie and garage-band. I am interested in incorporating technology into my classroom that allows me to do things that I could not do otherwise. I have taught a course on evaluating Internet sources to teachers as part of my districts’ internal university. The ISTE standards for students have been useful in my approach to the twenty-first century skills both with students and
with teachers. I worked with a web designer to create an online, forensic, role-playing
game for my general students. I have my prep level students use an app to create comic
book characters based on their research of a specific element and produce raps about
chemistry content we have covered over the school year. I also understand that teachers
may be contextually constrained in their use of iPads by the structure of the school day
(Cuban, 2001). Keeping a research journal helped me to remain reflexive about my role
both as researcher and practitioner.

Technology integration is happening currently in schools across the country and
this study contributes to furthering an understanding of how teachers navigate this
activity. This study is significant because it provides an in depth examination of how
science teachers used the technology with specific student populations. This study
broadens the focus to understand how multiple contextual factors influence how teachers
use technology. Authentic teacher voice and an emic perspective can contribute to
moving toward a broader definition of technology integration that is situated in practice.
It provided multiple teacher perspectives on technology integration as it happened. As
classroom technology becomes ubiquitous it is vital to provide the research community
with insight into how teachers navigate the complex process of technology integration.
An emic perspective makes space for teachers to create their own definition of effective
technology integration that is a function of their multiple contextual realities.
CHAPTER 2

LITERATURE REVIEW

Effective technology integration as defined by academics, educational researchers and organizations is not occurring in schools. This complex process is mediated by several factors: the barriers faced by teachers, teacher beliefs, teacher knowledge and context. Teachers are positioned as problematic to effective technology integration. Researchers focus on changing teacher beliefs and increasing teacher knowledge to promote a vision of effective technology integration. There is a need for research that begins to investigate teacher technology use as it is embedded in a variety of contexts.

Effective Technology Integration Defined

Determining what constitutes effective technology integration is not a new endeavor and has plagued education since the 80’s. In this decade the issue was how microcomputers in the classroom could be used to promote learning as a student-centered, self-directed process as opposed to an emphasis on basic skills with drill and practice. Seymour Papert of MIT, advocated this use of microcomputers. He envisioned the microcomputer as an opportunity to help students with metacognition and created a programming language for children called LOGO. He took a broad approach to how computers could revolutionize both teaching and learning. To Papert (1980), a computer
is not just a tool for game playing or drill and practice, it is a device that a student could work with in a manner that allows the student to use metacognition to solve a problem pertinent to them. He viewed the computer as an “object to think with” (p137). In his view, the computer is not simply a tool for teaching a child how to do math, it is a tool that the child can control and influence, both learn math and learn about their own learning.

Current definitions of effective technology integration are similar to Papert’s. Organizations like Partnership for 21st Century Skills (www.p21.org/our-work/p21-framework) and ITSE (www.iste.org/students/iste-standards/standards-for-students) agree on a definition of technology integration as using technology to problem solve, analyze, communicate and collaborate. Both focus on using technology for the higher order thinking skills of analysis, synthesis and evaluation. Educational researchers also propose a similar definition of effective integration that focuses on problem based, authentic, student centered uses and a constructivist pedagogy. Ertmer and Leftwich (2013) define best practices as “technology enabled learning which is seen as a student centered problem based learning in which technology is a tool that allows them to collaborate on authentic learning activities.” (p.180). They also define effective integration as use of “technology as a cognitive tool to facilitate authentic student learning” (p.176). Kelly (2008) suggests that teachers minimally use technology for basic skill practice and focus more on having students participate in “multi-step projects that require searching the Internet, evaluating what is found and then applying it to the solution of a problem” (p43). This definition builds on the one presented by Papert with the added dimension of collaboration and the use of information communication technology or ICT. Effective
technology integration remains defined by academics, educational researchers and organizations, not teachers.

**Lack of Technology Integration**

Schools have failed to achieve technology integration as defined by educational researchers and organizations. Teachers use technology for record keeping, communication and planning. They use technology in a teacher directed manner for basic skill practice. Constructivist, problem-based, student-centered uses of technology are not happening in the majority of classrooms nationwide. National survey data from the Pew Internet and American Life project of AP and National Writing Project (Pew Internet 2013) teachers found that of teachers surveyed, 97% of them have access to a projector connected to a laptop or other digital device, 96% had access to a computer lab, 71% had access to a laptop cart. 95% of teachers reported using this access for research and finding information on-line. This survey revealed that teachers primarily use technology to find information and plan for instruction (92%) and teacher-directed activities of online searches. The NEA national survey of teachers determined that most teachers use technology more for administrative tasks and less for instruction related tasks. When teachers did have students use technology, only 32% reported having students use technology to research or solve problems several times a week (NEA, 2008).

This trend continues as researchers focus on technology use in states and school districts across the country. In a study of Florida teachers, only 20% reported using computers as a problem-solving tool (Barron et al, 2003). When examining the practices of teachers who are described as “tech-savvy” by their schools, Bauer and Kenton (2005) found that they did not integrate computer technology for both teaching and learning.
They found 80% of teachers reported using computers less than 50% of the time. The authors interpreted this as a lack of technology integration since these teachers were described as heavy tech-using teachers. O’Dwyer, Russel and Beber (2004) found that teachers used technology for preparation and were not having students use technology to produce a product.

All of these surveys and studies rely on teachers self-reporting the ways in which they use technology and may not be an accurate representation of actual use of technology in classrooms. Overall, they reveal that teachers have increased access to technology but employ it to maintain teacher directed classroom practices and prepare for instruction.

**Factors that Impact Technology Integration**

A variety of factors impact technology integration in classrooms. These factors are barriers encountered by teachers, teacher beliefs, teacher knowledge, and school contextual factors. These factors work in combination to prevent effective integration, or to promote it. One focus of the research on technology in the classroom has been on the barriers teachers encounter when attempting to integrate technology into their classrooms. These barriers have been described as first order barriers and second order barriers (Ertmer,1999). First-order barriers are external to teachers such as access, administrative support, tech support and time. These barriers are specific to school, district and state contexts. They are environmental factors that impact how teachers use technology. Another set of barriers is described as second-order barriers, which are intrinsic to teachers (Ertmer, 1999). Teacher beliefs about teaching and learning and the role of technology in the classroom are second order barriers.
Many studies examine how first order barriers of time, lack of technology support, lack of administrative support, lack of access and assessment prevent teachers from achieving effective technology integration. Hew and Brush (2007) identify the barriers of resources, institution, and subject culture. Bauer and Kenton (2005) examine technical issues and time as barriers. The barrier of time is a common issue in studies both in terms of the structure of the school day and teacher time to plan for instruction. (Chou, Block and Jesness, 2012; Garthwait and Weller, 2005; Grimes and Warschauer, 2008). Technical support is another issue that can prevent technology integration (Hernandez-Ramos, 2005). One important issue raised by Wachira and Keengwe (2011) is that teachers “reported that they were hardly involved in decision making as to what technology was needed in their schools” (p.20). Teachers identified assessment, student behavior, class size and inclusion of severe needs students as additional barriers (An and Reigluth, 2011). These are all first-order barriers that are a product of the national, district, school and classroom contexts in which teachers function. The statement about teachers’ lack of input into decisions about technology reveals that decisions made outside of the classroom can create contextual barriers to technology integration within the classroom. High stakes, standardized testing and the emphasis on improving test scores is a function of a national context in which classroom technology integration is embedded.

The majority of these studies are quantitative and based on teacher self-reporting. Hernandez –Ramos (2005) and An Reigluth (2011) were mixed-methods studies, which included observations and open-ended questions. These studies all reveal the impact of contextual factors of time and tech support on teachers’ technology integration efforts.
There is a need for an in-depth examination of teachers using technology in classrooms that includes an understanding of how contextual factors of time, class size, and student ability level, all impact teachers’ decisions on how they use technology.

Some research investigates factors that positively contribute to technology integration. Ely (1999) describes eight conditions that facilitate technology integration as dissatisfaction with the status quo, knowledge and skills of implementers, resources, time, rewards for participants, participation, commitment and leadership. In higher education, Surry Ensminger and Haab (2005) found that the RIPPLES model illustrates factors that can facilitate technology integration. Components of this model are, resources, infrastructure, people, policies, learning, evaluation and support.

**Teacher Beliefs**

Effective technology can occur when teachers hold constructivist beliefs about technology. Guzey and Roehrig (2012) found that teachers who held constructivist, student-centered beliefs about teaching and learning, used technology for student centered inquiry, and made the choice to use technology in their classrooms. Windschitl and Sahl (2002) found that teachers were able to move toward more constructivist use of technology since they already had constructivist beliefs but that the “technology did not initiate teachers’ movement toward constructivist pedagogy” (p198). These teachers already held constructivist beliefs and technology became a vehicle to enact those beliefs. Vannatta and Fordham (2004) found that teachers who were more constructivist and open to change tended to use technology more. O’Dwyer, Russel and Beber (2004) determined that teacher self-reported computer proficiency and teachers’ beliefs had a positive impact on tech integration. Teachers’ constructivist beliefs and positive beliefs about
computers coupled with a belief in their own competency all combine for an increase in their use of technology in classrooms.

When teachers don’t have constructivist beliefs, educational researchers have suggested ways to engender them with this approach. Ertmer (2005) calls for educators to address teachers’ beliefs to change them so that teachers can “use computers to their full potential“ (p 37). Ertmer and Leftwhich (2013) hold that teacher beliefs are what allow teachers to overcome first order barriers and integrate student-centered, authentic uses of technology. According to Ertmer and Leftwhich (2013), teachers require more professional development on learner-centered teaching so that teachers can implement a more constructivist approach to technology integration.

Researchers suggest that changing teacher beliefs will lead to effective technology integration. Teacher beliefs can be modified through professional development and communities of practice that move teachers toward student-centered uses of technology (Kopcha, 2008; Lawless and Pelligrino, 2007; Polly and Hannafin, 2010; Rehmat and Bailey, 2014). The research does not determine if changing teachers’ beliefs enables them to overcome the first-order barriers they may encounter. It lacks an understanding of how teacher beliefs interact with the contextual first order barriers of school culture to influence technology integration.

**Teacher Knowledge**

Teachers need technological pedagogical content knowledge (TPCK) to implement effective tech integration. Mishra and Koehler (2008) propose TPCK as a body of knowledge essential for teachers to have in order to attain the goal of technology integration. They view teachers as “an autonomous agent with the power to significantly
influence the appropriate (or inappropriate) integration of technology in teaching” (p3). They view TPCK as being content specific and define teachers as “curriculum designers” (p.3). Quantitative studies have shown that for in-service or pre-service teachers, taking a course on using the TPCK framework increases a teachers’ self-reported confidence about their ability to integrate technology effectively (Graham et al., 2009; Neiss, 2008; Tournaki and Lyublinskaya, 2014). Qualitative studies found similar results, that course work can improve teacher confidence with TPCK (Maeng et al, 2013; Neiss, 2005).

Research has shown that a methods course specific to content that focuses on developing TPCK in pre-service and in-service teachers is effective at improving their confidence about technology integration (Guzey and Roehrig, 2012; Niess, 2005; Rehmat and Bailey, 2014). This research is limited to an understanding of what these teachers claim to know or what they do during the course. It does not provide information on how these teachers apply TPCK once they are working within a school. It does not reveal how a variety of factors beyond content can interact with the newly acquired TPCK within the context of classroom or the context of a school.

Ertmer and Brantley-Dias (2013) have critiqued TPCK research. They describe the framework as too big and that most research has used surveys to measure teachers TPCK. They view survey results as not producing an accurate representation of participants TPCK. They suggest multiple observations of a teacher in order to provide more generalizability of a teachers’ TPCK and that there are other factors to be considered such as school and classroom cultures, and school and district policies. My
study addressed these issues and provided multiple observations of teachers as well as includes these other factors while paying attention to school, district and state policies.

**School Context**

Technology integration is a function of teachers interacting within a school context. Internationally researchers examine the impact of school context on technology integration. In Taiwan, Hsu and Kuan (2013) found that access to the technology, school support and school culture combine with teacher attributes to determine technology integration but differences between integration are mostly due to teacher attributes and less to school context. In Flanders, researchers found that school policies on ICT and teacher perceptions about those policies impact technology use (Tondeur, Valcke, and Van Braak, 2008). In Turkey, researchers qualitatively determined that school level issues of lack of access to computers and the attitude of principals had a negative impact on technology integration (Akbaba-Altur, 2006).

Due to the move toward the Common Core standards, the national context in which technology integration occurs is distinct. In the U.S., Inan and Lowther, (2010) found that school-level factors of availability of computers, technical support and overall support in combination with teacher belief had a positive influence on technology integration. O’Dwyer, Russel and Beber (2004) studied the school and district organizational characteristics that are related to the increased use of technology as both a teaching and learning tool in elementary schools. The school-level factors of availability of computers, technical support, and overall support positively influence teachers’ beliefs and teachers’ readiness. They were unable to distinguish between the impact of district policies and school level policies on teacher technology integration and acknowledge that
this process may be different in both middle schools and high schools. Zhao (2002) looked qualitatively at the contextual factors that impact technological innovations. The success of the innovations were dependant upon the interplay between the innovator (teachers) the innovation (the project) and the context (school). When the innovation was considered distant and more progressive than the school culture, the innovation was less likely to succeed. The study also identified human infrastructure as a factor that could inhibit the success of innovations and found that teachers required help from people to write grants, obtain materials and tech support. These finding reveal the impact of school level factors on teachers who innovate with technology. The international and national studies predominately used quantitative methods survey methods to identify the relationship between teacher attributes and school context. They are in agreement that school-level factors can impact technology integration. Overall these studies reveal interplay between the school context and teacher attributes that work in concert to impact technology integration at the classroom level. They maintain their focus on school context and do not look more broadly at district or state contexts. A deeper understanding of this interplay is required.

The field has tried to address issues of technology integration by addressing the teacher, course content and school context. It has not situated technology integration within the multiple broader contexts in which teachers function. It is important to understand how barriers, teacher belief and teacher knowledge function within multiple contexts beyond the classroom and school context.

The body of research that examines teacher beliefs and teacher knowledge stipulates that if teacher beliefs can be modified to more constructivist pedagogy, and
teachers receive training with TPCK, then effective technology integration will occur. The solution to the problem of teachers not having the correct belief or knowledge system is to provide in-service teachers with professional development and for pre-service teachers to have courses that train them how to integrate technology appropriately (Grahram et al, 2009; Guzey and Roehrig, 2012; Harris, 2008; Hew and Brush, 2007; Kopcha, 2010; Lawless and Pelligrino, 2007; Maeng et al, 2013; Neiss, 2005; Rehmat and Bailey, 2014). This approach reduces teachers to technicians. It focuses on the deficiencies of teachers and seeks to change them while ignoring the very real institutional constraints at the national, state, district, school and classroom level that teachers encounter on a daily basis. These multiple contextual elements influence the ways in which teachers can integrate technology. Technology integration may be more complex than current research describes.

O’Dwyer, Russel and Beber (2004) emphasize a need to change teacher beliefs but recognize that it is not the sole responsibility of teachers to increase technology integration. The research acknowledges that teachers face more first- order barriers to integration but seeks to modify teachers to align with an externally defined vision of technology integration (An and Reigeluth, 2011). Ultimately in the examination of school context and teachers, there is still a focus on changing the teachers to accommodate effective technology. The lack of technology integration ideal is the fault of the teachers regardless of the institutional limitations they encounter. The contextual component remains focused on the school level.

This research conforms to the cycle Cuban (1986) identifies in the history of new technologies in education. It “starts with exhilaration about the potential of the
technology, scientific studies that claimed the technology was as effective as a teacher, disappointment in the lack of impact and finally blaming teachers for the lack of use” (p. 7). Each new technological innovation claimed it would change teacher practice and improve student learning. None of the new technologies entering the classroom were a result of teachers demanding the new technology. Cuban sees the cycle as containing hype about technology, study of its impact, dismay at lack of results which culminates in teacher blaming. As a product of non-teachers trying to change teacher classroom practice. He describes teachers as having “situationally constrained choice” (p. 63). The ways in which teachers will incorporate any technology into their classroom is limited by the institutional constraints of separate subjects, a 50-minute period, tracking of students, high stakes standardized testing and access to the technology itself, all of which are first order contextual barriers. Historically, the advocates for any technology blamed teachers for lack of incorporating the technology into their classrooms. The current research on technology integration continues this tradition. Cuban (1986) explained that teacher were using technology less due to classroom and school limitations. The current research on technology integration conforms to the cycle as identified by Cuban. There is a need to examine how the situational constraints on teachers can impact the ways in which they integrate technology. Previous studies have entered classrooms with a working definition of effective technology integration and then tried to explain why this integration doesn’t happen by examining the barriers and the deficiencies of teachers. Instead of entering in a classroom with a preconceived notion of what constitutes effective technology integration, I studied how teachers made decisions about technology integration given the state, district, school and classroom context. I wanted to know how teachers responded to
the demands of these different contexts. This study allowed for a description of effective technology integration that is situated in practice, produced by teachers, and represents the complexity of technology integration.

There has been some acknowledgement of the impact of school and district policies on technology integration but this is an area in which more research is needed (O’Dwyer, Russel and Beber, 2004; Zhao, 2002). Teachers do not work in vacuums; they are part of an institution. An understanding of the interplay between state, district initiatives and polices on actual classroom technology use is necessary. This study provided an opportunity to understand how district initiatives and policies along with the current standardized testing environment, impacted the decisions teachers make about technology in their classrooms. It provided an in-depth, emic description of how teachers navigate that process.

None of the case studies of technology integration (Windschitl and Sahl, 2002; Grimes and Warchauer, 2008; Chou, Block and Jesness, 2012; Guzey and Roehrig, 2012) provide information about the ability level of the students. This is a classroom level contextual component that can impact how teachers use technology in their classrooms but has been ignored. Ability-level grouping impacted ways in which I choose to use technology with my prep level students who are 40% special education and 12% ELL students compared to my general level students where I have fewer students with individual education plans or IEPs and fewer ELL students. My study provided an opportunity to address this oversight by going in to tracked classrooms from AP, to honors, to general to prep-level classrooms and determine how ability grouping of students informed the way teachers implemented technology integration. It is an
important contextual component that current research has not addressed. It also allowed me an opportunity to observe how AP and honors teachers are using technology in their classrooms.

The research on technology integration is a conversation between researchers and teacher educators that problematizes teachers. It is research conducted on teachers not with teachers and not by teachers thus authentic teacher voice is marginalized. My study provided a space in which both myself and other teachers told their own technology integration story. In my study none of the teachers were given a choice to use iPads since the district has made the decision to provide them to all students and staff. This provided a unique opportunity to study how teachers make decisions regarding technology use when technology is imposed upon them. Case study and Self-study of teachers engaged in the process of technology integration contributes the missing teacher perspective to the current research.

**Self-Study**

Self-study or teacher inquiry is the process of teachers investigating their own practice. It is attributed to the work of Joseph Schwab as the humanization of educational inquiry for studying classrooms as a practical way of improving professional practice. (Clarke and Erickson, 2004). It involves a cycle of inquiry in which teachers question their practice, approach a problem, examine research and evidence to create solutions, which are then implemented and evaluated. The new insights gained through this process can be communicated with others. It proposes a view of teaching practice as evolution and can be a site for teachers to investigate themselves and their practice (Bullough and Pinnegar, 2001). It posits the teacher as active creator of knowledge and recognizes that
they are engaged in a process of decision making throughout their school day. (Clarke and Erickson, 2004). It has been proposed as a way of improving teacher education. It views personal experience as a source of answers to local questions of practice (Allender, 2005).

**Self-Study and Technology Integration**

Self-study on technology integration has been conducted with both pre-service and in-service teachers. Dawson and Dana (2007) employed teacher inquiry with pre-service teachers engaged in a practicum on technology integration and found that this methodology allowed pre-service teachers to reflect on their use of technology. It also led to conceptual change in the pre-service teachers, giving them an opportunity to understand their classroom context, review literature, and investigate their use of technology by collecting data, analyzing that data and sharing their work with other pre-service teachers.

In both China and New Zealand, teachers have used self-study to examine their own technology integration practices. In New Zealand, Sue Hodge (2007) used self-study as she incorporated an interactive whiteboard into her classroom. Li (2014) employed self-study as a method of investigating how to incorporate Information Communication Technology in college classes at the Beijing Institute of Fashion Technology. These studies allowed the educators to focus on their own process of technology integration and created a space for them to reflect on their pedagogical practice. Self-study provided an opportunity to move beyond just reflection and allow these educators to transform both their concepts of technology integration and the way they use it in their various classrooms. This is an invaluable process for them as educators.
In the U.S., Dawson (2012) studied in-service teachers involved in a statewide technology initiative by investigating how 353 teachers used technology while participating in action research. More of this type of research is needed since the U.S. has a unique national context as well as a variety of statewide contexts. This is research that prioritizes teacher perspectives and acknowledges that context is an integral part of technology integration. Self-study provides an opportunity to conduct research that has practical implications for both students and teachers. My study contributed to the emerging field of self-study on technology integration and enabled me to apply knowledge practically, as I was engaged in technology integration in my own classroom. It allowed for teacher voice to be prioritized, something previous research on technology integration has not done.

