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I, Susan Farber, hereby submit this original work as part of the requirements for the degree of:

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Student Signature: Susan Farber

This work and its defense approved by:

Committee Chair: James Basham, PhD

James Basham, PhD

Kay Seo, PhD

Kay Seo, PhD

Catherine V. Maltbie, EdD

Catherine V. Maltbie, EdD

Holly Johnson, PhD

Holly Johnson, PhD
The Effect of Guided Self-Reflection on Teachers’ Technology Use

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Susan Farber, M.A., M.Ed.

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Committee Chair: James D. Basham, Ph.D.
Abstract

The purpose of this study was to pilot an instructional planning tool grounded in guided self-reflection on the instructional planning practices and instructional behaviors of a small sample of teachers. I designed the instructional planning tool, which was named the Informed Technology Integration Guide (ITIG). Participants used the instructional planning tool to document their definitions of effective technology use, their selection of resources (traditional instructional and digital or emergent technologies) and instructional strategies to facilitate students’ exploration of topics and skills based on standards and instructional goals. The ITIG provided a sequence of self-reflection questions to facilitate teachers’ evaluation of the instructional activity documented in the ITIG. These questions focused on how well the use of technology supported the instructional goals of the activity.

Through observations, interviews, and analyses of submitted ITIGs, I collected triangulated data to create a rich, descriptive narrative to share these participants’ decisions concerning the use of technology to support instruction and student learning. Participants also provided survey data to determine their level of technology use and their beliefs about the role of technology in education, while recognizing contextual factors impacting technology use decisions. The survey instrument, observation and interview protocols were modified from prior research investigating technology use levels and effective instructional strategies.

This pilot of the instructional planning tool, survey, and protocols yielded evidence that teachers’ documentation and reflection on their instructional planning impacted their decisions concerning the instruction they were planning. Participants recognized the power of reflection to guide them to enhance their use of technology and expand their awareness and consideration of alternative forms of emerging and traditional instructional technologies to impact student
learning. They also realized the degree to which their use of technology aligned with instructional strategies they employ to create effective activities. Some participants viewed technology as a central aspect of contemporary life and demonstrated the process of technology transparency (Bruce & Hogan, 1998).

I also present evidence of the need to reconsider how we measure effective technology use levels. Many research teams tend to use survey data and frequency counts, which omit the contextual factors and interrelationship of technology use amid content area curricular goals. I propose the need to consider and document how well teachers develop skills in blending the selection of technology, resources, instructional strategies, and pedagogy to address students’ needs and infrastructural realities to measure technology use levels.

As this study is preliminary, additional investigation of the benefit, usability and sustainability of this instructional planning tool with a significantly larger and more diverse sample will offer guidance as to the impact of