My Story

As an undergrad at the University of Illinois, I was introduced to constructivist pedagogy in a curriculum and instruction course. My teacher assistant suggested I read Teaching as Subversive Activity by Neil Postman and Charles Wiengartner, a book that introduced me to the field of media literacy, and the work of Marshall McLuhan. While student teaching I began to read as much of the work of Marshall McLuhan as I could get my hands on. To me this meant a focus on how media impacted how my students understood science. I began my teaching career in the fall of 1998 and taught physical science. This course covered chemistry, physics, earth science and astronomy. During the astronomy unit, a student informed me that we didn’t land on the moon. He believed this because he watched the program Fox Moon Hoax in History class. I was horrified that a fellow colleague would show students such a program without a critical consideration of
it’s content and a lack of knowledge of basic facts. From that moment on, I was
determined to find a way to incorporate media literacy into my science classroom. Early
in my teaching career I struggled with how to achieve this fusion.

In 2003, while wandering the Internet on a desktop computer in the teacher
workroom, I came across the answer. Appalachian State University in Boone, North
Carolina offered a master’s degree in Educational Media with a media literacy
concentration. I was hooked. This program allowed me to apply media literacy to science.
I created an elective course called Science and Society to closely examine how media
shapes our understanding of science. As long as I could align the course to the College
Readiness Standards and show how I was preparing students for the ACT, I had the
freedom to teach in a way that was meaningful to me and was aligned with constructivist
pedagogy and media literacy principles.

Once the district mandated the goal of increasing AP enrollment in 2006, my
school increased the number of AP courses it offered and my Science and Society
elective class expired. Again I had to struggle to find another avenue for applying media
literacy and constructivist pedagogy at a time when NCLB and my school district
increased the emphasis on test scores and test preparation. After completing my degree
in 2008, I began to present on media literacy to teachers and parents. I started to work on
issues regarding the ways students were using social media, concentrating specifically on
cyber bullying, and sexting. These were issues that could be addressed using media
literacy skills to help students become critical consumers and producers of media. I
created a course called Evaluating Internet Sources that I taught to teachers for the
district’s internal university. The focus on twenty-first century skills and the student
standards proposed by ITSE provided me with a rationale to administrators for the need to focus on these issues and allowed me to advocate for a media literacy perspective.

As iPads and cell phones infiltrated my classroom, I was continually faced with a dilemma as to how to use the technology in a way that speaks to my belief in helping students think critically about the media they devour and create. At the same time I am expected to raise students test score. At times these goals seem at odds with each other. This is a struggle I am currently engaged in. Self-study provided me an opportunity to work through this struggle.

**Theoretical Framework**

Two theoretical frameworks shape this study. The first framework applies an ecosystem metaphor to understanding how multiple contexts impact classroom technology use. Zhao and Frank (2003) proposed an ecological framework for analyzing technology use in schools. In this framework the schools is an ecosystem, computers and teachers are separate species and external innovations are invading species. This framework provides a way of understanding technology use in “a multilevel ecological hierarchy” (p.815). The framework outlines factors that influence technology use as the school ecosystem, teachers’ niche in the school ecosystem, the interaction between teachers and school, compatibility between teachers and technology and opportunities for teachers and technology to adapt or experience mutual adaptation. Another component of the metaphor is the process of reciprocal altruism, when teachers are helping each other achieve technology integration.

I modify this metaphor to describe the state context as the biosphere or the complete ecosystem since it was not part of the original metaphor. I chose to start my
metaphor at the state level I wanted to broaden the scope of the framework to examine more contexts. The district context represents a specific biome within the biosphere. The school context is a habitat that contains a community composed of administrators, teachers and students along with the abiotic or nonliving components of the habitat such as classes taught, technology infrastructure and physical space. Teachers occupy specific classroom niches within the habitat and interact with other teachers, administrators and student populations. In this study teachers’ niche within the school habitat is the subject taught and the ability level of the course. (ELL, general, prep, honors or AP). I modified the framework in this way because the original framework was employed in research on elementary schools and I applied it in a high school where teachers have distinct courses and ability levels. I incorporated the terms biosphere, biome after consulting my population ecology textbooks from my undergraduate work in science education.

Zhao and Frank (2003) describe the framework as focusing on “the vital role of local context in filtering external resources, opinions and innovations” (p. 831). This model views teacher use of technology as a function of relationships within the school ecosystem and acknowledges the outside political pressure entering the school ecosystem. Zhao and Frank’s (2003) original study of this framework included, surveys, interviews of administrators and only observed the technology infrastructure in multiple districts and schools (p.819). They did not conduct classroom observations of technology use. In their metaphor Zhao and Frank(2003) define teachers as a keystone species but students are described as a biotic or living component of the habitat. Since I conducted classroom observations, I considered students a keystone species as well. I extended the metaphor to describe barriers to technology integration as limiting factors. A limiting
factor is an environmental resource that is “far below optimum” for an organism to function (Starr & Taggart, 1992, p. 791). Limiting my focus to one state, one district and one school with classroom observations of teachers in a qualitative case study provided an understanding of how the ecosystem metaphor applied to teacher technology use.

The second framework is Technological Pedagogical Content Knowledge (TPCK). TPCK is an expansion of Pedagogical Content Knowledge (PCK) as proposed by Lee Shulman. Shulman (1987) describes PCK as “the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized represented and adapted to the diverse interests and abilities of learners and presented for instruction” (p.8). TPCK is a framework that addresses what teachers need to know to integrate technology. The framework also posits the teacher as having the autonomy to design curriculum. Mishra and Koehler see technology integration efforts as context-dependent and propose that technology integration be tailored to specific content and classroom contexts (2008). This framework proposes that teachers need a variety of types of knowledge, content knowledge (CK), pedagogical knowledge (PK), pedagogical content knowledge (PCK), technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK), and finally technological pedagogical content knowledge (TPCK). Content knowledge (CK) is knowledge about subject matter. Pedagogical knowledge (PK) is knowledge about techniques and methods of instruction and assessment. Pedagogical content knowledge (PCK) is knowledge that is applied when the teacher is able to transform their subject matter to meet the needs of their students. Technological knowledge (TK) is when a teacher has a broad understanding of technology and knows when and what technologies
will enable them to provide their students with an understanding of their specific subject matter. TCK is when a teacher has an ability to see when the technology and content interact and TPK knows how teaching and learning is changed by the use of specific technologies. TPCK is described as knowledge that is obtained through the interplay of content, pedagogy and technology which Mishra and Koehler maintain is necessary for effective teaching with technology (2008). This is a complex but cumbersome framework with many moving pieces. Cox and Graham (2009) have further refined it and proposed an elaborated model of the TPCK framework. They define PK as a teacher’s knowledge of pedagogical activities that could be used, CK as a knowledge of the possible subject specific representations, PCK as the knowledge of both strategies and representations in a specific content, TK as knowledge about emerging technologies, TPK as knowledge of pedagogical activities with emerging technologies, TCK as knowledge of topic-specific representations with emerging technologies and TPCK as knowledge of how to align content-specific activities with representations using emerging technology to enable students to learn content (p.64). It is this elaborated model that I will be using in this study since it further clarifies the constructs of TPCK. The iPad in this elaborated framework may be considered an emerging technology. Cox and Graham (2009) suggest that these new definitions be used in case study with in-service teachers. This research provided exactly what these researchers called for and can contribute to understanding how teachers use technology, specifically iPads. Brantley-Dias and Ertmer (2013) have suggested a need for using TPCK “to facilitate technology-enabled subject-specific teaching and learning” since they view a lack of this type of research in the field (p.115). They state that “we are still missing a thorough description of what TPCK or its
components look like in action” (p.116). This research provided this description and is specific to the subject of science.

Combined these frameworks provided an understanding of how TPCK functions within an environment. I consider TPCK as part of the teacher niche. The TPCK teachers use was studied to determine how it interacts with the state, district and school ecosystem. These frameworks applied to the self-study since I have a specific teacher niche as the only teacher for prep physical science class and I examined how my TPCK functioned within my niche and within the broader school habitat and district biome.
CHAPTER 3

METHODOLOGY

This study attempted to identify how the state biosphere, district biome, school habitat and classroom niches impacted how teachers made decisions about technology integration. It provided an in-depth emic examination of how a teachers’ TPCK functioned within a specific classroom niches. It is also enabled me to reflect on my own classroom technology integration efforts

Research Questions

1. How do teachers navigate a variety of contexts when making decisions about how to integrate technology in their instructional practices?
   A) How are teachers integrating technology in their classrooms?
   B) How do the state, district, school, and classroom contexts impact teacher decisions about technology integration?
   C) How does a teacher’s knowledge (TPCK) inform and shape their technology practices and decisions?

2. How do I navigate a variety of contexts when making decision about how to integrate technology in my instructional practice?
   A) How do I integrate technology in my classroom?
   B) How do the state, district, school, and classroom contexts impact my decisions about technology integration?
C) How does my knowledge (TPCK) inform and shape my technology practices and decisions?

3. How does the process of studying technology integration practices of other teachers influence my own classroom decisions about technology integration?

This study was conducted using a qualitative, multi-case study and self-study approach. Case studies of technology integration are typically conducted by outside educational researchers not by teachers. All of cases, myself included provided an emic view on teachers engaged in the process of technology integration that prior research lacks. My role of a participant researcher enabled me to provide an in-depth look into how teachers apply their technological pedagogical content knowledge in multiple contexts. Case study is appropriate when “a how or why question is being asked about a contemporary set of events” (Yin, 2014). Case study allows for the description of “an intervention and the real-world context in which it occurred” (p.19). Technology integration is currently happening in schools across the country and this study contributes to furthering an understanding of how teachers navigate this activity within a variety of contexts. A qualitative approach can provide an understanding of the “complex interrelationships” (Stake, 1995) and place an emphasis on “contexts as important to understanding” (p.39). Using case study to examine the multiple contextual variables in technology integration is appropriate.

Self-study is a practical approach that allowed me to take what I observe in other classrooms and apply it to my own classroom. Bullough and Pinnegar (2001) describe
quality self-study as attending to context. This process helped me to grow as a teacher and provided me insight into how my classroom niche impacted how I decided to use technology with the two students populations that I work with (general level and prep). It allowed me to investigate how my TPCK functions within my teacher niche. LaBoskey (2004) describes the purpose of self-study as research that it is aimed at improvement (p.820). I worked through the conflict between my constructivist, media literacy background and the state, district and school policies that are imposed on me. It was chance for me to reflect critically on how I navigate the process of technology integration. Observing how other teachers decide to use technology in classroom contexts that differ from my own enabled to me reflect on how I adjusted practices for my specific classroom context. Authentic teacher voice is marginalized in technology integration research and a self-study approach pays “attention to insider and marginalized voices “(LaBoskey,2004 p. 831). Self-study encouraged me to reflect on my classroom practice, focus on personal conflicts between theory and practice while seeking to improve my use of technology.

**District Biome**

The district is located in a suburb of a large Midwestern city and is comprised of six high schools. In 2014, the total enrollment was 12,000 students. The district commits to investing in technology. In 2006, LCD projectors were provided to classrooms in all of the schools and for the past five years, it has implemented a 1 to 1 iPad deployment. This started in 2010 with allowing teachers to submit proposals to participate in a 1 to 1 iPad pilot program. The first year there were nine proposals for 1 to 1 iPad pilots that included 350 students district wide. Steadily over time the number of proposals created by teachers
increased and by the 2014-15 school year, there were 57 proposals for 1 to 1 iPad pilots with 75% of students in the district participating. Technology support is provided at every school. Each building has a full time Innovative Technology Facilitator (ITF) and a division technology coach. The division coach is a classroom teacher who is available to provide support for teachers as they use iPads in their classrooms (Keith Bockwald PowerPoint presentation, 4/23/15).

The district provides teachers with professional development through internal university courses, which can count toward professional growth hours and toward recertification. There are two courses available, Teaching with the iPad 1 and Teaching in a digital classroom 2. These courses are taken in sequence. By the 2014-15 school year, of the 850 teachers on staff, only 50 people have not taken the course.

In 2006 the district mandated instructional goals to all of the six high schools within its purview.

1. Each No Child Left Behind (NCLB) sub-groups average Educational Planning and Assessment System (EPAS) growth will surpass that of the previous cohort by 10% annually in reading, English, math and science until growth from Explore to ACT exceeds six points.

2. Increase student success rate (as measured by a grade of A, B, C) per course by at least five percentile points each year until the threshold of 95% is attained.

3. The number of students enrolled in at least one AP course will increase over the previous year as will the number of students taking at least one AP exam and the number of students earning a passing score on an AP exam until at least 50% of
all students have earned a score of three or higher on an AP final. (www.d214.org/about-district-214/district-goals/)

When teachers set their yearly goals for evaluation, they have to address these district goals. The district implemented Professional Learning Communities (PLCs) in 2006. Every Thursday morning the PLCs meet and originally were directed to develop their own goals that aligned to the district goals.

**School Habitat**

The study was conducted in a large suburban high school situated in a middle-income residential community. In the 2014-2015 school year enrollment was 2,149 students. The school investment in making technology available to teachers began in 2008 by giving teachers their own laptop computer. In addition to a laptop, teachers have access to four mobile laptop carts and six computer labs. The school could be considered technology rich.

There is a great deal of technology available for teachers to use in the science department. AP biology, chemistry, and physics teachers use computer-based labs (CBL) that allowed for the use of Vernier lab pros with probe ware to collect data and laptops to graph the data. I used this technology with my physical science students. In the 2012-2013 school year I participated in an i-Pad pilot program that provided 7 i-Pads to chemistry teachers. That same year the school purchased fifteen Vernier lab quests 2 (probe ware was already in use) because of their compatibility with iPads. That school year, however our PLC time was dedicated to focusing on standardized test preparation as required by the division head. When I asked for PLC time for chemistry teachers to discuss how we could use iPads and to learn how to use the Vernier lab quests, I was
denied. General chemistry teachers rarely used these iPads since a full class set of 15 was not available and the iPads were kept locked in a room. Only the division head had a key.

In 2013-2014, teachers proposed an iPad pilot for all sophomores. It was approved and in the 2014-2015 school year, all of the sophomores in Chemistry received iPads. These iPads had the graphical analysis app that was compatible with the Vernier lab quests previously purchased. Across the school, only 300 students did not have iPads. For the 2015-2016 school year the whole school participated in a 1 to 1 iPad deployment. During this time there has been a decrease in the number of computer labs available to teachers.

Participants

In January 2016, at the beginning of second semester, I emailed all of the science teachers in my division looking for participants (See Appendix A for recruitment email). I received positive responses from four colleagues. There were two male and two female volunteers. I met each volunteer individually to sign the consent forms. The volunteers produced four case studies that reflect a variety of experience with the one to one iPad pilot and a variety of classroom contexts. One male teacher has used the iPads for three years in an honors and AP classroom. The other male teacher was in his first year of the 1 to 1 iPad deployment in a prep and AP classroom. One female teacher was in her first year of using the iPad in an ELL general classroom. The second female teacher was in her second year of 1 to 1 in an ELL general classroom. I participated in the self-study as I entered my second year of a 1 to 1 iPad classroom and used it with my general and prep level classes.
Data Collection

Three of the four teachers were observed five times during the third quarter of the 2015-16 school year using an observation protocol (see Appendix B). One teacher was observed three times. The observation protocol is a TPCK based technology integration observation instrument created by Judi Harris, Neal Grandegenett and Mark Hofer that is licensed through creative commons and made available on-line (at http://activitytypes.wm.edu/Assessments). This observation instrument has been pilot tested and shown as valid and reliable. The authors of this instrument designed it to assess observed evidence of TPCK during classroom instruction either from direct observation or video-recorded observation. It was pilot tested by the authors in four middle school and high school classrooms and then revised. After the revision twelve teachers and teacher educators tested the reliability of the instrument by using it to assess six pre-service and six in-service teachers. Using statistical analysis they found that “the results of the reliability testing across the eleven judges using ICC calculations, percent agreement computations and the Cronbach’s Alpha measure we conclude that this observation instrument has comparatively strong reliability” (Hofer et al., 2011, p.4356). The authors examined the validity of the instrument by having it reviewed by seven experts in educational technology to determine how well TPK, TCK and TPCK were represented in the rubric and to suggest changes if needed. They also made the rubric and scoring guide available on line and suggest it be used in conjunction with interviews and document to provide a comprehensive understanding of technology integration. This observation instrument was created to focus on specific curriculum based technology
integration and focuses on the “use of technology integration knowledge in observable teaching” (p. 5). According to Brantley-Dias & Ertmer, (2013) “no studies to date published in a peer reviewed journal that have used this instrument” (p.117). This observation instrument allowed me to observe TPCK in a specific classroom context and was triangulated with other data as suggested by its creators.

After the first observation, each teacher was interviewed using an interview protocol in a semi-structured format. I asked specific questions about what was observed (see Appendix C). Interviews were conducted in empty classrooms before, during and after the school day. During these interviews I inquired about when I could make another observation when teachers are using iPads or attempting to try something new with technology. Teachers were able to suggest other days I could observe their use of technology. This process had one draw back in that teachers could attempt to showcase their best foot forward. Inquiring about an opportunity to observe them trying a new use of the iPad may have alleviated this. Being a participant observer and a colleague of the teachers helped reduce teacher concerns since I was not in a position to evaluate their technology integration but simply seeking to understand their decision making process. The consent form indicated that the data collected would not be used for evaluative purposes.

I remained open to informal interviews opportunities as they presented themselves in the teacher work- space, during hall duty, during passing periods and before school. This was another advantage of being a participant observer. I know the teachers who participated and I had opportunities to interact with them as part of the regular school day. Informal interviews can provide teachers an opportunity to reflect on their own use
of technology, make changes to their practice and allow me to watch that process as it unfolds in their classrooms. Yin (2014) describes an advantage of the research as participant observer as providing “the ability to perceive reality from the viewpoint of someone inside a case” (p117). Another advantage is that as participant observer and as a colleague of the teachers participating there is a level of trust and teachers may have felt more willing to confide in me since we are “in the trenches” together. One of the benefits of the participant/observer stance was that it enabled me to frequently member check with participants on what I had observed in their classrooms or what I had heard in the interviews. I found throughout my observations that my identity as a teacher was always primary and that of a researcher secondary. This could also be a potential source bias as well since it means I was wary of teachers wanting to vent their frustrations about barriers to technology integration. One downside to this position is that “the participant observer may not have sufficient time to take notes or to raise questions about events from different perspectives as a good observer might” (p.117).

Another source of data was my research journal. I started journaling about my own technology use in the second semester of 2014-2015 and continued into the 2015/16 school year. I documented on my own use of technology with my prep and general students. Once I began observing teachers, I documented how my observation of other teachers translated into my classroom practice. I recorded my informal interviews with participants in this journal as well. I collected documents from the state and district websites. I collected emails from the district biome and building habitat.
Data Analysis

Documents were analyzed using content analysis to distinguish between the state biosphere, district biome and building habitat. These documents were also open coded using the categories of assessment, time, and access to resources.

Both theoretical frameworks provided me with categories for categorical aggregation. TPCK framework as elaborated by Cox and Graham (2009) was used to analyze what types of knowledge teachers employed within their classrooms. Cox and Graham define the terms of Technological Knowledge (TK) as how to use emerging technology, Technological Content Knowledge (TCK) as knowledge of topic specific representations using emerging technology, Technological Pedagogical Knowledge (TPK) as knowledge of general pedagogical activities that using emerging technology and technological pedagogical content knowledge (TPCK) as knowledge of how to use subject specific activities or topic specific activities with topic specific representations that use emerging technology to facilitate student learning. The use of TPCK as a framework provided me with a way to analyze data and define categories for categorical aggregation. Observations interview transcripts and my research journal were coded as TCK, TPK, TK and TPCK as categories. The rubric from observation protocol also helped to categorize the observations using the same codes (See Appendix B). It was designed to directly observe TPK, TCK and TPCK (Hofer et al., 2011). Each observation was scored using the rubric. A score of 3 or 4 on the fit section of the rubric indicated that the teacher was displaying TPCK. A score of 3 or 4 on the technology logistics section revealed TK. A score of 3 or 4 on the instructional strategies and technology section
indicated TPK and a score of 3 or 4 on the curriculum goals and technology section indicated TCK.

The ecological framework was applied to data analysis and provided codes for the categories of reciprocal altruism and mutual adaptation. Interniche interactions and intraniche interactions were also categories that I derived from my modification of the ecological framework. These codes were applied to interview transcripts, classroom observations and my research journal entries.

Two themes emerged from data analysis; Student Technological Knowledge (STK) and Technology Enhanced Technology Integration (TETI). One theme that emerged from my research journal was that of social capital.

In addition to categorical aggregation I employed direct interpretation on my research journal. I created TK cycle diagram to determine the impact of the state biosphere, district biome, building habitat on my own technology integration. The diagrams allowed me to show when STK and interniche or intraniche interactions impacted my technology integration as well.

From each case I created a case descriptions of what I observed and what I did in my own classroom. After writing the descriptions I then created a case diagram that illustrated the categories, identified the multiple classroom niches in which each category occurred, and the impact of district biome, and building habitat on technology use. These diagrams were then used to perform cross case analysis to determine which categories were most prevalent along with similarities and differences between the cases. Cross case analysis of the case diagrams helped me identify patterns in how the district biosphere, building habitat and classroom niche impacted participants.
Validity

Using the Cox and Graham’s elaborated model of TPCK ensures construct validity since this model provides a clear operationalization of the terms to be used in both data collection and data analysis. This study has external validity through the use of analytic generalization. “Analytic generalizations can use a case study’s findings to implicate new situations” (Yin, 2014, p.42). This research can provide insight to other schools; administrators, teachers etc. who are trying to help teachers effectively integrate technology in their classrooms. Methodological Triangulation was used to provide construct and internal validity. I collected data from classroom observations, semi-structured and informal interviews, and my own research journal. This provided multiple sources of evidence of emergent themes as well as themes explicated in the TPCK and ecological framework. I was able to member check with participants often after interviews as another way of providing internal validity. Informal interviews with the participants occurred frequently during data analysis to clarify interview transcriptions and observation data. I recorded these interactions in my research journal.

I practiced reflexivity during observations and was able to identify when during classroom observations my identity as a teacher was primary and as a researcher was secondary. If a student asked me for help during a classroom observation to access a website or set up a lab I provided it. I wrote about my positionality in my research journal often. During observations I refrained from disciplining students who were off task or distracted by technology. I was aware of my personal conflict of teacher vs. researcher. My research journal was where I could explore this conflict. I employed “rich thick descriptions” in my case descriptions and in my research journal (Merriam, 2009, p.227).
In self-study, validity is redefined as trustworthiness (Pinnegar, 1998). In order to achieve trustworthiness I provided details of context and triangulated data. Observations of my colleagues produced multiple perspectives on technology integration. Pinnegar (1998) suggests being explicit about how the research was conducted. Employing document analysis to describe the state bioshpere and district biome and defining the specific and multiple niches inhabited by the participants I followed the suggestion of Bullough and Pinnegar (2001) of attending to context. They also suggest that authority can be determined by providing sufficient evidence. I attempted to provide sufficient evidence through having four participants and keeping a research journal from the spring of 2015 to the spring of 2016. I utilized transparency by making my practice of technology integration explicit to myself (Mokhe, 2014). In my research journal I wrote daily about how I integrated technology in my classroom. I wrote entries after a class, before school, during my lunch period and free periods. I also wrote about my experiences while observing other teachers and conversations from informal interviews.

**Limitations**

One of the limitations of the study is that the teachers who participated are in the same district and school context. It is also limited to science teachers. All of the teachers who volunteered to participate in this study were tenured. They ranged from 31 years of experience to 11 years of experience. This study does not include the experience of a young non-tenured teacher.

Another limitation is that this research was conducted in a district and school that has abundant technological resources. Districts or schools with fewer technological resources may not be able to generalize to their contexts from this research.
My position as a practitioner researcher could be a limitation as well. I was engaged in the process of technology integration and I knew my colleagues well. Merriam (2009) describes this role as being marginal and hard to maintain. During observations I found this to be true. The use of TPCK as a framework could be another limitation. Brantley-Dias and Ertmer (2013) propose that TPCK may be too unwieldy and ignore other variables that effect technology integration.
CHAPTER 4
CASE STUDY RESULTS

Overview of Study

The purpose of the case study was to investigate how the state biosphere, district biome, building habitat and classroom niche impacted science teachers’ technology integration process and to produce a rich thick description of teachers engaged in that process. I wanted to determine how the building, district and state contexts either encouraged or discouraged teacher use of technology within the classroom. It was an opportunity to observe how a teacher’s Technological Pedagogical Content Knowledge (TPCK) functions within the state biosphere, the district biome, the school habitat and the classroom niche. As more districts move towards a one to one technology initiative, it is essential to understand how multiple contexts facilitate or hinder technology integration. The emic perspective of a teachers involved in technology integration can reveal new insights about how teachers navigate multiple contextual variables as they work to integrate technology in their classrooms.

Research Questions

1. How do teachers navigate a variety of contexts when making decisions about how to integrate technology in their instructional practices?
A) How are teachers integrating technology in their classrooms?

B) How do the state, district, school, and classroom contexts impact teacher decisions about technology integration?

C) How does a teacher’s knowledge (TPCK) inform and shape their technology practices and decisions?

Data was analyzed using Cox and Grahams’ Elaborated TPCK Framework (2009) to describe teacher knowledge on display when using technology in their classes. Zhou and Frank’s (2003) ecological metaphor for technology integration was also employed to describe how the state, district and school context or ecosystem impacted teacher technology use. This metaphor describes schools as ecosystems and teachers as a keystone species who occupy specific niches within the school ecosystem. I extend this metaphor and view the state as the biosphere in which the district constitutes a biome and the school as a habitat. The classroom in which teachers and student populations interact is a niche. Teachers and students are considered different keystone species that occupy the same niche of the classroom. I define a niche as a specific course taught. Each ability level grouping of the same course represents a different niche. For example an Honors Biology class is a distinct niche from a General Biology class. I use the term intraniche interactions when teachers in the same ability level and same course were able to work together on technology integration. Three Honors Biology teachers discussing their use of the website Schoology would constitute an intraniche interaction. AP Physical Science teachers discussing technology integration in a PLC meeting would also be an intraniche
interaction. I use the term interniche interactions to describe when teachers in different ability levels or different courses worked together on technology integration. For example, a math teacher and a science teacher discussing technology integration in the teacher workspace would be an interniche interaction. An Honors Chemistry teacher working with a General Chemistry teacher would also be an interniche interaction due to the different ability levels. Teachers and students are distinct species who interact in the classroom niche.

**Results**

**The Ecosystem**

The state represents the whole biosphere or the “entire realm in which organisms exist” (Starr and Taggart, 1992). The district represents the biome or a subdivision of the biosphere and provides resources to the species within it. The building represents the habitat, the place where species live. Administrators, teachers and students are populations of different species that compose the community. The classroom functions as the niche within the habitat and is inhabited by teachers and students.

**State Biosphere**

By analyzing documents provided by ISBE through their website, an understanding of the state context as the biosphere emerged. The State of Illinois passed the Performance Evaluation Reform Act (PERA) in January 2010. This bill requires that performance evaluations of administrators and teachers include data and indicators of student growth. This bill does not specify what data or indicators of student growth should be used in evaluations. Illinois Administrative code 50 outlines how school districts can implement a performance evaluation plan for teachers. It delineates that
student growth account for 25% of a teacher’s performance evaluation. In addition it
details that there are three types of assessment to be used. It requires one type I, or type II
along with one type III assessment. A type I assessment is defined as “a reliable
assessment that measure a certain group or subset of students in the same manner with
the same potential assessment items and is scored by a non-district entity” The SAT and
AP exams and the ACT’s EPAS are examples of a type I assessment. Type II assessment
is defined as an assessment that is created, adopted and approved by the school district,
used district wide by all teachers in a specific grade, course or subject area. Type III
assessment is an assessment that is “aligned to the course curriculum that a qualified
evaluator and teacher determine measures student learning in that course”. Senate Bill 7
was signed into law in April of 2011 and stipulates standards by which the State
Superintendent can take action against a teacher for incompetency, how teachers acquire
tenure, reduction in force, the dismissal of tenured teachers, the process of collective
bargaining and the right to strike. (http://www.isbe.state.il.us/PERA/default.htm) In
March of 2014 the State of Illinois adopted the Next Generation Science Standards
(NGSS). (http://www.isbe.state.il.us/nils/science/default.htm). According to this website,
the PARCC test for the NGSS for life sciences for sophomores was scheduled to be
administered in the spring of 2016. This assessment was administered to freshman in
their life science classes (Personal communication, May 11, 2016). As of this writing the
State of Illinois does not have budget and it is unclear how this will impact state
standardized testing.

The state biosphere impacts teacher technology integration in the building habitat
by requiring teachers to align their curriculum towards testing. This evident in the
directive given to science teachers by the Division Head that PLC time was to be spent aligning curriculum to the NGSS to prepare students for the PARCC testing in the spring of 2016 (written journal, August 27, 2015). The state biosphere contains the barrier of assessment to technology integration (Hew and Brush, 2007; An and Reigluth, 2011). The pressure of high stakes testing “can be a major barrier to technology integration” (Hew and Brush, p. 230). An and Reigluth (2011) found that teachers identified assessment as a barrier to technology integration since teachers “focus on preparing students for high stakes tests” (p. 61). Assessment is a limiting factor that exists at state biosphere level through PERA and Administrative code 50. The impact of this limiting factor will be discussed more specifically in the case study and self-study results.

On July 11th, 2016 the Illinois State Board of Education announced that the PARCC test would be replaced by the SAT test for all high school students. (http://www.isbe.net/news/2016/july11.htm) This means that moving forward the state biosphere will shift from focusing on aligning to the NGSS to aligning to the SAT. This change does not remove the barrier of assessment. As the state context continues to shift it will impact the ways in which teachers at the school level integrate technology. Teacher technology integration adapts to the changing assessment conditions in the state biosphere. It limits the resource of time available to teachers in their building habitats by restricting time in PLC to focus on alignment to NGSS standards. Time and assessment are limiting factors to the teacher species.

**District Biome**

I divided district context into four parts based on document analysis of emails and the district website. The first is the recognition the school district receives for it’s
technology program as disseminated by the district through emails to staff and as stated on the district’s website. The second category is infrastructure and access. The third category is time. The fourth is assessment. These categories combine to create a district biome that is supportive of technology integration despite assessment being a limiting factor at this level.

In February of 2016 the superintendent sent out an email to all staff informing them that the district had been recognized by the White House as part of the President’s Computer Science for All initiative due to incorporating coding into math classes (D. Schuler, personal communication, Feb 1, 2016). The district was ranked second in the nation in the 2012 Digital School District Survey. In 2010, the district received the National School Board Associations Salute Trailblazer Award and was named a Technology Leadership Network Salute District. In 2015 the district was recognized as an Apple Distinguished Program for 2015-2017 for its one to one mobile device program. It was also named a Top 10 District by the Learning Counsel. The district website does not explain how the district was selected for these honors or what the criteria for selection was. Despite this lack of information, these awards taken together signify the district’s commitment to technology integration.

The district biome supports technology integration by providing teachers access to a wide array of technologies for classroom and personal use. The district provides each teacher with a laptop and an I-pad. Access is enhanced by the districts’ next generation fiber optic network which is a new network that “provides higher levels of bandwidth and flexibility that allows us to support teaching and learning in a digitally connected world.” (K. Bockwodlt, personal communication, February 8, 2016) The district
purchased Noteability and Puffin apps for students and teachers. Noteability is an app that allows teachers to incorporate videos, and drawings into lectures and enables students to take notes directly on their ipads. The Puffin app allows for websites that use adobe flash animation to function on the ipad. Teachers were also provided with the Casper focus app. Casper focus allows teachers to lock students into a specific app to reduce student distractions. (R.Collins, personal communication, April 4, 2016). This district biosphere support breaks down the 1st order barrier of access to technology and provides an infrastructure conducive to technology integration. Ertmer (1999) identifies access as a 1st order barrier and main resource constraint that inhibits technology integration. The district biome creates an environment in which teachers have access to resources of both hardware and software which can facilitate technology integration. This is consistent with studies that found that availability of technology has a positive impact on technology integration (Inan and Lowther, 2010; O’Dwyer, Russel and Beber, 2004).

Yet another level of district support is that of providing funds through an Innovation in Teaching and Learning Grant made available to teachers for the past two school years. While not technology specific, it is an opportunity for teachers to submit a grant proposal. The award is $2,500. (M.Zipp, personal communication, September 4, 2015). Teachers can use the grant money to purchase apps.

The district provides teachers with paid time to focus on technology education through spring and summer workshops and an institute day in April. Through negotiation with the Education Association, the district provides a total of $100,000 to be shared by all the schools for school year workshops “to work on digital conversion of curriculum and technological innovations for use in your classroom” (T. Waters, personal
communication, February 3, 2016). The requirement is that these workshops occur after the completion of the school day or on weekends in teams of two or more teachers. Teachers submit proposals for their workshops to the building Associate Principal for Instruction. The spring workshop time was limited to only two years. (D. Seemann, personal communication, May 31, 2016). This means in the 2016-17 school year there will be less time for teachers to work toward technology integration. Teachers can also propose summer workshop time to the building Associate Principle for Instruction. Summer workshop time alone may be inadequate for teachers to achieve technology integration.

The April Institute day is a result of contract negotiations between the Education Association and the district. The current contract requires one institute day a year that focuses on “technological innovation and digital conversion of curriculum” (T. Waters, personal communication, March 3, 2016). Spring and Summer Workshop time in addition to the April institute day provided teachers with time to develop their Technology Knowledge or TK. It allows time for intraniche and interniche interactions to enhance technology integration. However, the elimination of the spring workshop time restricts teachers’ ability to continue to develop TK through those interactions.

While awards and recognition do not have a direct impact on teacher classroom technology use they do signify a district context that supports technology integration. The district level supports that have a positive impact on teacher technology use are the fiber optic network, providing teachers access to technological tools (apps, laptops, I-pads) and grant money for teacher innovation. Workshops and Institute days provide time for teachers to engage in interniche or intraniche interactions around issues of technology
integration. This is time in which teachers can engage in reciprocal altruism by sharing their knowledge and skills about technology integration efforts with other teachers. These facets provide a supportive district context that knocks down the 1st order barriers that teachers face of access and time (Ertmer, 1999). Ely (1999) identifies resources and paid time as conditions that facilitate technological innovations. The RIPPLES model also identifies elements that support instructional technology integration. The components of the model are resources, infrastructure, people, policies, learning evaluation and support (Surry, Ensminger, Haab, 2005). According to this model the district context provides resources and infrastructure. Here the district biome supports technology integration by providing access and paid time to teachers. These are environmental resources that facilitate technology integration.

The impact of the state biosphere on the district biome is revealed in the District’s plan to incorporate student data in the evaluation process. The education association in agreement with the Administration will use the overall percentage of students who graduate within five years (type III assessment) and the number of AP/dual credit courses completed annually, AP scores of 3 or higher, composite growth on explore to ACT with the subgroups of Hispanic, IEP students, at-risk students and low income students (K. Lasko, personal communication, December 17, 2015). As teachers are faced with pressure to improve student performance on assessments there is less time to focus on technology integration or technology may be harnessed to improve student achievement on assessments. While the district biome is supportive, the imposition of the state biosphere can detract from the time and energy teachers have to engage in technology integration. The assessment context may limit the ways in which the technology is
integrated into the classroom by using it to increase student performance on standardized tests. Assessment is a limiting factor to technology integration at the district biome level.

**Building Habitat**

The building habitat was revealed through document analysis of emails and websites and from my research journal. Emergent themes of this analysis were technology support, weekly Professional Learning Community (PLC) meetings, and the arrangement of physical space in the teacher workspace in the Math/Science Division. These factors combine to both support technology integration and in some cases inhibit technology integration.

Technology support is provided through the Innovative Technology Facilitator (ITF) and a tech help desk located in the school library staffed by Educational Support Personnel (ESP). The ITF at the school sends out emails to all the teachers informing them of when he will hold mini classes to help them incorporate technology. Each mini class focuses on a specific way teachers can use technology in their classrooms such as creating YouTube videos or showing how the Casper focus app works. The ITF makes himself available to work one on one with teachers and is available to attend PLC meetings when teachers request it. He also maintains a schoology page that teachers can access that provides information on using Google drive, Google forms, notability, SAMR, creating a schoology page, ibooks, Socrative, and Kahoot (J.Vlk, personal communication, February 5, 2016). The building habitat contains Ely’s (1999) condition of resources in the form of the ITF who then shares his TK with teachers.

Teachers can call down to the tech help desk or stop to the library for help as issues with technology arise. They also provide tech support to students as well. The
ESPss can address a wide range of technological issues that occur regularly in a classroom either with the LCD-projector and Apple TV, a student’s I-pad or issues with a teachers’ laptop. The ITF and the tech help desk combine to create a building context that provides timely tech support for teachers and students, as well as opportunities for teachers to gain Technological Knowledge (TK). Here the building habitat reveals one of the components of support as identified by the RIPPLES model (Surry, Ensminger, and Haab, 2005). The building habitat provides tech support to teachers and students. This support is essential to technology integration (Inan and Lowther, 2010; O’Dwyer, Russel and Beber, 2004; Hernandez-Ramos, 2005).

In the beginning of the 2015/2016 school years, teachers were assigned their PLC membership and goals by the Math/Science Division Head. The Science PLCs were all directed to create common assessments and examine the Next Generation Science Standards (NGSS). They were tasked with the goal of determining if they were covering these new standards and creating common assessments. The Math/Science Division Head assigns teachers’ PLC membership and delineates the goals. (written journal, August 27, 2015) Teachers do not have the autonomy to create their own goals or determine membership for their PLCs. Thus PLC membership and PLC goals are a function of the building habitat, which in turn are a function of the state biosphere due to the State’s adoption of the NGSS. The state biosphere impacts the school habitat by limiting teachers’ ability to use PLC time to focus on technology integration. Teachers are constrained by multiple contextual variables that limit their ability to integrate technology. The building habitat reveals what Larry Cuban (2001) calls “contextually constrained choice”. The state political context places emphasis on standardized
assessment being part of the teacher evaluation process thus limiting the autonomy of teachers in technology integration process. The barrier of assessment (Hew and Brush, 2007; An and Reigluth, 2011) hinders the ability of teachers to have interniche or intraniche interactions about technology integration in their PLC meetings. Time is a limiting factor in the building habitat.

In 2014 there was construction at the school and the Math Science Division teacher workspace was altered. The physical space where the teacher’s desks are located contributes to intraniche and interniche interactions due to the open office space where teachers’ desks are located. The desks are arranged in quads with two desks that face another set of two desks. There are thirty desks arranged in an L shape with ten desks and then another twenty. Math teachers’ desks are clustered near each other. Science teacher desks are grouped by content with Biology, Chemistry and Physics teachers all facing each other. Using the Zhao and Frank ecological metaphor, the teacher workspace is an abiotic or nonliving component of the building habitat that teachers function within (2003). This habitat creates opportunities for both intraniche and interniche interactions to occur. Two of the cases recounted instances of discussing technology integration with math teachers in this space. Carrie describes this process of “hearing people out” as occurring in the space (Personal Communication, January 22, 2016). For Ann the space allowed her to discuss with a math teacher about using google quizzes (personal communication, January 23, 2016).

Case Studies

Four case studies provide a glimpse into how individual teachers integrate technology in their classroom niches. They reveal the student/teacher and teacher/teacher
species interaction as these populations interact with in the classroom niche while using technology. It is an opportunity to discover how a teacher’s TPCK functions within the classroom niche.

**Jeff**

Currently Jeff teaches AP Physical Science and Prep Physical Science, both courses for Juniors. He has been at the school for 13 years. He is a member of the Physics PLC. The Prep Physical Science course is co-taught. This means that Jeff works with a special education teacher. Jeff teaches one class of Prep Physical Science with the co-teacher. The other section has the same co-teacher but a different content teacher. He teaches three classes of AP Physical Science. The special education co-teacher is not a member of the Physics PLC. In addition to teaching Jeff also sponsors Student government and Science Academic contests. His duties as the Student Government sponsor require him to meet with students throughout the school week and attend functions sponsored by the Student Council. As the Science contest sponsor he meets with students once a week after school and attends weekend competitions. This is his first year where all of his students have I-pads. (personal communication, January 20, 2016). Jeff occupies two classroom niches, AP Physical Science and Prep Physical Science.

Jeff’s predominate use of the i-pad was as a data collection device in the Prep level during labs. His use of the Hudl technique app for data collection was mediated by the interniche interaction from the AP niche. He chose to use this app because of previous use with his AP students. (personal communication, January 20, 2016). Jeff understood the need to modify the use of this app with his Prep student population. After his first use of the app as a recording device, Jeff became aware that his students needed direct
instruction on how to use the app to accurately record data. These students also required direct instruction on the math skills they lacked to interpret the data they were collecting. Classroom observations found that it took two days to collect data since it took longer for his students to learn how to use the app, and then analyze the data they collected. (classroom observations, Feb 23, 24, 2016)

Behavior was an issue for Jeff in his Prep class. The prep students were more distracted by the technology, and were observed on social media sites, Snap chatting, texting and listening to music during instruction. Students often came to class late and both Jeff and his co-teacher circulated the classroom attempting to keep students on task. Jeff chose to use the Hudl app with his Prep students since he used it in AP Physics (Personal communication, January 20, 2016). My first observation of a lab was the first time he had used this app with his prep students. The second and third observations were more successful than the first observation since Jeff provided instruction on how to film with the app. The Hudl app allowed students to rewind video to get accurate start and stop times.

These labs reveal Jeff using TPCK since he has an understanding of how to “coordinate the use of subject specific activities with topic-specific representations using emerging technologies to facilitate student learning” (Cox and Graham, 2009). By using the I-pads to provide more accurate data collection, Jeff helps his students to understand the relationships between variables. Jeff is willing to try new things with Prep Physics students that he has modified from previous use in AP Physics. His use of technology in one niche (AP) impacts his use in another (Prep).
Jeff used the i-pad to provide students with an understanding of content through the use of a simulation website and the Puffin app. Jeff and his co-teacher circulate through the classroom helping students access the website and navigate between the digital copy of the lab instructions downloaded from the class Schoology site and the simulation website. As with the data collection app, his students required direct instruction on how to use the apps. Students themselves offered suggestions on how students could navigate to the website Jeff wanted them to use. Students have what I define as Student Technology Knowledge (STK) that becomes a resource for Jeff in the classroom. The student and teacher species engage in reciprocal altruism with in the classroom niche. Zhao and Frank (2003) describe reciprocal altruism as when “teachers help and respond to members of their common organization, the school, to promote the well being of the school” (p.813). In this instance the reciprocal altruism is exhibited between teacher and student for the well being of the two species in the classroom niche.

Jeff exhibited his TK by using the Puffin browser to access a website with Flash animations that would not normally run in Safari. The use of this website simulation to reveals Jeff’s TCK (technological context knowledge) as he uses the I-pad to provide his students with a topic specific representation of course specific content. Cox and Graham define TCK as “knowledge of how to represent concepts with technology “ (2009). This shifts the classroom from teacher-centered to student centered.

Jeff invited me to observe his AP class. His use of the i-pad was extensive. His students use it as a note-taking device using the noteability app. His students also use schoology, and wave pad audio app to collect data then perform calculations. The pace of the AP class was much faster than in the Prep class, students were more engaged and less
class time was taken to explain how to use the app or how to perform the calculations. Students had an easy time navigating between the lab document in schoology and the app on their I-pads. This use revealed Jeff’s TPCK in having the students use the app to calculate beat frequencies. He is adept at using technology for a subject specific activity with topic specific representations to help his students understand content using emerging technology (Cox and Graham, p.64). The subject specific activity is the lab in which students record a sound with the app on their I-pads. The app enables the students to see the topic specific representation of the actual sound waves then use the app to calculate the beat frequency. Jeff’s decision to use the app was a result of the intraniche interaction in his PLC meeting. He was shown the app by another AP Physics teacher and then he used it in his class (personal communication, March 3, 2016).

In an informal conversation after this observation Jeff told me that he was going to modify it for his Prep students later in the fourth quarter (Personal communication, March 3, 2016). Here the intraniche interaction between Jeff and another AP Physics teacher encourages his use of technology with his AP students. Additionally there is an interniche impact of reciprocal altruism by increasing Jeff’s TK so that he can modify use of the app with his Prep level students. Jeff is aware of how classroom context, specifically ability grouping impacts his use of technology. Jeff felt that his Prep students just needed more time to work with the apps and acknowledged the need to tailor the lab he performed in AP for his prep students (personal communication, March 3, 2016). I journaled about this interaction with Jeff:

Jeff felt that once he figured out the technical issues students were having with the i-pads, the simulation helped them figure out the phases on the moon. Jeff is
willing to try new things to gain TK. TK is expanded in practice (written journal, March 4, 2016).

Jeff’s use of technology in both Prep and AP Physics is most impacted by his intraniche interaction with the other AP teachers. He describes the other Prep teachers as less open to using tech with Prep students. He continues to try to integrate technology into his Prep Physics course despite the protestations of his colleagues who occupy this niche with him. He explains

In AP I work with a team like …. who is thoughtful and has experience with the technology and is more interested in using it. So when we put our brains together its easier to brain storm to come up with different things we want to try. In Prep first of all we don’t spend much time together as a three-person team (personal communication, January, 20,2016).

The building habitat has a positive use on Jeff’s use of I-pads in AP but a negative impact on his use with Prep. Jeff meets weekly with the other AP teachers and often technology use is a focus of their discussions. He does not meet regularly with the other Prep teachers. He describe the Physics PLC meeting

The course is new (AP Physics 1) our PLC hasn’t been a Physics PLC; it’s been three AP Physics teachers doing their own PLC thing (personal communication, January, 20,2016).

Despite the mandate from the Division Head to focus on NGSS, the AP teachers chose to use their PLC time to concentrate on planning for this new course and technology integration. In these meeting teachers engaged in reciprocal altruism and collaborated on technology integration. This is possible because all members of the AP
Physics 1 niche were present in the PLC meetings. Ely’s (1990) condition of time being available facilitates Jeff’s use of technology. For Jeff, in his AP niche, time is not a limiting factor. While Jeff uses technology more with his AP class, he attributes this mostly to the attitudes towards technology held by teachers in these different niches and lack of meeting time with the other prep teachers. In his use of technology in the Prep niche, Jeff encounters the second order barrier of teacher beliefs (Ertmer, 1999).

The difference between Prep and AP, it’s the team I work with my two other colleagues (Prep) we don’t meet as much and my two other colleagues in Prep are more technophobic (personal communication, January, 2016).

Jeff continues to expand upon his TK by learning about new uses of technology. He has created a YouTube channel of himself explaining problems for his AP students to watch after going to a mini class the ITF held.

I’m trying to learn all these little things. I don’t know on my own I would be able to find all this little things and be innovative (personal communication, January, 2016).

In this case the building habitat has a positive impact on his tech usage since he has learned from ITF. Building technology support serves to provide Jeff with opportunities to increase his TK. This building habitat of tech support and knowledge and skills are two of Ely’s (1990) conditions for integration. The district biome also supports technology integration since the AP Physics 1 niche participated in the spring of 2015 technology workshop. The Prep Physics niche did not take advantage of this workshop time and do not have the time to meet as a complete niche (personal communication, January 20, 2016).
The student ability level grouping or classroom niche impacts Jeff’s use. Students bring their own TK to the classroom or what I refer to as Student Technological Knowledge (STK). In the Prep level Jeff has to work to help students develop this STK in using Schoology and moving from documents in Noteability to websites. The Prep students are more distracted by the technology and their cell phones when compared to the single observation of AP students. Some of the Prep students require more support and direct instruction about how to use the apps and how to perform basic mathematical calculations. Jeff and his co-teacher spend class time monitoring student behavior. Prep students require more time to learn how to use the apps in lab environments. In AP, students have a more advanced STK and don’t need direct instruction on how to use apps or instruction on how to use a formula to perform a calculation. The AP students exhibited more content knowledge, which assisted Jeff in his technology integration. Behavior is not an issue with the AP students, at least not during my classroom visit. Variation in the student species impacted how Jeff decided to integrate technology in his two different classroom niches.

Overall Jeff’s use of the i-pad was during labs as a data collection and analysis device to help students understand relationships between variables. His use of the i-pad in AP impacted his use with Prep. He was aware of the modification needed to use apps with his Prep students. The district biome and building habitat are supportive and provide the condition of time (Ely, 1990) for the AP niche through spring and summer workshop time and PLC time that allowed Jeff to discuss technology integration with other teachers who occupy the AP niche. Time is not a limiting factor in this niche. In the AP niche Jeff exhibits his TPCK.
In his prep niche, the building habitat had a negative impact on Jeff’s technology integration since there was no PLC time to meet with the other Prep teacher and co-teachers. In this niche, time is a limiting factor that prevents Jeff from more technology integration. The second order barrier of attitudes of the other teachers in this niche had a negative impact on Jeff’s technology use and the district impact was neutral. Attitudes and beliefs are second order barriers to integration and Jeff experienced these barriers in his intraniche interaction with the other Prep teachers. (Ertmer, 2005; Hew and Brush, 2007). Student ability level in prep meant that Jeff had to modify how he used the Huddl app giving students time to practice with the app, changing the reading level of the lab instructions and providing in class support of the data analysis and calculations he asked these students to perform (classroom observations, February 23, 24, 2016). No spring or summer workshop time was used for intraniche interactions around the issue of technology integration with the prep students. In the Prep niche Jeff expanded his TK by trying new uses and learning from them. I observed Jeff’s TPCK and TCK, STK all of which supported new uses of technology in this niche.

Jeff confided in me that for the 2016-17 school year he would be teaching Prep but without a co-teacher. He was excited about the possibilities for more technology integration since he would be working alone. Jeff has a positive attitude toward technology education and is open to trying new uses with his Prep students. Jeff’s case study diagram summarizes these results.
Gary

Gary has taught Honors Physical Science for all of the 17 years he has worked at the school. For 12 years he has taught AP Physical Science. He is the only teacher of this course and works with other two other honors teachers. He is a member of the Chemistry PLC. He has used technology to collect and analyze lab data for all 17 years he has taught at the school. This started with the use of CBLs (computer based labs) with laptops, then Vernier lab pros with laptops and printer carts. The most recent version of this data collection and analysis technology is the Vernier lab quest 2. The lab quest is a device that can collect and graph data then communicate with the I-pads through the schools wifi connection. His extracurricular responsibility is to organize all of the
academic contests that students participate in. This consists of organizing transportation and materials for the students who compete. Along with this, he is responsible for the science awards ceremonies. He also does all of the equipment ordering for all levels of Physical Science. This is his third year using I-pads with AP and his second year with Honors (personal communication, February 11, 2016). He occupies two niches, AP and Honors Physical Science.

I observed two main uses of the I-pad in Gary’s Honors and AP classes. In Honors, Gary employed TPCK by having students use the lab quest as a data collection and analysis device. The other use was TPK for formative assessment of student knowledge in both AP and Honors classes. My first observation of Gary in his Honors class coincided with their first use of the lab quest to collect data during a lab. Gary instructed his students on how their I-pads communicates with the lab quest and told them to make sure their blue tooth connection on their I-pad is on. He showed them how to analyze the graph on the I-pad, how to take a screen shot of the graph and insert it in their lab document, and how to digitally submit the lab to him through the class schoology page. For the first lab, Gary provided his students with a paper copy of the lab instructions. He exhibited a high degree of TK (technology knowledge). When students have issues with the transfer of the graph to the I-pad Gary offered multiple solutions for students to try. He had them turn off the wifi on the lab quest, and then turn it back on and students were able to transfer data from the device to their I-pads. His honors students displayed a high STK (Student Technology Knowledge) despite their first use of lab quests. They were adept at taking a screen shot of the graph and importing it into the lab documents in the Noteability app on the I-pad. As students became more familiar
with the lab quest, Gary had them download a pdf of the lab from his schoology site. He continued to help students trouble shoot when technical difficulties arose during data collection and analysis. Behavior was not an issue in the Honors class. Students focused during labs and were not distracted by social media available on the I-pad. I did not observe any student being pulled away from the lab by the device. Gary never had to remind his students to remain on task. Gary has a high TK as a result of long-term use with the lab quest device. In his interview he revealed that he has been using the lab quests with the I-pads for three years. He joked with me that we still have all the old lab pro devices and said

Once you learn how to trouble shoot with one thing they switch to another and you have to learn a new system all over again (personal communication, February11, 2016).

These observations during lab revealed Gary using his TPCK. Gary is adept at being able to “coordinate the use of subject specific activities with topic specific representations using emerging technology to facilitate student learning” (Cox and Graham, 2009 p64). Gary’s TK evolved over time through the use of different types of data collection/ analysis technology. He anticipated that it will continue to evolve as new technology becomes available. Gary is adept at adaptation.

Gary used the I-pad for formative assessment with the Socrative app in both AP and Honors. Gary’s use of the Socrative app on the I-pad for formative assessment of his students reveals his TPK (technological pedagogical knowledge) which the Cox and Graham (2009) elaborated model describes as “knowledge of the general pedagogical activities that a teacher can engage in using emerging technology” (p.64). In these
observations his students were engaged with the app and Gary. They were not distracted by the I-pad. Gary did not have to redirect these students to the app at any point.

Gary is an innovator in his use of the lab quests. He started using them independently with his AP Chemistry students then shared his knowledge with the other Honors Chemistry teachers during both spring and summer workshop time for Honors Chemistry teachers. This time allowed Gary to develop the TK of the other Honors Chemistry teachers who did not have any experience with the lab quest device. He exhibited reciprocal altruism by sharing his TK with the lab quests in these interniche interactions. This interaction is a function of the district habitat that provided the resource of time. Gary told me in the interview

I piloted it (lab quest) in AP and then I adapted everything I had to the honors level. I shared it with the honors team (personal communication, February, 11, 2016).

This workshop time was essential for the intraniche interaction for the Honors Chemistry Team to integrate technology. Gary explains:

We had a lot of technological changes in honors chem. Not just with the lab quests but also with the Schoology and practice quizzes online for formative assessment, digital lab quizzes, and digital turn ins. The amount of work we have done in the past three years dwarfs whatever we have done in the past ten years (personal communication, February 11, 2016).

Gary acknowledges that without the district biome support of funding these workshops, this work with technology integration would not be possible.
Yeah, we couldn’t have done it without that time (spring workshop) and summer workshop (personal communication, February 11, 2016).

Ely’s (1990) condition of paid time allowed Gary to “learn, adapt, integrate and reflect” on technology integration (p.300). This time enabled Gary to share his knowledge and skills with another niche of teachers. Ely (1990) maintains “a teacher must posses the competencies to teach students the use of these tools” (p. 300).

I asked Gary how he decided to use the lab quests. He told me

We felt we needed the lab quests they decided they (district) were not gonna support laptop carts anymore and we needed a way for the students to get the data from the device to paper in some way . . . So Vernier adapted their technology to incorporate (the I-pad) (personal communication, February, 11 2016).

Since the school had previously invested in the lab pro devices, this was a new product offered by the Vernier company and was purchased by the school in 2012. Gary explained how the lab quests were a powerful tool in helping his students understand concepts.

Being able to take data from a probe to translate it in real time on a screen we found it to be very impactful. It helps them see relationships right away as they do it. They are directly manipulating data with their hands they see the effect right away (personal communication, February 11, 2016).

When I inquired about why Gary used the lab quest and the graphical app on the I-pad he told me
The graphical app was purchased by the district before they went one to one they asked us what apps would be beneficial for the students to have. I told them the graphical app (personal communication, February 11 2016).

In Gary’s case the district biome supports technology use by asking teachers what they need, then providing them with the resources to incorporate the technology they request. Zhao and Frank (2003) identify a factor that impacts technology integration of opportunity for mutual adaptation (p.819). Here there is mutual adaptation between the district biome and the teacher. The biome responds to teacher need and provides adequate resources. The district biome supported Gary’s use of technology by providing access to technology by purchasing the graphical analysis app. This is the resources component as identified by (Surry, Ensiminger Haab, 2005) and Ely (1990) that is critical to integration. The other condition of time (Ely, 1990) exists as well. Gary himself is one of the components of the RIPPLES model of people as well as Ely’s knowledge and skills. Since he has TK, which he shares with his colleagues. Gary was provided time for him to share his TK gained in AP with the other Honors teachers. This is an example of interniche interaction as well as an intraniche in which reciprocal altruism occurred. Gary’s TK gained in AP was transmitted to the other Honors teachers. It also typifies the altruistic behavior of teachers when Gary worked by himself first in AP with the lab quest then shared his work with the honors teachers. Using the ecological metaphor, Gary participates in “reciprocal altruism” (Zhao and Frank, p813). He shared his TK with other teachers readily. Gary adapted to the changing technology made available to him by the district biome.
Gary used the lab quest with Honors and in AP chem. Because students gain STK in honors through use of the lab quest Gary finds they can do more with the tech when the reach AP. The lab quest technology enables his students to go further by creating their own labs but requires them to have the STK from previous use in Honors.

I ask them to do more. Instead of producing just one graph I will ask them to produce permutations of different graphs. After the students have a strong grasp of how the lab quest works and the probes works we can ask them to design labs (personal communication, February 11, 2016).

Gary uses his TPK and states that the I-pads have “changed my efficiency of feedback with all the formative assessment we have available” (personal communication, February 11 2016). When asked about using PLC time for integrating technology in honors chem., Gary revealed that the Division Head told him that PLC time was not to be used for technology integration discussions (Personal communication, February 12, 2016). This highlights that while the district biome is supportive in terms of providing teachers time to meet in the summer and the spring, along with the purchasing of specific apps requested by teachers, the building habitat did not support intraniche interactions by prohibiting the honors teachers to discuss technology integration in their PLC meetings. There are fewer opportunities for mutual adaptation and reciprocal altruism. Gary is unable to share his TK with his colleagues during this time. The lack of time in PLC for technology integration is a direct result of the state biosphere emphasis on assessment and NGSS. Lack of time is a first order barrier (Ertmer, 1999). For Gary time is both a resource at the district level due to workshops but at the building level a limiting factor.
Gary achieved a high TK as a result of consistently using technology over a course of a 17 year career starting with CBL (computer based labs) and lab pros with laptop carts. He has three years experience of working with lab quests and I-pads to modify materials. Over this time period he learned how to trouble shoot with the lab quest technology. His TK is constantly adapting and evolving to the changing technologies he has access to. Mutual adaptation of a teacher to new technologies is an ongoing process. As a result of constantly changing the types of technology he has access to for classroom use, Gary identifies time as a huge issue (personal communication, February 11, 2016). It is time consuming to create the classroom materials that accompany the use of technology in labs. It is time consuming to gain the TK to trouble shoot problems that arise when the technology malfunctions. Gary continues to expand his TK by attending sessions during Institute days where he learned about using doceri and educreations to create videos for his students. However, creating these videos is time consuming and Gary wonders if he will ever get a chance to make all of the videos he wants to (personal communication, February, 11, 2016). This is a function of the district biome that provides teachers time through institute days. These days provide an opportunity for teachers to share the ways in which they are incorporating technology in their classrooms with each other and contribute to building teacher TK. Time remains a barrier to Gary for more technology integration.
Carrie

Carrie is a veteran teacher. She has taught at the school for 31 years. In that time she has taught a variety of Life Science courses. She has an ELL certificate and currently teaches General Life Science, ELL General Life Science and AP Life Science. This means she occupies three distinct teaching niches. She is a member of the Life Science PLC and this is her first year of participation in the 1 to 1 I-pads. The ELL and General Life Science course are for freshman while the AP Life Science course is for seniors. When I began my teaching career she was my co-teacher when I student taught at the school. She serves as a building representative for the teachers’ union and has done so for the past eight years. She attends twice-monthly union meetings and quarterly meetings
with the school principal. This responsibility includes addressing issues between teachers and administrators as it relates to the teacher contract.

I observed Carrie using the I-pad for formative assessment in two ways. The first use she employed the website Kahoot and the second was a schoology lab quiz with an ELL General class. During the Kahoot, her students were on task and excited about using the Kahoot website to review before a test. Students raced each other to get the correct answer while speaking Polish and Spanish. They were excited and engaged. A student exclaimed, “I love Kahoot!” For the schoology lab quiz, Carrie and the aide moved around the classroom to make sure that students can access the quiz. Students were quiet while taking the quiz.

When I spoke to Carrie prior to the observation of the Schoology quiz, she indicated to me that she was not going to do the lab quiz on Schoology but on paper. I asked her why she decided to give the quiz in schoology. She told me that she did not have the time to create the quiz in schoology and did not know how to create pictures that included the colored bands on the gel electrophoresis. Another young teacher, her student teacher from last year, created the quiz and then shared it with her (personal communication, February 2, 2016). Since she did not have to create the Schoology quiz herself, she decided to use it with her students. The Schoology web site enables teachers to share materials. This intraniche interaction with a young teacher helped Carrie attempt a new use of technology despite her lack of TK on how to create the quiz herself. It is an example of what I define as Technology Enhanced Technology Integration (TETI). The access to technology that Carrie has, her laptop and the Schoology site, facilitated her technology integration. Despite Carrie’s lack of TK in creating the quiz, she tried a new
use of Schoology for formative assessment because the technology enabled teachers to share work they created. Without the technology facilitating sharing, this use may not occur. Here the access to technology and an intraniche interaction with a younger teacher enabled Carrie to integrate technology in her classroom.

Carrie exhibited her Technology Pedagogical Knowledge (TPK), which is “knowledge of general pedagogical activities that a teacher can engage in using emerging technologies” (Cox and Graham, 2009). The website Kahoot and schoology lab quiz on I-pads were used to formatively assess student knowledge, while providing immediate feedback to the students and to Carrie. This use is “independent of a specific content” (p.64). The Kahoot website and schoology lab quiz formatively assess her students’ knowledge of genetics and allowed her to respond immediately to their misunderstandings. She prefered the Schoology lab quiz because on a paper version it is black and white and the Schoology version had the colored bands similar to what students produced in the lab. She was concerned that when students have problems with the website such as when a student shows her on the I-pad that they selected the correct answer but the site shows her an incorrect score for that student she was unsure of how to resolve that issue. She worried that she “can’t problem solve well” and sent the student to the tech help desk located in the library. She has figured out that she can reset the quiz so that a student who encounters problems can retake it (personal communication, February 2, 2016). Carrie was in the process of increasing her TK through mutual adaptation as she used the Schoology site. She gained confidence in her abilities when an intraniche interaction with a younger teacher with broader TK, shared the quiz he created with her. In environmental or ecological terms teachers exhibit altruistic behavior in intraniche
interactions that support technology integration (Zhao and Frank, 2003). Carrie’s TK adapts and grows as she continues to try new ways of integrating technology in her classroom. This growth is aided by the technology itself. Teacher and the technology mutually adapt.

Carrie’s students performed a genetics lab in which students use their I-pad to create gels, and then use their knowledge of genetics to solve a problem. The lab, previously done with paper scissors and tape, was performed on the i-pad. Carrie used her TPCK since she was coordinating a topic specific activity of a lab, using a topic specific representation, the gel electrophoresis, to facilitate student learning. In addition this use was problem based and students apply their knowledge of genetics to solve a crime. Carrie’s interaction with a young teacher who created the lab and shared it with Carrie impacted her decision to use the I-pad this way (personal communication, February 2, 2016). It is another example of TETI in which the technology gives teachers the ability to easily share work through the Schoology site. The intraniche interaction with a young teacher who has more TK in the creation on materials enables Carrie to attempt new uses of the I-pad in her classroom. Just as with Gary, time is both a resource at the district level but a limiting factor at the building level for Carrie. She stated

I’m getting my Schoology page for gen bio I’ve built that ya know from scratch really this year and then . . . and I have worked on the AP bio one but that’s about all I can handle for this year. It’s time consuming (personal communication, January 23, 2016).

The district biome provided support for technology integration by supplying time in which the intraniche interaction can occur during the spring technology workshop.
We (gen bio team) did a little bit last spring when the PLC applied for technology money for some workshop time (personal communication, January 23, 2016).

Outside of the school day and workshop time, Carrie sees her fellow teachers engaged in the time consuming process of technology integration.

I think most people are doing it (creating digital materials) during their prep time or on the weekend (personal communication, January 23, 2016).

She has a positive approach to using the I-pad in her classroom and is aware of her need to increase her TK.

I embrace the technology. I don’t know how to do a lot of the stuff out there and maybe I’ll add one or two more things to my repertoire (personal communication, January 23, 2016).

Even with support from the ITF and district spring workshop time, technology integration is a time consuming process for teachers. It is not something that can be accomplished with one workshop or one meeting with an ITF. It is a process that teachers are continuously engaged in and exhausted by. The barrier of lack of time is considered a resource barrier (Bauer and Kenton, 2005; Chou, Block and Jesness, 2012; Ertmer, 1999; Hew and Brush, 2007; Garthwait and Weller, 2005; Grimes and Warschauer, 2008).

Carrie identifies interactions with other general biology teachers or with math teachers as the thing that influences her use of technology the most. These occur out in the teacher workroom or when she is at her desk and is listening to teachers discuss technology use.
I’ll hear people talking about something and I’ll just turn around and ask them about it. Then once I hear about what they are doing I think oh that’s for me or that’s not for me (personal communication, January 23, 2016).

She decides if it for her if it is simple and easy to use or improves what she does already. Here the building habitat has a positive impact on Carrie’s technology use. The physical space of the teacher workspace provides an opportunity to hear what other teachers are doing. It creates opportunities for TK to be shared among teachers and allows reciprocal altruism to occur. Both intraniche and interniche interactions happen in this space and serve to enhance Carries’ TK. The abiotic component of the building habitat supports technology integration (Zhao and Frank, 2003). Carrie admits that she is still learning and is engaged in the process of developing more TK.

I am still not comfortable with Schoology and with Noteability I can’t trouble shoot but if the kids know how I am all for it (personal communication, January 23, 2016).

Students come to classes with STK which can be a resource for teachers in the beginning phase of learning TK. Carrie is aware of her lack of TK.

I need more training to practice trouble shooting. I f the kids are having trouble other kids can help. They (students) teach me things. I don’t feel like I have to know everything (personal communication, January, 23, 2016).

Hew and Brush (2007) identify the lack of technology skills and knowledge as a barrier to technology integration. Carrie is aware of her lack of TK. I only observed her three times. Her less frequent use of the I-pad may be due to her lack of TK.
For Carrie the school ecosystem is supportive to integration especially other teachers, ITF and tech support available in school.

I like how supportive everyone is (teachers, ITF) everyone is happy to assist the tech ladies (*ESP that work at the tech help desk in the library*) I would have abandoned it without all the support from everybody (personal communication, January 23, 2016).

The tech support is identified as a condition for integration in the Ripples model (Surry, Ensminger, and Haab, 2005). It is evident here and serves to facilitate Carrie’s classroom use of technology. Carrie encounters the resource barriers of lack of time and lack of knowledge and skills (Hew and Brush, 2007). The impact of these barriers is mediated by the intraniche and interniche experiences in the teacher workspace and by TETI. Carrie is able to navigate these barriers through the help of a younger teacher. She remains open and flexible to future technology integrations. I was only able to observe Carrie three times. Her lack of confidence in her TK meant she used the technology less often.

In the interview I asked Carrie about the use of technology with her AP class. She indicated that she did not integrate technology in AP beyond having a schoology site for the class. She attributed this to the pressure of having to cover a specific amount of content prior to the AP exams (Personal communication, January 23, 2016). As the state and district focus on assessment, the pressure to increase AP scores negatively impacted Carries’ technology use in this niche. Hew and Brush (2007) identify assessment as “a major barrier to technology integration” (p230) and state “the pressures related to high stakes testing gave teachers little time to attempt new instructional methods involving technology” (p230). In her AP niche Carrie typified this process.
Carrie experienced the barriers of assessment, time and lack of knowledge and skills (Hew and Brush, 2007; Ely, 1990). She used TETI and intraniche interactions to try new things. Despite the barriers she encounters she maintains a positive attitude toward technology integration.

**Figure 3. Case Study Diagram Carrie**

Ann

Ann has taught at the school for 11 years. She maintains an ELL certificate. Currently she teaches a stacked ELL General Physical Science, General Physical Science and General Life Science. The stacked ELL General Physical Science course has four / five ELL students and Ann is provided an ELL aide to assist those students. The Physical Science courses enroll sophomores and the Life Science course enrolls freshman. This was her first year teaching Life Science. She is a member of the Life Science PLC. This
is her second year using I-pads in Physical Science and her first year using them in Life Science. She served on two committees. One is the district evaluation committee that works with teachers, and administrators around issues with the Danielson rubric for teacher evaluation. She is part of the building standards based grading committee that meets to watch webinars about standards based grading. She implements this in her General Physical Science and Life Science classes. From time to time she is pulled from her classes for committee meetings. This spring she has the added responsibility of mentoring a student teacher (Personal communication, February 17, 2016). Ann occupies three niches.

Ann used the I-pads for formative assessment, to teach content and to engage students in discussions. She regularly used the schoology site for lab quizzes. On multiple observations I saw her use the schoology site to assess students understanding of labs. This revealed Ann’s TPK (technological pedagogical knowledge) as she used a lab quiz in Schoology on the I-pad as a tool for formative assessment. Students and teachers received feedback right away. Ann also showed her TK by being able to overcome problems with technology for a student who was unable to take the quiz online.

She used her Technological Content Knowledge or TCK which is “knowledge of a topic specific representation using emerging technology” (Cox and Graham, 2009). She used an online tutorial to introduce students to directions on how to draw a Lewis Structure diagram. Instead of lecturing her students on the process of creating a Lewis Structure Diagram, Ann employed an online tutorial instead. I asked her why she had her students use the computer lab she told me the tutorial uses flash animation that the I-pad
does not support (personal communication, March 16, 2016). Here she revealed her Technology Knowledge and her awareness of the limitations of the I-pad.

Ann and I occupy the General Physical Science niche and worked together using the district spring technology workshop to create an online role playing game. On this website students take on roles to meet in a committee where they have to make a recommendation to a school principal who wants to decide whether or not to remove drinks containing aspartame from the vending machines at the school. Ann asked me to be there for the first time her students logged in to the site to get assigned a character for the Aspartame role-playing scenario we created. This observation required me to play a dual role of both observer and to provide tech support to Ann and her students as she experimented with a new use of technology. Most students were able to login but a few had difficulties accessing the site. This was not solved by me with my superior TK but by other students who suggested opening the link in Safari. Even when opening the link in Safari, one student still was not able to log in to the website. I suggested he close all of the other tabs he had open in his browser window. This did not solve the problem. Again a student offered a solution. He told the student who was unable to log in to take his browser setting off private and finally the student logged in to the game site and was assigned a character. These were small technical issues, both of which were solved by students’ technical knowledge or STK. Students engaged in reciprocal altruism within the classroom niche. This interaction benefited both teachers and students and facilitated technology integration.

Ann had a Flipped classroom. Students reviewed resources outside the classroom then used that information to participate in an online discussion as a character with a
specific viewpoint to express in the conversation. Instead of having a whole class
discussion about the safety of Aspartame, students discussed in small groups online. As
with, Gary, Jeff and Carrie, Ann identified time as a major obstacle to technology
integration as well as preventing her from expanding her own TK. Ann experienced time
as a limiting factor (Bauer and Kenton, 2005; Chou, Block and Jesness, 2012;
Ertmer, 1999; Hew and Brush, 2007; Garthwait and Weller, 2005; Grimes and
Warschauer, 2008). She attended a mini class with the ITF on i-books and spoke with
two AP teachers about their use of i-books.

I love love love the idea of an iBook. I don’t have any fricken time to do it. You
can put all the tutorial videos there you can embed chapter quizzes you can do all
of those different things. I just don’t have the time to do it (personal
communication, January 23, 2016).

She used her laptop find online resources for students. The Lewis structure
tutorial that I observed was a result of a Google search (personal communication, January
23, 2016). In this instance she engaged in Technology Enhanced Technology Integration
(TETI). The access to technology she has as result of the district biome enabled her to
find new ways to incorporate technology in her classroom teaching. The district biome
had a positive impact on Ann’s technology use through providing access and by
supporting intraniche interactions. The district context reveals Ely’s (1990) and the
RIPPLES model condition of resource availability (Surry, Ensminger, and Haab, 2005).
The General Physical Science team used the spring workshop time for the past two years
to focus on technology integration. Ann attended the courses on technology from the
Internal University but stated:
I almost wish I could go back and do it again I feel like we have learned so much more. I took it when just had the I-pad the kids didn’t have it yet. By the time we go to 1 to 1 I forgot half of the stuff. Its almost like I need a refresher every year because oh this is a new thing (personal communication, January 23, 2016).

As technology evolves and changes, teacher TK has to adapt and change as well. This means that teachers need time and opportunities for TK development consistently throughout the school year and their careers. Ann is open and flexible in trying new uses of technology to expand her TK.

I am willing to try things. I am someone who will try it and bomb. I have no problem doing that (personal communication, January 23, 2016).

She describes her biggest need for technology integration as “time and support” (personal communication, January, 23, 2016). For Ann the building habitat did not support her in her quest to increase her TK since the Biology PLC time was focused on NGSS. The Division Head is also a member of this PLC and dominated the discussion. This left little time for Ann to engage in intraniche interactions with other Life Science teachers during these meetings. Time is both a resource at the district level but a limiting factor and a significant barrier to technology integration at the building level. (Bauer and Kenton, 2005;Ertmer,1999;Hew and Brush, 2007 ;Chou, Block and Jesness, 2012; Garthwait and Weller, 2005;Grimes and Warschauer, 2008).
Figure 4. Case Study Diagram Ann
CHAPTER 5
SELF-STUDY RESULTS

Overview of Study

The purpose of the self-study was to understand how multiple contextual factors impacted my own classroom use of technology. I wanted to understand how the state biosphere, district biome, building habitat and classroom niche impacted they ways in which I incorporated technology in my own classrooms. I also was interested in examining how observing other teachers using technology would impact my own use. I sought to understand how my TPCK functioned within my different classroom niches. The self-study provides the emic perspective of teacher engaged in the process of technology integration.

The benefits of this research are that it gives a rich thick description of what a teacher engaged in the process of technology integration actually does. This emic perspective can reveal how TPCK functions with in the ecosystem of a school. It can reveal what contextual factors can support teachers as they strive toward technology integration.

I began with the self-study component in February of 2015. I wrote daily journals about my use of the I-pad with my Prep Physical Science and General Physical Science students. Once I began observing other teachers in third quarter of 2016, I continued to
journal about what I was seeing in the classroom observations paying attention to how it influenced my own classroom use. I used the ecological metaphor to attempt to understand how various components of the state biosphere, district biome, building habitat and classroom niche factored into my classroom deployment of technology. I employed the same data analysis from the case study to my journal entries.

Research Questions

1. How do I navigate a variety of contexts when making decisions about how to integrate technology in my instructional practice?
   A) How do I integrate technology in my classroom?
   B) How do the state, district, school, and classroom contexts impact my decisions about technology integration?
   C) How does my knowledge (TPCK) inform and shape my technology practices and decisions?

2. How does the process of studying technology integration practices of other teachers influence my own classroom decisions about technology integration?

In my prep level classes the student population is composed of special education students who have a variety of issues including but not limited to; processing deficiencies, behavior disorders, autism, and learning disorders. There are also students identified as English Language Learners or ELL. Overall, these students have less content knowledge of science and math and are below grade level in reading ability. I teach this course with a special education certified co-teacher. In the general level course I have
fewer special education students, students have more content knowledge of science and math and most of them are reading at grade level. I occupy two classroom niches prep and general physical science. I have a positive approach to technology integration. I was interested in using the technology available to me to try things I couldn’t do without it. While I do not participate in extracurricular activities at the school I have been in grad school while teaching full time.

I integrated technology in my classrooms in a variety of ways. I worked with a friend in Tel Aviv, Israel to create three on line role-playing games that I used with my general students. In the first game students applied their knowledge of balancing equations and predicting products of reactions to work online in a small group to determine if an explosion in a lab was an accident or deliberately set in the spring of 2015. In the fall of 2016 I used two role-playing games. I designed an Atomic theory role-play where students took on the role of different scientists who proposed theories about atomic structure. I used an existing role play in which students advised a town Mayor on whether or not the town should build a Nuclear Power plant. I collaborated with other general physical science teachers to create a role-play about drinks containing aspartame, which I used in my general classroom in the third quarter of the 2016 school year.

I used the Comic Book app with my prep students to have them create a comic book based on an element from the periodic table. In this project my students researched an element, created a superhero or villain based on their element, and used the app Comic Book to create a comic book story about their element superhero/villain.

I had my Prep students use garage band and I-movie to produce songs about the science we learned over the course of the semester. I call this the Science Raps project. I
wrote an Innovation Grant Proposal in the fall of 2014 and again in the fall of 2015 for this project. Students wrote a rap, produced original music and created a video about content covered during the school year. I was awarded a grant for the 2014-15 and 2015-16 school year. This award provided me with the money to purchase I-movie and garage band for all my prep students. It also allowed me to pay a musician, who just happened to be my husband, to help my students produce music in garage band.

Several uses of technology were incorporated into both my prep and general classrooms. Over the course of the study I used Schoology and Kahoot for formative assessments. I used a variety of online simulations and videos to teach students content. I used the spring workshop time to write labs for using the lab quest technology which I used with both niches.

**State Biosphere**

Only once during the study did the state biosphere impact my technology integration efforts. In March of 2015 I started to look ahead to May to reserve computer labs for two periods a day. I knew that the Science Raps project took several weeks to accomplish and that my students needed to be in a computer lab that had both garage band and I-movie already installed on the desktop computers. The previous year I had tech support create a shared server for my students to save work and give access to all members of their group for collaboration. When I went to my school librarian to reserve computer lab time for my students he told me that the labs would be used for PARCC testing and I couldn’t reserve them (written journal, March 17, 2015). My students would have to do all of their work on the I-pad. I was unsure about how they would collaborate and share their work since I was familiar with having students save to a server that all
students could access. It also meant that the TK I had gained from previous work in the computer lab would not be applicable to the I-pad. I would need to acquire new TK to have students create their songs and videos on the I-pads.

Here the state biosphere directly impacted my technology integration by limiting access to computer labs. The barrier of assessment reared its ugly head. This barrier is one that “can result in the shift of using technology from teaching and learning to using it to facilitate assessment” (Bichelmeyer as cited in Hew and Brush, 2007). The emphasis on standardized tests at the state level meant that computer labs were unavailable for student learning and instead harnessed for student assessment. Using the ecological metaphor, standardized testing was a limiting factor that inhibited my efforts at technology integration.

**District Biome**

Several features of the district biome facilitated my use of technology in the classroom. The district provided resources of access and time. The district biome gave me access to technology through the Innovation grant, which provided money to purchase garage band and i-movie for my prep students. The district also provided students with the graphic analysis app for using the i-pad with the lab quest. Another app provided by the district was the Puffin app that allows sites using adobe flash animations to run on the i-pad. Having my own personal laptop and i-pad enabled me to experience Technology Enhanced Technology Integration (TETI). There were two ways in which the district ensured that I would have the resource of time to work on gaining the Technology Knowledge and collaborating with teachers in the general niche. Time was provided
through the April Technology Institute Day and through the Spring Technology workshops in the spring of 2015 and 2016.

When the state biosphere limited my access to technology as a result of the limiting factor of assessment, the district biome allowed me to overcome this obstacle by providing me with the grant money to purchase apps, and time to learn how to use them. On the April Institute Day in 2015, I spent part of the day working in garage band and i-movie on my i-pad so that I could gain the TK to help my students create their songs on their i-pads. I also used the time to engage in TETI. I sat in my office, which I like to call the bat cave, since I do not have a desk in the common teacher workspace. I worked on the role-playing website to test it before using it for the first time in my classroom. I had the Pandora website open on my laptop, my cell phone in my hand texting one of the designers in Chicago, while watching another designer in Tel- Aviv, Israel play the game on my I-pad. Every piece of technology available to me was deployed in order to make sure my first game would function on the I-pad (written journal, April 7, 2015). The access to technology provided by the district biome, enabled me to collaborate long distance to create role-playing games. This process appealed to my background in media literacy and reminded me of the term coined by Marshall McLuhan of the “global village”. As I continued to work with the role-playing site and create new games in the fall of 2015, I often Skyped with the designers in Israel (written journal, October 10, 2015). Without access to multiple communication technologies, this would not occur. I noted in my journal

I think it is interesting that my tech integration is mediated by technology itself. I am Skyping with a designer in Israel on my I-pad as I seek to integrate
technology in my classroom. This is crazy town, man (written journal, September 8, 2015).

The April Institute day was valuable for it allowed me to mutually adapt to the new technologies of garage band and i-movie that I would be using for the first time. I had the time to play with the apps before introducing them to my students. I was also in the process of adapting to the role-playing website.

In February of 2015 I wrote the proposal for the spring technology workshop for physical science teachers. In the proposal I included an honors teacher (Gary) and an AP teacher who had experience with the device. We received six hours of workshop time. In March of 2015, we learned how to use the devices from the AP teacher and Gary who had TK from using the devices. The general niche proceeded to write labs for the general level while I wrote the labs for my own use at prep level. I had to adjust the lab instructions and analysis questions for the lower reading and math ability of my prep level students. The district biome of the spring technology workshop provided paid time for an interniche and intraniche interactions in which I learned how to use the lab quest device then created lab documents for use in my classroom. Through the process of reciprocal altruism, teachers outside the general physical science niche shared their expertise with novice users of the lab quest device in an interniche interaction. The general teachers then worked in an intraniche collaboration to write labs for use in the general level classrooms while I wrote the labs for use in the prep level.

The following year, I created and submitted another proposal for the general physical science niche to meet to work on technology integration. The 2016 spring technology workshop provided me an opportunity to share the role-playing game website.
Ann was already on board since she had observed my use of the website for the Nuclear Power unit. We were approved for eight hours of workshop time. Ann was excited about creating a new game around the idea of having students use their knowledge of naming compounds to debate a scenario about whether or not the school should get rid of drinks in the vending machines that contain aspartame. We would have to come up with the characters and use the creator on the website to design the game ourselves. This meant I would not be creating this alone. My previous experience creating games was very time consuming. Collaborating with others reduced the time it would take to create the game, write the scenario, create character biographies, and create the student handouts. I found at least one other teacher who was excited about using this game. I noted in my journal that was happy to discover that:

I am not doing this by myself and there are other teachers who are excited about the possibilities of using this site (written journal, January 29, 2016).

This spring workshop was another opportunity for an intraniche interaction in which I was able to share my knowledge of the role-playing website with other teachers. I was able to engage in reciprocal altruism and collaborate with my fellow teachers. Collaboration reduced the amount of time it took to create the game and eliminated time as a limiting factor to my technology integration. The district biome provided the conditions identified by Ely (1990) and Surry, Ensminger and Haab, (2005) of access and having resources available which enabled my knowledge and skills to expand and adapt. Hew and Brush (2007) also consider resources as necessary to overcome barriers to integration. Paid time through workshops allowed for intraniche and interniche collaborations. Workshop time created opportunities for me to experience reciprocal
altruism, mutual adaptation and expand my TK. In the district biome time was not a limiting factor to my technology integration efforts. The intraniche interaction in the spring workshop meant that the creation of a new game would not be as time consuming for me and I learned about using the lab quest device.

**Building Habitat**

The building habitat both facilitated and inhibited my technology integration. My use was facilitated by the tech support provided by the ITF while the PLC inhibited it since it was not a site for technology integration. PLC conversations around issues of technology integration did not occur since we were mandated to focus on examining the NGSS and creating common assessments.

During the 2015 April institute day, I played with garage band and I-movie on my I-pad. I needed to find a way to have students share the work they would create on their i-pads. I googled how to import a song from garage band into I-movie. When that didn’t yield any useful information I went to my ITF’s office and told him my dilemma. He showed me how to email the file to myself, and then open it in I-movie. This would allow my students to share work with out saving it to a shared server since they would not be in a computer lab. When I encountered a problem, I had the tech support in the form of the ITF to help me over come it. The ITF supplemented my own attempts at gaining the necessary TK.

The ITF also provided an opportunity for me to learn more about the Casper Focus app. I attended a meeting the ITF held on how to use the Casper focus app to lock students into an app or website to prevent them from being distracted from other uses of the i-pad during my planning period (written journal, February 16, 2016). The ITF
represents several factors identified as necessary for technology integration. Here Ely’s (1999) conditions of knowledge and skills and resources were present. The ITF was a resource who helped my knowledge and skill to grow. The building level contains conditions as identified in the RIFPLES model of people and support in the form the ITF who helped by providing tech support. (Surry, Ensminger, and Haab, 2005). The ITF was a resource for me on multiple occasions helping me to expand my TK as I attempted new uses of the ipad in my classroom. His help increased my confidence when I had to use the ipad with my prep students instead of being in a computer lab for the Science Raps project. I also knew that if I had problems during the project he was available to come to my classroom to provide assistance. This support facilitated my experimentation in media production in my prep classroom. I did not have to have all of TK to have students produce media on their ipads. Help was only a phone call away. The ITF support also provided me with a way of managing student distractions with the casper focus app.

For the 2015-16 school year I was a member of the Physical Science PLC. At our first all math/science division meeting of the school year we were directed by the Division Head to look at the NGSS and see where we were meeting these standards within our courses (written journal, August 25 and October 1, 2015). When we were directed to select a PLC leader for the school year, I journaled about that meeting. In our chemistry PLC no one wanted to be the leader. I said I would do it next year because I did not want to be the leader and be working on my dissertation. Nobody wanted to do it and two members indicated that they would do it but were not invested in it. This could be a result of the div head telling us what to work on instead of letting the PLC decide what the focus would be since it is not seen as
issues that the members were concerned about. Since we were told what to work on we may not get a chance to talk about tech as much as I would like (written journal, August 27, 2015).

Over the course of the study, I found that most of my time in my PLC meetings was spent grading labs, grading tests or quizzes and updating my online grade book. We spent little time discussing NGSS and did not discuss technology integration at all. I described how these meetings usually went in my research journal:

We had our PLC meeting today which consisted of people working individually and we did not have any conversations about anything (written journal, January 21, 2016).

And

So far this PLC has spent three meetings discussing NGSS the rest of the time teachers in the PLC worked independently (written journal, January 28, 2016). I repeatedly referred to the PLC as “nonfunctional”. I wrote in my journal about why I thought we were not working well as a PLC. I concluded that “When PLC goals were externally imposed on our PLC the PLC failed to function” (written journal, March 11, 2016). I also attributed this lack of function to the fact that the PLC consisted of four members. Of the three total honors teachers, only two were present. Of the four total general teachers, only three were present. There was no full niche of teachers present but there were no interniche interactions around the issue of technology integration. I wrote that in these meetings “Usually everyone does their own thing” (written journal, March 28, 2016). These meetings were not sites of reciprocal altruism or mutual adaptation. They did not contribute to facilitating my technology integration efforts.
PLC time was a missed opportunity to engage in both intraniche and interniche interactions around technology integration. I responded to this experience by volunteering to be the PLC leader for the 2016-2017 school year in an attempt to interject some reciprocal altruism around issues of technology integration into these meetings. As with the previous school year, we were instructed to focus on literacy and the SAT test in our meetings. I shared an app with my PLC that would allow students to download Discover and Science News magazines to their ipads to address literacy. To my surprise Gary told me the app would be useful. I adapted to the demands of the state biosphere and building niche by finding ways to incorporate technology that address the limiting factor of assessment being imposed on me and my fellow teachers. Conducting this research inspired me to find ways to make opportunities for reciprocal altruism, interniche and intraniche interactions happen for myself and my colleagues while inhabiting an ecosystem where assessment is a limiting factor. At the building level the ITF provided me tech support which facilitated my integration while the PLC did not. I moved forward this school year by trying to create a space in our PLC meetings for technology integration despite the continued focus at the state biosphere, district biome and building habitat on assessment.

**Classroom Niche**

In the classroom niche, several features impacted my technology integration. Behavior, ability level and Student Technology Knowledge were issues I faced while integrating technology in my prep and general classrooms. This was also where I examined how my TPCK functions within my classroom. I found I used TPCK, TPK, and TCK. I discovered that Student Technological Knowledge to be helpful in facilitating
my technology integration. My TK was expanded through the use of technology and the STK of my students.

In my general classroom I encountered behavior issues during my first use of the role-playing website in the spring of 2015. Students did not read the background of the case and did not read the information that would help them discuss the problem. Students made inappropriate comments to each other in the game and were posting pictures of prom dresses in the discussion feed. There was a time lag between when students posted in the discussion feed and when students saw responses to their comments. The biggest issue was with student accountability and behavior not with the game itself. I noted in my journal:

Just because you design a student-centered problem based use of technology does not mean that students will automatically be engaged. There is no magic bullet and a variety of pedagogies are needed. There is no one-way to teach with technology effectively. I just do the best I can (written journal, April 20, 2015).

The last time I used the role-playing site during this study I again experienced issues with student behavior. In my journal I wrote

many students were not engaged and one student was unable to see the messages. This could be since it is the day before spring break but this is a class in which I often have behavior problems with students not wanting to focus on what we are doing in class, they are on I-pads watching movies or listening to music.
Just doing something innovative with tech does not mean students will buy in or automatically be engaged but it could also be due to the fact that it is right before spring break and students have checked out (written journal, March 18, 2016).

This experience taught me that I have to consider not just the classroom niche when integrating technology but the time of the year as well. This use was the day before spring break. As I continue to use the role-playing game with my general level students I will be more aware of when during the school year I use it. I decided to use the role-playing games with my general students and not my prep level students because it required more independent reading. I was aware that my prep students were not reading at grade level.

I integrated technology with my prep level students differently than with my general students. I had my prep students use technology to produce media with the Comic Book app and the Science Raps project. I made this choice because I wanted to engage my prep students and felt these uses of technology would help them focus on learning content. I found with the Comic Book app that my prep level students required more time to learn the app first before I asked them to create their own comic book. I took two class periods to have them practice with the app before using it to create their comic book based on their element (written journal, January 4 and 6, 2016). I also had to modify the reading level of the lab quest labs in order for my prep level students to participate. I was able to do this during the spring workshop. In the classroom my prep students took longer learning how to use the device and struggled more with the data analysis (written journal, October 20 and 21, 2015). The differences in student ability level in my two niches
impacted how I choose to integrate technology in my general and prep level niches.

Student species variation in ability level was a factor in my integration practice

**Student Technological Knowledge**

Student Technological Knowledge (STK) assisted me in technology integration in both my general and prep classroom niches. While observing Ann’s first use of the role-playing game Student Technological Knowledge overcame the technical issues that arose when students tried to log in to the site. This then informed my use when later in the day I used the website in my own classroom. I was able to avoid the pitfalls since my TK was expanded by STK (written journal, March 16, 2016).

During the Science Raps both the musician and my students helped my TK to expand. My husband spent three days in my classroom helping students record lyrics and create their own beats in garage band. He showed me how to copy and paste several songs into one song. A student showed me a way to transfer the music from garage band into I-movie without having to email it. I had her help other students groups that struggled with this and watched her as she explained it. This allowed me to help other students who encountered the same problem. Another technical issue that arose was that the song would get cut off if the video wasn’t long enough. A student in my second period class explained this to me. I noted in my journal:

This project allows students who have technical knowledge to shine and they become resources for me as well as their classmates. I also feel more comfortable using these apps on the I-pad and am looking forward to doing this again next year, assuming I get the grant and can pay the musicians and purchase the apps (written journal, May 27, 2015).
Student Technology Knowledge facilitated my technology integration efforts and helped me gain the confidence that I could expand my TK through interactions with my students. It meant that students assisted me and other classmates as I introduced a new use of technology. I was learning along with them. This created a classroom environment in which students and teachers grew together. It also allowed students who have more STK to be seen by their fellow students as experts and capable of teaching their peers. Despite their lack of knowledge of science content and math, this project enabled them to share their strength and expertise with media production. It served to enhance their own self concept and changed the way I viewed them too. My prep level students had knowledge that I had not tapped previously. Incorporating technology revealed their expertise to me.

When using the lab quests my general students struggled with reading and following directions on the lab about how to set up the lab quest and collect data. In my 6th period general class I relied on the STK of a pair of students who had successfully collected their data and sent it to their I-pads. I had them move around the room helping their classmates sync their I-pads with the lab quests (written journal, October 19, 2016). Student Technological Knowledge is a great resource for teachers.

There were multiple interactions within the classroom niche that positively contributed to my technology integration efforts. Students are a keystone species that engage in reciprocal altruism in student-to-student and student-to-teacher interactions. Students are a resource for each other and for myself. I found that harnessing STK made my classroom a site where the two species of students and teacher could learn from each other. It was relief to me. I didn’t need to know everything about an app or device before integrating it, STK supplemented my TK and served to expand it. STK increased my
confidence that if something didn’t work, I could turn to my students for help. STK encouraged me to take risks and try new things in my technology integration efforts in both of my classroom niches.

**TPCK**

In my classrooms I employed TPCK, TPK, and TCK while integrating technology. Over the course of the study I gained a great deal of new TK. Each use of a new technology, lab quest, role-playing games, science rap project and the Comic Book app required an expansion of my TK that occurred over the 2014-15 school year and into the 2015-16 school year. This also happened within a single school day from period to period.

I used TPCK when using the lab quest, using role playing games and using the Comic Book app. The use of the lab quest with my prep and general students is an example of TPCK since I used emerging technology to facilitate student learning through a subject specific activity of a lab with a topic specific representation of graphs (Cox and Graham, 2009).

Creating and using role-playing games also utilized my TPCK. The Atomic theory game represents use of my TPCK by having students do the research and present to each other. Here I used technology to create an experience in which students use emerging technology to participate in a topic specific activity by discussing atomic theory, while using topic specific representations through presenting various models of the atom (Cox and Graham, 2009). The technology allows me to move from a teacher directed lecture on the history of the atomic model to a constructivist student-centered approach. Students taught each other, shared their information through the discussion and created the assessment. I used emerging technology for subject specific activities with
topic-specific representations on several occasions in my General classroom (Cox and Graham, 2009).

I enacted my TPCK when I had my prep students use the comic book app. My students performed a topic specific activity of researching elements with a topic specific representation of turning an element into a comic book character using emerging technology to help them learn about the elements of the periodic table (Cox and Graham, 2009).

I used Kahoots in General and Prep classes for formative assessment. I also used lab quizzes through the Schoology site with my general students. Using the i-pad for formative assessment revealed my TPK, where technology improves feedback for formative assessment. (Cox and Graham, 2009). On one occasion using technology for formative assessment showed me that my students needed more time to work on specific content.

Using TPK, I can adjust the classroom schedule to meet the needs of students based on immediate feedback (written journal, March 1st, 2016).

I used my Technology Content Knowledge and employed a variety of websites to help both my prep and general students learn specific content. I used websites that ran simulations to show molecules in motion. My students built atoms with animations that enabled them to see how electrons move in an atom. I also used videos online to help teach content to students. In my research journal I described the usefulness of online videos:
They can stop and start and turn on close captioning while they watch. This allows them to go at their own pace and provides a way of differentiating for students (written journal, February 16, 2016).

This function of the videos was important for the variation in student ability at the classroom niche level. For my prep students this meant that my ELL students could use close captioning to help them with language acquisition. Prep students with processing deficiencies were able to slow down the video or go back and re-watch to make sure they understood what was being presented. Students engaged with the video content in ways that supported their diverse needs. The videos provided students with options on how to access the content, which meant that students could mutually adapt to the technology.

I experienced mutual adaptations with each use of technology be it lab quest, role-playing games, comic book app, garage band and I-movie. Zhao and Frank (2003) describe this as a function of the contact between the two species, the teacher and the technology “the more contact the two species have with one another the more they adapt to each other” (p. 826). This contact requires multiple school years in which adaptation can occur. I gained TK through repeatedly using a variety of technologies over time.

Repeated use of the lab quest helped me to gain TK. As I learned from my mistakes I made modifications on my next use. My TK was expanded in a feedback loop. I tried new uses of technology, experience glitches, made changes and then tried again. My TK adapted in both a long term and short-term cycle (See figure 1 and figure 2).

I used the role-playing games four times from the spring of 2015 to the fall of 2016. As I continued to use the games, my TK adapted through technology use. The resource of time was invaluable to this process. I wrote in my journal:
Time is a huge issue to try out the site first before the students do, and create the handouts. Since I started with my first game last spring I also am becoming more familiar with the site and what my students need to participate in the discussion section (written journal, January 9, 2016).

My fourth time using the role-playing website was the most successful. My TK was in constant development and I learned through trying new things and failing often. But these failures were opportunities. I was fearless. Each time something didn’t go as planned, I made changes. I became more confident in my ability to address problems as they arose and made modifications on the fly. I gained awareness that this process was valuable in expanding my TK. It was through use of technology itself that my TK grew.

Technology integration became a recursive, adaptive, evolutionary process where each new use spurred growth in my TK. Using the ecological metaphor, my TK expanded in a feedback loop with input from resources at the state biosphere, the district biome, the building habitat and classroom niche. The limiting factors of time and assessment impacted this feedback cycle (see TK cycles figures).

**How does the process of studying technology integration practices of other teachers influence my own classroom decisions about technology integration?**

As I conducted this research I learned about the importance of both interniche and intraniche interactions for technology integration in the classroom niche. This encouraged me to share the TK I achieved by sharing more of technology integration work with my colleagues. I gained new TK by observing Gary’s use of the lab quest. Through attempting technology integration and taking risks in my classroom niches, I reconnected to what I enjoyed most about teaching. I became aware of how I had to adapt to the
administrator species as I navigated the ecosystem limiting factors of time and assessment to attempt new uses of technology in my classroom niches.

**Inter and Intraniche Interactions**

At the start of third quarter I sent out an email asking for volunteers for my case study. Four teachers volunteered to participate. Once they signed the consent forms, I began interviews and observed technology use in classrooms. The interviews revealed to me that inter and intra niche interactions had a large impact on teachers’ classroom technology use. I realized that I could do a better job of sharing the role-playing games with my General niche and sharing my TK gained. To this end I wrote the proposal for the 2016 spring technology integration workshop. This was the only opportunity the general niche teachers had for an intraniche interaction since the full niche was not meeting during the PLC time. The general niche played a game I created and collaborated to create another game. I because of this research I sought out an opportunity for myself to engage in reciprocal altruism in an intraniche interaction.

After an informal interview with Carrie about her use of a lab quiz on Schoology in her ELL Life Science course she told me that a younger teacher created the quiz she used. I spoke with this younger teacher in the teacher workspace and he told me that his masters’ thesis was on having students use technology to collaborate. I showed him the role-playing game website and offered to help him create a game if he was interested (written journal, February 19, 2016). Prior to conducting this research I would not have ventured out of my bat cave to share my work with even my General Physical Science Team, let alone a new Life Science teacher. I sought out an interniche interaction with a teacher who was receptive to attempting a new use of technology in his classroom.
After speaking with the younger teacher I wrote:

One thing I am getting out this research is that it is the interaction with colleagues that has the biggest impact on teacher use. This means sharing more of my work with others and venturing out of my bat cave more. I do not have a desk out in the math science teacher desk area. (written journal, February 24, 2016).

In the spring of 2016, I received an email from the school technology committee. The email contained a survey inquiring about what technology people were interested in learning about and asking if people would be willing to share what they are doing with technology for the institute day in April. I responded to the email that I could present on the role-playing site. In my journal I wrote:

I have not really shared much with other teachers and this research has shown me that since those interactions have the most impact on tech use, if I want to help move people to more innovative uses I have to share what I am doing. It has revealed to me that I do have colleagues that are willing to go out on a limb with me and try new things but I have to make myself and expertise available to people (written journal, March 5, 2016).

In April of 2016, I shared the role-playing game website with my fellow teachers during the institute day. This research encouraged me participate in reciprocal altruism through both inter and intraniche interactions. Previously I had shied away from these types of interactions and I began to actively seek them out. Within a year I moved from working independently in an office space I dubbed “the bat cave” to sharing my work with my colleagues and offering assistance in using the role-playing website or creating new games. This spring I will be teaching an Internal University course to teach teachers
across the district how to create their own role-playing games. This is another opportunity for me to engage in reciprocal altruism in an interniche interaction with other teachers who are interested in this type of technology integration.

New TK

Observing Gary use the lab quest with his honors chemistry class taught me more about the lab quest. I watched him help students who were unable to sync their graph from the lab quest to the I-pad. This was a problem I had encountered with my first use of the device. Through watching him run down the list of things to try when the devices, were not syncing, my TK was expanded. My solution was to have my students take a picture of their graphs but this meant that they could not analyze their graph in the app. Observing Gary taught me how to trouble shoot and gave me other fixes that would allow students to open the graph in the app and do analysis. As I continue to use the lab quests in the 2016-17 school year, I found that my greater TK lab quest facilitated the integration of this device. I continue to learn more TK from Gary. He showed me how to recalibrate the screens on the lab quest before using the lab quests this fall. Through continued reciprocal altruism and an interniche interaction my TK is still expanding.

Taking Risks

Integrating technology allowed me to be creative, try new things and attempt more constructivist uses of technology. I took risks by trying new uses and found it was this process that I enjoyed.

This process for me is what I love about technology and teaching I am taking a risk and trying new stuff. To me this is a joyful process (written journal, November 15, 2015).
In my journal I wrote about this process:

This stuff is what gets me excited about teaching and lets me move from a teacher directed lecture to students centered creation of models and having them explain it to each other. I still have some details to work out but I also think that going through it once, I can make changes. Sometimes my students are my guinea pigs for trying new things (written journal, October 21, 2015).

I wrote about my attempts with the role playing games

It does require a level of comfort ability with chaos. I find that it energizes me and I wish I could do more of this type of work with all my students. This is the stuff I really enjoy and it was almost a let down to go from playing the game to a traditional lecture with a practice worksheet with my general kids (written journal, May 16, 2015).

I found that integrating technology in new ways allowed me to enact more constructivist and student centered approach. My classroom niches became sites of experimentation. I was confident that even when I encountered technical difficulties my TK would expand. I experienced mutual adaptation through attempting new uses of technology. I took great delight in this process. Technology integration was fun. At the back to school barbeque this fall, I had an interniche interaction with a teacher who teaches coding. He shared an app with me called Hopscotch that will teach students how to code and allow them to create games on their ipads. I am looking forward to trying this use with my prep students since games are a main distraction for them I will have them create games about the science content we cover. This research has shown me the importance of these types of interactions and I seek them out where previously I hid out in my bat cave.
Adapting to the ecosystem

Often I found myself paying attention to what administrators were saying in meetings and used the same terminology when writing grants or spring technology workshop proposals.

One strategy I employed was to invite my division head into my classroom when I was trying out a new use of technology. I appropriate the language that is being used by administrators to integrate technology in a way that is aligned with my more constructivist approach. Ideally I want students to use technology to learn content then apply that knowledge to solve a problem. I am not interested in getting others to teach the same way I do. I am just trying to create opportunities for myself to teach in a way that is meaningful to my students and myself. I find joy in teaching when I do this. I have found the strategy of being subversive about being subversive to work for me when I do things differently. Surprisingly, I have been supported. One strategy that has worked has been inviting my Division Head into my classroom when I try new things (the comic book app, when my students were working with a musician, the day we watched our science raps video, the day I first used the on line role play) and appropriating the language that other administrators are using to advance their agenda for my own agenda (written journal, June 1st, 2015).

It almost feels like I am getting away with something. Using the ecological metaphor the administrators are another keystone species who serve as gatekeepers for my access to technology. Administrators speak a different language than the teacher species. They are
in positions of power and could inhibit or facilitate my technology integration efforts through their approval or denial of my workshop proposals and grants. Through interactions with the administrator species I adapted not to the technology but to the language the administrators used. I became fluent in the language the administrator species spoke. I crafted my proposals for workshops and grants using the administrator language I heard in my building habitat. I attended to the language at the district biome level that administrators used in their emails and grant proposal documents then adapted my proposals accordingly. This ensured that I received both the workshop time and innovation grant and was able to integrate technology in my classroom in a way that was consistent with my constructivist approach.

My TK grew from observing Gary, and learning from students how to open a link in Schoology in safari, and using the lab quests with my own students. I experienced my TK expanding in both short term and long term cycles as I used the lab quests for the first time, used the comic book app again, used the I-pads for my Science Raps project and worked with the role playing game website. I learned the language of the administrator species which enabled me to create opportunities for reciprocal altruism in interniche and intraniche interactions for myself and my colleagues during the spring workshops. I moved from working independently to sharing my work with colleagues and venturing into the habitat of the teacher workspace I had previously avoided. I wrote about this personal transition in my journal about the institute day April 4th, 2016:

What a difference a year makes. Last year at this time I was watching one of the designers in Tel Aviv play the game we designed on my I-pad while texting
another designer on my phone. This year I presented the role-playing website to some science teachers and showed them how to use it.

**Figure 5. Self-Study Diagram**
Figure 6. Lab Quest TK Feedback Loop
Figure 7. Science Raps TK Feedback Loop

- **State Biosphere**: PARCC testing no computer labs available
- **TK 2011-15**: computer lab shared server
- **New TK for use in Spring 2016 school year**: Grant money to purchase apps
- **TK moving to 1**: use of apps in class April 2015
- **TK moving to 1**: use of apps in classroom May 2015
- **TK moving to 1**: build tech skills
- **Classroom Nickn**: Student Technological Knowledge
- **Classroom Nickn**: Grant money provides expert technical support services in classroom
- **Building Habitat**: Tech support from ITF
- **District Biosphere**: District money to purchase apps
- **Institute Team**: time to work with teachers and students
CHAPTER 6

DISCUSSION

Overview

This chapter provides a summary of the key findings from the self-study and case study. It includes implications for state, district and building policies that support technology integration. It contains recommendations for technology integration and further research.

Key Findings

Some of the significant findings were the impacts of the state biosphere, district biome, building habitat and classroom niche on how teachers decided to use the I-pad in their science classrooms. The state biosphere detracted from time to integrate due to an emphasis on standardized testing as mandated by state law and adoption of NGSS. The state biosphere imposed the limiting factor of assessment due to PARCC testing and PERA. The limiting factor of assessment contributed to the limiting factor of time by decreasing the amount of time teachers devoted to technology integration. The district biome and building habitat worked to facilitate teachers’ technology integration and overcome the obstacles due to the state biosphere. The district and building contexts helped teachers overcome barriers of access and the limiting factor of time. The building habitat both facilitated and hindered technology integration. Ability level grouping
impacted how teachers decided to use technology in their classrooms. The state biosphere impacted the building habitat through structuring of PLC time to focus on NGSS alignment thus decreasing time for technology integration discussions. Time and assessment are limiting factors at the state biosphere, district biome and building habitat levels that impacted how teachers decided to use technology in their classrooms.

This study provided an opportunity to see TPCK in action. Use of the ecological metaphor revealed that gaining TK to integrate technology was a long-term process. As teachers engage in the use of technology, TK adapted to the ecosystem as it changes. I found that the technology itself was a tool employed by teachers to further integrate technology in the classroom (TETI) and that student technological knowledge (STK) was a valuable resource for teachers integrating technology.

**State Biosphere**

The State biosphere had a negative effect on technology integration in the form of the limiting factors of time and assessment. These components at the state biosphere level can be considered limiting factors or environmental resources that limit technology integration. The adoption of the NGSS at the state level impacted how PLC time was structured at the building level. PLC time to discuss technology integration was curtailed. Instead of PLC’s being a site of teacher collaboration on technology integration, this time was used to focus on NGSS alignment of curriculum. Only Jeff’s PLC deviated from the building mandate to use that time for NGSS alignment. Teachers were spending time in PLC meetings discussing NGSS standards not technology integration.

Another impact of state policy can be seen in the way technology was used for formative assessment by Ann, Carrie, Gary and myself. Teachers used technology in
multiple ways to assess student understanding of content. Ann, Carrie and I used Schoology Lab quizzes, Carrie and I used Kahoot and Gary used Socrative. The coupling of test scores with teacher evaluation due to PERA meant that teachers focused on improving students’ performance on standardized tests. The use of I-pads for formative assessment aligned the use of technology to improving test scores. Assessment is a barrier to a student centered constructivist problem based use of technology (An and Reigluth, 2011; Hew and Brush, 2007). However the ability to provide students and teachers timely feedback should be considered effective use due to pressure exerted by the state biosphere on test scores. The technology was employed by teachers to ensure students are learning content, which will be assessed by the PARCC testing on NGSS. This could be considered effective use since teachers employed technology to help them achieve externally mandated goals that are a function of state policy and state testing.

Time that could be devoted to teacher collaborations around technology integration will now switch to aligning curriculum to the SAT assessment. For the 2015-2016 the focus was alignment to NGSS, with the removal of PARCC comes a new assessment and teachers in PLC’s were given a new mandate for the 2016-2017 school year. At the state biosphere level, focus on SAT alignment creates assessment as a limiting factor which also contributes to time a limiting factor as this state biosphere impact is felt at the district and building levels.

**District Biome**

The district context served to have a positive impact and negative impact on teachers in this study. The district provided teachers’ access to technology and paid time
to meet but also imposed the limiting factor of assessment due to compliance to the state biosphere policy of PERA.

**Access and Time.** The district biome supported technology access for all participants by providing access to technology and giving them the resource of paid time to meet. This time allowed for intraniche interactions through the spring and summer workshop time. When asked about the district goals in the interviews, no teacher indicated that these goals impacted their decisions on technology use in the classroom. Jeff stated, “I don’t think about those goals at all” (personal communication, January 20, 2016).

The district provided teachers with access through personal laptops, and purchasing the noteability, puffin and graphic analysis app. They invested in the infrastructure by improving the fiber optic network to increase bandwidth. Every teacher in this study, including myself, used the Schoology website to communicate with students, and to disseminate information to students with a class calendar. Ann, Carrie and myself all used the Schoology site for formative assessment. Through the district innovation grant I was able to purchase garage band and I-movie for my students.

Teachers used summer and spring workshop time to create class websites, learn about lab quests, and create materials for their courses. These workshops were sites for mutual adaptation of teachers to technology and teachers experienced reciprocal altruism in the sharing of technology integration tools and gaining TK from other teachers in intraniche interactions. Moving forward the district will not be offering the spring workshop time for technology integration. This limits teachers to summer workshop time
and the April institute day. Carrie describes the process of creating a class website in Schoology for AP Life Science:

I have worked on the AP one but that’s about all I can handle for this year. It’s time consuming (personal communication, February 2, 2016).

While the district biome enables teachers to overcome the limiting factors of time and assessment imposed by the state through providing access to technology, losing the spring workshop time may limit teachers’ ability to continue the process of technology integration. Despite the district biome providing access, the loss of spring workshop time will further reduce the limited time teachers have to integrate technology. Time is a limiting factor at the district biome level.

**TETI.** The district biome provided access to technology and allowed for teachers to experience what I refer to as Technology Enhanced Technology Integration (TETI). Access to the technology itself positively impacted technology integration. Ann described this process:


I repeatedly used Skype, texting and social media to collaborate with people in Tel Aviv on the role playing games. Carrie attempted new uses of technology through sharing with colleague on the Schoology site. Having access to technology enabled teachers to search and collaborate through websites, which facilitated technology integration. This study revealed the importance of teachers having access to technology, which in turn enables technology integration efforts. This access is a function of the district biome and facilitated technology integration.
Assessment. Assessment is a limiting factor at the district biome level. The district plan to comply with PERA includes AP scores and growth on ACT scores as the student data that comprises part of a teacher’s evaluation. For AP teachers, the focus on test scores intensifies. For Gary this meant that his AP Physical Science students only got to create labs using the knowledge of the lab quest device after the AP exam (personal communication, February 11, 2016). Carrie described feeling pressure to prepare students for the AP exam.

Carrie: I feel this pressure in AP every period.

Me: What’s that pressure?

Carrie: The content that we feel like we need to get through. The labs are longer so we feel like we have got to get the labs started right away can’t mess around (with technology integration) and then some time we will end up with time at the end but it is hard to pull them (students) back in. They are either working on something else and I don’t want to start with that (using technology for formative assessment) because then we don’t have time for the lab (personal communication February 2, 2016).

For these teachers, decisions on how to integrate technology were impacted by the timing of the AP exams and the need to cover specific content prior to the exam. Despite providing teachers access to technology and paid time to meet and engage in intra and interniche interactions around technology integration, the limiting factors imposed by the state biosphere also impacted the district biome. Assessment and time as limiting factors existed at the district biome level and combined to inhibit classroom technology integration efforts of teachers.
Building Habitat

The building habitat had both a positive and negative impact on technology integration.

The physical layout of the teacher workspace is an abiotic component of the habitat that creates an environment, which fosters both intraniche and interniche interactions among teachers. Science teachers and math teachers share the same physical space. For Carrie and Ann, this physical space allowed them engage in interniche interactions and talk with math teachers about ways to incorporate technology. Ann talked with an AP teacher about the use of ibooks and a math teacher about Google quizzes (personal communication January 23, 2016). Carrie was encouraged to try new uses of technology after a younger teacher produced and shared digital quizzes and activities with her. Carrie stated that

the things that are impacting me the most are certainly listening to colleagues and then either asking them more about it and then when I hear about it its’ like would that work for me or not work for me. That’s why I like having a desk out there I’ll hear people talking about something and I’ll just turn around and ask them about that (personal communication, February 2, 2016).

Due to the layout of the teacher works space, the building habitat served to have a positive impact on teacher technology use by providing teachers access to those within and without their own niches. Access to teachers already integrating technology encouraged teachers in this study to attempt these new uses in their own classrooms and contributed to their decisions to integrate technology. Reciprocal altruism in these
interactions had a substantial impact on teacher decisions about how to use technology by encouraging new uses.

The building habitat of weekly PLC meetings only had a positive impact for Jeff in the AP Physical Science niche. The reason for this was that this PLC had all of the AP niche teachers present. These teachers chose to focus on technology integration and not on the NGSS alignment as dictated by the Division Head. For Gary, Ann and myself this facet of the building context had a negative impact on technology integration since PLC time was not used for conversations about technology integration.

The building habitat had a positive impact by helping teachers gain more TK. The ITF provided learning sessions that helped three of the teachers in this case study develop their TK. In interviews, this facet of the building context had a positive impact on Carrie (schoology), Ann (ibooks), and Jeff (YouTube videos). For Gary the building context of institute days enabled him to gain more TK by introducing him to the video recording websites of doceri and educreations. I approached the ITF when I couldn’t figure out how to share student work in garage band on the I-pad. He was also essential in helping direct me to the appropriate resources for technology support and getting the money to purchase the Comic book App. According to Zhao and Frank (2003), “Mutual adaptation between species especially between existing and new species requires frequent contact and active integration at a local level” (p830). This adaptation occurred during workshop time, on institute days and in informal interactions as a result of an open teacher workspace. The District biome and building habitat combine to have positive impacts on technology integration when they provide teachers with these opportunities for contact in which both intraniche and interniche interactions can happen. This study confirmed this
finding of Zhao and Frank (2003) that interactions among teachers have the biggest impact on how teachers decide to use technology. “what matters most for teachers is their peers in the local environment” (p. 830).

In addition this study reveals that these interaction require long time periods and occur over multiple school years. Achieving technology integration is a long-term process. Teacher Technology Knowledge (TK) is constantly adapting to the changing invasive species of technology. Gary has been integrating technology into his chemistry classes for seventeen years. As a result of long-term use of technology Gary has a very high TK. He pioneered the use of lab quest with his AP students first and then was able to share this knowledge through spring and summer workshops with his fellow teachers (personal communication, February 11, 2016).

I also experienced a long term TK cycle with my use of the role playing game website and through repeated use of the site gained the knowledge on how to integrate in with my general level students. It took me over one year from first working with the role playing game site to develop my TK with the site then being able to share through inter/intranchie interactions that TK with my colleagues. Each new technology I used required me to expand upon my TK (see TK cycle figures). I journaled about the long-term nature of this process:

I am seeing that I work with teachers who have been engaged in various efforts of technology integration over the past four years. Tech integration is a long-term process that requires support from the district through purchasing apps, professional development, tech workshop time, etc. (written journal, February 2, 2016).
These interactions have an accumulated impact on teachers’ technology integration and require sustained contact. This sustained contact can be achieved over time and through support at the district biome and building habitat. District and building level policies that increase the opportunities for teacher interaction and long-term commitment to providing teachers time for these interactions can positively impact technology integration. Zhao and Frank (2003) state that “the informal help and information that teachers provide to each other have important associations with the computer use” (p. 830) and that “the play and experimentation that teachers engage in during breaks in the school day and outside the school context are critical to technology implementation” (p. 830). My finding that the largest contributor to technology integration is other teachers confirms this result qualitatively. All of the cases including myself, made decisions to integrate technology because of interniche and intraniche interactions with other teachers. Ann and Carrie’s decisions to integrate technology were influenced by conversations with other teachers in the teacher workspace. Jeff was able to discuss technology integration in an intraniche interaction in his PLC, which then enabled him to modify the integration for his prep level students. Gary shared his TK with honors, general and prep level teachers during spring workshop time that enabled me to use the lab quest device in my classrooms. These interactions occurred informally in the teacher workspace, and during spring and summer workshops.

In addition this play is also a function of time. When district and building contexts are supportive of providing time for play to occur it creates a positive feedback loop within the ecosystem in which innovation is encouraged and teachers decide to integrate technology through reciprocal altruism. However time is a limiting factor at the state and
building levels, as less time is devoted to technology integration due to the limiting factor of assessment (SAT and AP exams) teacher technology integration is inhibited. Ann explained that she would like to create ibooks for her general physical science class but stated, “I just don’t have the time to do it” (personal communication, January 23, 2016). For the 2016-17 school year, teachers will be restricted to only summer workshop time and the April Institute day. This may not be enough to compensate for the limiting factors from the state biosphere and building habitat. PLC time may be a site for these interniche and intraniche interactions to occur. If PLC time is mandated at the building level to focus on SAT assessment, this may or may not be possible. This is consistent with previous research that describes time as a 1st order barrier (Bauer and Kenton, 2005; Ertmer, 1999; Hew and Brush, 2007; Chou, Block and Jesness, 2012; Garthwait and Weller, 2005; Grimes and Warschauer, 2008).

Another component of time is revealed when examining these cases. Each teacher has voluntarily taken on additional responsibilities on top of classroom teaching. These extra curricular activities constitute another niche teachers occupy outside of their classroom niche. Teachers in this study are not just preparing for classroom instruction during their planning periods before or after school. They are on committees, sponsor student activities, represent their fellow teachers in contract negotiations, order equipment for their fellow teachers and plan award ceremonies. These activities all require time spent outside of the classroom in meetings, going away for weekends for student competitions along with setting up classrooms for labs, grading papers and planning for instruction. They are mentoring new teachers by taking on student teachers. Or in my case, in graduate school taking classes after school and spending weekends in
the library. All cases reveal dedicated professionals who work tirelessly both inside and outside their classroom. Technology integration is an additional task teachers accomplish amidst an already complex endeavor of teaching science. The emic perspective of a teacher doing research reveals that time is a more salient issue when you include the extracurricular activities teachers engage in as yet another niche teachers occupy in the building habitat. This can be generalized to athletic coaches or teachers working on advanced degrees. Once the school day itself is over, much of a teacher’s work continues on into the evening. Extracurricular commitments are another niche teachers occupy that can contribute to the limiting factor of time inhibiting technology integration.

Research from the emic perspective of a teacher illuminates the variety of roles teachers play within the school ecosystem. They occupy multiple niches. Many teachers have taken on additional responsibilities to classroom teaching and as a result time becomes an extremely valuable but restricted limiting factor. Technology integration happens in a complex ecological framework in which teachers reside in multiple niches with multiple demands on their time. Time and assessment are limiting factors that inhibit technology integration and these factors are present at the state biosphere, district biome, and building habitat.

Classroom Niche

Several components of the classroom niche were revealed in this study. Ability level grouping influenced how teachers decided to use technology in their classrooms. The classroom niche was where I was able to watch teacher’s TPCK in action. It was also where I was able to observe and define a new component to TPCK of STK. At the
classroom niche level I was able to observe STK on multiple occasions and journaled about my own experience with it in my general and prep classrooms

**Ability Level.** Prep level and general students required more time and direct instruction on how to use technology properly, they are less engaged and more distracted by technology. When using technology to collect data in a lab prep students needed more time due to processing deficiencies, behavior disorders, and lack of motivation. Jeff took apps he used with his AP Physics students and modified them for use with his Prep Physics students. Jeff provided a description of a typical prep level student

The average prep kid here has a combination of lets say learning deficiencies it could be an issue of genuine learning disabilities or they have so many gaps in their learning from when they were younger they are just not at the level of their normal peers (personal communication, January 20,2016).

He described how he had to modify the way he used an app from AP to Prep

What we did is I spent more time the day before okay lets do a sample situation. Lets record it. I had everybody get up and do a sample where they recorded something and we found start and end time and talk about it so the next day when we did the actual lab It went pretty well. You know it’s always one of those things with prep their ability. It was just releasing a ball. They are videotaping and their hand is in front of the ball. You gotta make sure it’s visibl. (personal communication, January 20,2016).

This is triangulated through my observations of prep students and observations at the AP and honors levels and my own experience. Prep students were more off task and distracted by social media during observations. I experienced behavior issues using
the role-playing website in my general classroom. The two observations I made of Gary and Jeff’s’, AP classes revealed to me that behavior was not an issue, the pace of instruction was faster and students were on task. Gary’s honors students entered his classroom with higher STK, were less distracted by technology and more engaged in class work.

For Jeff and Gary their use of technology with their AP classes had an interniche impact on their use of technology with in a different niche. Gary piloted the lab quest with his AP Chemistry students and then shared that TK gained with the Honors and General Niche. Jeff took apps he used with his AP Physics and modified them for use with his Prep students. During the spring technology workshop I modified the lab quest lab for use with my prep level students by adjusting the directions for a lower reading level. This addresses a gap in the research on technology integration that largely ignores ability level grouping. It preliminarily reveals that ability level grouping can impact how teachers decide to use technology in the classroom. Ability level grouping and its impact on technology integration is an important issue worthy of more study.

TPCK. TPK and TCK were the most common application of teachers’ TPCK in the classroom. TPCK was observed when teachers used the lab quests or an app to collect and analyze data in lab. The most common observation was of TPK. Technology helped Gary, Ann, Carrie and myself formatively assess our students and provide them with immediate feedback. Gary used Socrative app with his honors and AP students. Carrie and I both used the Kahoot site to prepare students for summative assessments. Ann used Schoology to give her students lab quizzes, which spurred my use of this as well. Here, TPK, technological pedagogical knowledge was displayed in a variety of uses of
technology for formative assessment. The pedagogical activity of formative assessment is achieved with emerging technology (Cox and Graham, 2009). This use of technology for formative assessment has what Zhao and Frank (2003) call fecundity. They describe fecundity as “the capacity of some uses to spread more quickly than others” (p.814).

Jeff, Ann and myself displayed Technological Content Knowledge. Jeff used an online simulation to help his Prep Physics students learn about phases of the moon. Ann used an online simulation to help her students learn how to create Lewis Structure diagrams. I had my students do an online web quest to learn about nuclear power plants. The online simulations are topic specific representations using emerging technology and reveal “knowledge of how to represent concepts with technology” (p. 64).

TPCK, was observed in Gary’s use of the lab quest with his honors students, and Jeff’s use of a wave app with his AP class. It was evident in my use of the lab quests and my use of role playing game. In lab environments, the lab quest device, the graphical analysis app on the I-pad, and the wave app were all emerging technologies employed in a subject specific activity of a lab that produced topic specific representations in the form of graphs which facilitated student learning of science content (Cox and Graham, 2009).

One component not included in the TPCK framework is that of Student Technological Knowledge or STK. I observed students suggesting how to trouble shoot problems in both, Jeff and Ann’s classroom. I experienced it during my Science Raps projects where a student helped me overcome an obstacle to sharing work in garage band to I-movie. When I first used the lab quest in my general classroom, I relied on STK to help other students in my classroom sync their lab quests with the I-pad. Carrie stated:
I need more training to practice trouble shooting. If the kids are having trouble other kids can help other kids. I have some basic knowledge I am happy other kids can help. I use them they teach me things I don’t feel like I have to know everything (personal communication, February 2, 2016).

Teachers do not have to have all of the technological knowledge in order to integrate technology. Students come to classrooms with this knowledge and are a valuable resource to teachers as they work to integrate technology in their classrooms. Students engage in reciprocal altruism by sharing their STK with teachers and their fellow students. This can help a teacher’s own TK grow. As a result of this teacher-student interaction in the classroom niche, mutual adaptation can occur. Expanding the TPCK framework to incorporate STK illuminates how the framework functions in classrooms. Student technological knowledge is a fundamental contributor to technology integration and is a resource for teachers. Incorporating STK into this framework posits students as essential to the technology integration process while revealing the complex nature of technology integration.

**Social Capital.** One of the things that distinguished my technology integration efforts from the other cases was my access to social capital and a more constructivist approach. My use of technology deviated from the other cases in that I tended to try student centered, problem based, and collaborative work with my students more often than my colleagues. I attempted constructivist uses of technology. Despite sharing the role playing game and using the spring workshop in 2016 to create a new game, only Ann and myself used the game in our classes. With the Atomic theory role-play, the Comic Book app, and the Science raps projects my students were using technology to create a
product and teach each other content. Both the role-playing game and the Science Raps project are a function of my broad social network. I worked to expand my TK by trying new things and working with people who have skills of web design and music production that I do not possess. I brought resources external to the district biome into my classroom niche when using the role–playing game and for the Science raps project. I was contacted by a friend from my undergraduate college days through social media asking me if I wanted to create games for my students. I responded yes and then created three role-playing games with support from web designers. I was able to bring my husband into my classroom when my prep students were creating their science raps. His expertise with music production was an external resource that enabled me to have my students produce media within my classroom. I wrote in my journal:

I am able to do and try different things related to technology because I know people outside of the tech support at school that I can contact to try new things, thus I am leveraging my social capital to bring new resources into my practice. This social capital fuels my innovative use of technology. Not everyone has a musician for a spouse, knows rappers, or has international web designers as friends. These are resources that enhance my technology integration and exist outside of the district and school contexts (written journal, March 31, 2015).

**Expanding the Definition of Effective Technology Integration**

According to the previous research only my use of the atomic theory role play, science raps, comic book, Ann’s use of the role play game site and Gary’s use of having AP students create their own labs using the lab quest device would be considered effective, as they are student centered, problem based and constructivist (Ertmer and
Ottenbriet-Leftwich (2013), Kelly (2008). Project 21, ISTE). Using technology for formative assessment and to teach content are teacher directed uses of technology. However they were the predominate uses of technology that I observed. The research community needs to expand the definition of what effective technology integration is and it should not be limited to student-centered, collaborative, constructivist, problem based activities. Ertmer, Gopalakrishnan and Ross (2001) advocate for this as well when they suggest, “the description of exemplary practice included in the literature should be broadened to include more examples of how teachers adjust their constructivist practice to reflect real constraints and conflicting needs” (p. 21). Classroom uses of technology to help students gain content knowledge and formatively assess their performance meets Hamilton’s (2007) definition of technology integration. This definition included use of technology to introduce curriculum and for assessment. These were uses I observed throughout this study and incorporated into my own classroom niches. A further expansion of this definition would include using technology to support students in the process of gaining the basic skills necessary in a specific content.

One of the constraints this study examines is that of administrators demanding that teachers align curriculum to the NGSS since the state has adopted these standards. This is evident in the structure of PLC time to focus on common assessment and NGSS alignment leaving teachers in this study with less time to engage in conversations about technology integration. Teachers align their use of technology due to state mandated testing. Time and assessment are limiting factors that prevent teachers from more innovative uses of technology. These limiting factors are a function of the state biosphere, district biome and building habitat that impact teacher use of technology for
formative assessment at the classroom level. Using technology for formative assessment is effective use since teacher evaluations are tied to standardized testing due to state policy. Effective technology integration is context dependant.

The definition of effective technology integration depends on the classroom context. For students who lack basic skills, integrating technology to support skill acquisition should be considered an effective use. Gary and I both modified how we incorporated technology to address the learning disabilities of our prep level students. I chose not to use the role playing website with my prep level students since their reading level was much lower than that of my general level students. Teachers decide how to integrate technology based on the needs of the student populations in their various niches. Different student populations have different needs. Technology integration in an AP class looks very different than technology integration at the prep level. Effective technology integration has to respond to student needs. When students have low reading levels, processing deficiencies, and behavior disorders then effective technology integration can allow for differentiation. Using technology can provide students with the basic skills they need to be able to use technology to problem solve and work collaboratively. The authors of the observation rubric also suggest a definition of technology integration that is based on using technology as tools and resources to support teaching and learning of specific content (Hofer et al., 2011).

Larry Cuban (2001) explains why teachers don’t integrate in the research ideal as being due to the Historical, Social, Organizational and Political Contexts of Teaching, which refer to the broader contexts in which schools exist. He describes teachers as having “contextually constrained choice” and overcoming barriers and policies in order
to integrate technology. What Cuban found is that teachers ended up adapting the technologies to their needs and the limitations of the six period day and that most of the teachers were not achieving the ideal of effective integration as defined by experts. In order for teachers to be able to use new technologies in innovative ways and in ways suggested by researchers it is schools themselves that must change, not teachers. Cuban concludes by stating “without attention to the workplace conditions in which teachers labor and without respect for the expertise they bring to the task, there is little hope that new technologies will have more than a minimal impact on teaching and learning” (p.197). This means that unless researchers are willing to advocate for the elimination of standardized testing, Common Core, subjects segregated into distinct courses and the 8 period day, there will not be much effective technology integration that is authentic, student centered, and problem based as best practices suggest. Teachers who do find a way to achieve this do so in spite of the technology not because of it and they overcome institutional barriers to achieve this. Research that focuses on changing teacher beliefs does nothing to change the systematic constraints in which those beliefs operate. If teachers are being evaluated by student performance on standardized tests and lack time to work collaboratively on technology integration, changing their mindsets won’t lead to more effective technology integration. The definition of effective technology integration needs to be expanded to accommodate the assessment context that impinges on teacher autonomy when evaluation is tied to student achievement on standardized tests.

**The Ecological Metaphor**

I expanded Zhao and Franks’ (2003) ecological metaphor using my experience and education as a Science teacher. Due to my background in biology and ecology this
framework was familiar and appealing. I referred back to my college textbooks on population ecology to define the state biosphere, district biome, building habitat and classroom niches. Zhao and Frank (2003) started their quantitative analysis at the district level and examined four districts. They surveyed teachers but did not interview them or observe them using technology in their classrooms. Their observations focused on technology infrastructure while I observed and interviewed teachers using technology in their classroom niche. My focus was qualitative in nature. I started my expansion of the metaphor at the state level as the biosphere and the district as a biome located within the biosphere. Zhao and Frank (2003) did not examine state or federal policy in their regression model. By identifying the state as a biosphere I was able to examine the qualitative impact of state policy on teachers in their classroom niche. I maintain that each district should be considered to be a different biome. Each biome may respond differently to the state biosphere. I began at the state level and was able to see how state laws and policies impacted the district biome, building habitat, and classroom niche. I focused on one district biome, one school habitat and multiple classroom niches nested within the same district biome and building habitat. Just as districts biomes may differ in their response to the state biosphere, different schools may also respond differently to the same district biome. This allowed me to focus on the multiple niches teachers occupy within one building habitat.

Zhao and Frank’s (2003) original study was of elementary schools whereas I applied the metaphor to a single high school. This allowed me to explicate the classroom niche as a specific course and ability level. I included interniche and interaniche interactions into the metaphor for teacher species encounters.
I maintain that students are a keystone species that contribute to the classroom niche and technology use by engaging in reciprocal altruism with each other and with teachers. Classroom observations allowed me to experience this cross species interaction in the classroom niche. I consider administrators as a gatekeeper keystone species since they can provide or restrict teacher access to technology. In the original study administrators and students were described as merely biotic component of the ecosystem. Classroom observations and interviews with teachers revealed that students and administrators interact with the teacher species and those interactions are important environmental components of technology integration.

One thing that could further expand the metaphor would be to examine the role of administrators as another keystone species. My study did not this do this but administrators could be another component of the school habitat that impact classroom technology integration. Examining the interactions of teachers and administrators in the building habitat as a distinct populations existing within a community could provide another factor that impacts technology integration in the classroom niche and reveal further complexity. Another expansion of the metaphor could also being starting at the national level instead of the state level. Overall this metaphor was a useful tool to help me understand and reveal the complex nature of technology integration using terminology I was familiar with as a science teacher. Additional studies could examine the role of administrators, variation between district biomes in the same state, variation between state biospheres or variation between schools that share the same state biosphere and district biome.
Limitations

This study is limited in that it focuses on one school habitat and the subject of science. Teachers in different niches or subjects may respond to the district biosphere, school biome and classroom niches in different ways. This study only examined science teachers.

Another limitation is that this research was conducted in a technology rich district. All of the teachers and students had access to ipads and teachers all had district issued lap tops. Not all school districts provide this type of technology to teachers or students. This research may not be generalizeable to districts where access to technology is low.

None of the participants were new teachers. Ann had the least amount of experience at 11 years while Carrie was the most senior teacher at 31 years of experience. Carrie does mention using online quizzes and activities created by another younger teacher, who was her student teacher the year prior. Ann mentioned in the interview that the same younger teacher showed her the NGSS app for the I-pad. The perspective of young, untenured teachers who may be more comfortable or have more TK due to teacher training is missing from this study. All teachers who volunteered to participate are open to technology use. The perspectives of teachers who are resistant or oppose technology use are important to give voice to as well. This study did not achieve that.

Another limitation is that of the time of the study. While I was able to collect long-term data about my own technology integration, from the 2014-15 to the 2015-16 school year, I only observed my colleagues over the course of one quarter. More
observations over a longer time period could produce more data on how TPCK functions at the classroom level.

**Recommendations**

This research suggests that teachers need time to continuously develop their TK as emergent technologies make their way into classrooms. The process of TK adaptation to emerging technology is one that is long term and continuous. Teachers must constantly be learning about what the technology is capable of and have time to attempt new uses. Time remains a barrier to this process.

Providing long-term subject-based Professional Development on technology integration along with in time technology support could encourage teachers’ technology integration efforts. Teachers require time for interniche and intraniche interactions to explore technology integration prior to classroom use. Policies that support this process will contribute positively to technology integration at the classroom level. Professional development programs can support the evolutionary and adaptive nature of technology integration.

The District Internal University is one way of providing teachers up to date technology knowledge. Support at the building and district level can continue to provide teachers with access, technology support and time. Environmental factors of a building level ITF providing technology support, the district providing workshop time in the summer and spring, and the April institute day devoted to technology are all things that support this evolutionary nature of TK. Teachers require consistent professional development over the long term that is responsive to emerging technology while providing teachers the time they need to play and provide opportunities for both
interniche and intraniche interactions around the issue of technology integration. Teachers need professional development that is content specific and expands their TK. Policies at the building, district, and state level that support this process are necessary. One first concrete step would be allowing teachers to use PLC time to discuss technology integration while addressing NGSS standards or SAT assessment. Teachers need autonomy in PLC’s to decide how to use that time.

The definition of effective technology integration needs to be expanded as context dependent. In a context that emphasizes test scores and ties teacher evaluation to test scores, harnessing technology to improve test scores is effective use. When students enter classrooms lacking basic skills, integrating technology in a manner that allows them to develop those skills is effective integration. Effective technology integration may look different for different teachers, working in different contexts.

Teachers are as Cuban (2001) describes, “contextually constrained” (p.173) in their technology use and will remain so. Changing teacher beliefs toward a constructivist position without changing the constraints upon teachers will not lead to more student centered problem based constructivist uses of technology. There is a need for a broadening the definition of effective technology to include the contexts in which teachers function instead of blaming teachers for lack of proper technology integration. Cuban, Kirkpatrick and Peck (2001) suggest that in order for teachers to be able to employ a constructivist approach to technology integration that the ways in which the school day is organized need to change. Policies at the state, district or building level that limit time available for teachers to collaborate around issues of technology integration and emphasize assessment, inhibit technology integration that is student centered.
problem based and constructivist. Until these policies are removed, teachers will integrate technologies in ways that enable them to meet the constraints placed upon them.

**Suggestion for Further Research**

Case study comparing technology use in new untenured teachers compared to older more experienced teachers would provide new light. It is also important to hear from teachers who resist technology use. This study found that for teachers to acquire TK, there is both a long term and short-term process of TK expansion. As technology evolves so must teacher TK. A longitudinal study could reveal how TK changes over time. Further study on ability level grouping and its impact on technology integration is needed. Applying the ecological metaphor to examine variation between states, districts or schools within the same district would be useful to continue to examine the complex endeavor of technology integration.

**Final Thoughts**

The dedicated colleagues I work with on a daily basis inspired me. This research reconnected me to my joy of taking classroom risks and learning from my failures. I saw my TK expand through use of new technologies and found that I have collaborators in Ann and younger teachers who are open to technology integration. It moved me out of myself and encouraged me to share my innovations with others. I pivoted from working alone in my bat cave to collaborating with teachers in my general niche, to sharing my work with other teachers in my division. I proposed an Internal University course for the District that would allow me to show other teachers how to create their own role-playing games. I am hoping to begin teaching this course in the spring of 2017. Had I not
discovered the importance of teacher interactions in technology integration, I would have never shared this TK with others.

My background in science education predisposed me to a quantitative research. At the beginning of this journey I assumed I would ultimately conduct a quantitative study. Through this process I was surprised to discover that qualitative research methods were what would answer the questions I was most interested in. I have had my perspective on research broadened.

While conducting this research, I dreamt about having virtually reality goggles for my students. I awoke the next morning, my mind spinning with the possibilities. I look forward to the day when I can take my students on a virtual field trip to Chernobyl to study the impact of nuclear radiation on the environment. When that technology is available I will be ready and waiting to use it and adapt.
APPENDIX A

RECRUITMENT LETTER
Dear colleagues,

As many of you know I am working on my Ed.D in Curriculum and Instruction at Loyola. My dissertation is on technology integration. I will be conducting a case study on how teachers are integrating technology with different populations of students. (AP, honors, general and prep level). I am interested in how the classroom context, school context and building context impact your decisions about how you are using technology in your classroom. I am looking for four to six volunteers. I would observe you in your classroom using technology five times and conduct an interview about how and why you decided to use the technology. Administrators will not be aware of your participation. None of the data I collect will be shared with administrators or used for evaluation purposes. Thanks for considering helping me out!

Sincerely,

Joanna Marshall
APPENDIX B

OBSERVATION PROTOCOL
Directions: This instrument is designed to focus upon the use of technology integration knowledge in observable teaching. Please record the key curriculum topics addressed, instructional strategies/learning activities observed and digital and non-digital technologies used by the teacher and or students in the lesson.

<table>
<thead>
<tr>
<th>Curriculum Topic</th>
<th>Key instructional strategies</th>
<th>Digital &amp; Non-Digital Technologies</th>
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What prior knowledge about students learning needs, preferences and challenges; access to technologies; cultural, language and/or socioeconomic factor may have influenced what has been observed in this lesson?
Directions: Referring to the notes made, and the response to the question about influences, complete the following rubric considering the lesson observed as a whole.

<table>
<thead>
<tr>
<th>Curriculum Goals and Technologies (matching technology to curriculum)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technologies used are strongly aligned with one or more curriculum goals</td>
<td>Technologies used in the lesson are aligned with one or more curriculum goals</td>
<td>Technologies used in the lesson are partially aligned with one or more curriculum goals</td>
<td>Technologies used are not aligned with one or more curriculum goals</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructional Strategies &amp; Technologies (matching technology to instructional strategies)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technologies use optimally supports instructional strategies</td>
<td>Technologies use supports instructional strategies</td>
<td>Technologies use minimally supports instructional strategies</td>
<td>Technologies use does not support instructional strategies</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology Selections (matching technology to both curriculum and instructional strategies)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology selection(s) are exemplary, given curriculum goals and instructional strategies</td>
<td>Technology selection(s) are appropriate, given curriculum goals and instructional strategies</td>
<td>Technology selection(s) are marginally appropriate, given curriculum goals and instructional strategies</td>
<td>Technology selection(s) are inappropriate, given curriculum goals and instructional strategies</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>“Fit” (considering curriculum, pedagogy and technology all together)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Curriculum, instructional strategies and technology fit together strongly</td>
<td>Curriculum, instructional strategies and technology fit together</td>
<td>Curriculum, instructional strategies and technology fit together somewhat</td>
<td>Curriculum, instructional strategies and technology do not fit together</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructional Use (using technologies effectively for instruction)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructional use of technologies is maximally effective</td>
<td>Instructional use of technologies is effective</td>
<td>Instructional use of technologies is minimally effective</td>
<td>Instructional use of technologies is ineffective</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology Logistics (operating technologies effectively)</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers and or students operate technologies very well</td>
<td>Teachers and or students operate technologies well</td>
<td>Teachers and or students operate technologies adequately</td>
<td>Teachers and or students operate technologies inadequately</td>
<td></td>
</tr>
</tbody>
</table>

Comments

Modified from “Technological Integration Observation Instrument” by Judi Harris, Neal Grandgenett and Mark Hofer
APPENDIX C

INTERVIEW PROTOCOL
Post-Observation

How long have you been teaching with iPads?

How long have you been teaching this specific course?

Why did you decide to use the iPad in your class today?

Tell me about a lesson with iPads that you feel went really well?

Tell me about a lesson with iPads that didn’t go as planned?

Tell me about the app you used when I observed you? How did you decide to use that app?

How would you describe a typical student enrolled in your course?

What professional development have you had for iPad integration?

Have you felt pressure to achieve the district goals?

Have you used PLC time to discuss with others how to use the iPad?

How do you decide how to use iPads in your course?

How has using the iPads changed your course?

Is there anything you would like to do with the iPads but haven’t yet?

What do you think is preventing this use?

Is there another day you would like me to observe
TEACHER CONSENT TO PARTICIPATE IN CASE STUDY RESEARCH

Project Title: Technology Integration in Context  
PI: Joanna Marshall  
Faculty Sponsor: Dr. Dave Ensminger

You are being asked to take part in a research study for a dissertation being conducted by Joanna Marshall a doctoral student in the Department of Curriculum and Instruction at Loyola University of Chicago.

You are being asked to participate because you are part of a 1 to 1 iPad program and teach science. Please read this form carefully and ask any questions you may have before deciding whether to participate in this study.

Purpose: This study attempts to understand how science teachers use the technology in their classrooms. It will attempt to understand how district, building and classroom contexts impact the ways in which teachers integrate technology into a science course.

Procedures:

If you choose to participate you will be asked to:
• Be observed five times when using iPads in your classroom  
• Participate in one, one-hour interview

The interview can be held in a private conference room reserved by the PI or at an coffee shop off campus as preferred by the participant.

These data collection activities are described below:

Classroom observations: You will be observed by the PI when using ipads or other technology in your science classroom. The PI will complete an observation protocol form for each observation. The PI will also take field notes.

Semi-Structured Interview: You will be asked to participate in one, one-hour semi-structured interview that will be audio recorded. This interview will be conducted to gain an understanding of why you choose to use the ipad and what contextual factors impacted this use.

Risks/Benefits: There are no foreseeable risks involved in participating in this research beyond those experienced in everyday life. Administrators will not be aware of your participation. Any data collected will not be used for evaluation or shared with administrators.

The benefits to you from participation may be a chance to reflect on how you are using technology in your classroom. The results may help other teachers attempting to effectively integrate technology into their classroom.

Confidentiality:
Research activities associated with your participation in Technology Integration in Context Teachers including observation field notes, completed observation protocol forms and audio recordings of interview will be kept confidential and reported anonymously. If you participate, you will be given a pseudonym to protect your anonymity. All identifying information will be removed from any documents.
Interviews will be recorded and uploaded to the researchers personal lap top computer with a log in. Once the research is completed the file will be deleted from the laptop. Any data collected will not be shared with administrators or used for evaluative purposes. All qualitative data will be expunged of any identifying information prior to use in reports; publications or presentations and pseudonyms will be used when low inference indicators and quotes are used in presentation or publications.

**Voluntary Participation:**
Your participation in data collection activities will be an ongoing element of your participation in: Technology Integration in Context. However, use of any data obtained by these methods is subject to your voluntary permission granted herein. Even if you decide to participate, you are free not to answer any question or to withdraw from participation at any time without penalty. If you currently have a relationship with the researcher or are receiving services from the cooperating research institution, your decision to participate will have no affect on your current relationship or the services you are currently receiving. You can ask to withdraw from research at any time. Should you decide to do so, we ask that you notify a principal investigator of your decision to withdraw.

**Contacts and Questions:**
If you have questions about this research study, please feel free to contact Joanna Marshall at 773-531-3869 or Dr. Dave Ensminger at densmin@luc.edu

If you have questions about your rights as a research participant, you may contact the Loyola Office of Research Services at (773) 508-2689.

**Statement of Consent:** Your signature below indicates that you have read the information provided above, have had an opportunity to ask questions, agree to allow data collected from evaluation activities to be used in generating internal and external reports, conferences and scholarly writing and agree to participate in this research study. You will be given a copy of this form to keep for your records.

<table>
<thead>
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<th>Participant’s Signature</th>
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<th>Researcher’s Signature</th>
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REFERENCE LIST


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VITA

Joanna Marshall was born in Oak Park and raised in Niles, Illinois. She attended Maine East High School in Park Ridge, Illinois and was a member of the swim team. She obtained her Bachelors degree in secondary education general science from the University of Illinois. While working on this degree she worked as a lifeguard and swim instructor for the University. Joanna can still tell you where all the pools are on the campus. She began her career as water aerobics instructor at the Mc Kinley Family YMCA in Champaign, Illinois.

She student taught in the suburbs of Chicago and immediately upon graduation was hired as a science teacher at the school where she student taught. During her nineteen years in this school she has taught a variety of science classes: biology, advanced biology, physical science, science and society and chemistry. While working full time as a teacher she obtained a Masters of Arts from Appalachian State University in Boone, North Carolina. She spent a few summers in Boone, used the pool there and emerged from the program as an Instructional Technology Specialist with a Medial Literacy concentration.

She currently resides in the Northwest Austin neighborhood of Chicago. She enjoys swimming, seeing any one of her husband’s band play live and runs an instagram account for her cat, Boo. Boo is a cat deejay and thanks to an extensive record collection has impeccable, eclectic taste in music.
The dissertation submitted by Joanna Marshall had been read and approved by the following dissertation committee:

Dave Ensminger, Ph.D., Program Chair
Associate Professor, Teaching and Learning
Loyola University Chicago

Leanne Kallemeyn, Ph.D., Program Chair
Associate Professor, Research
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Lara Smetana, Ph.D.
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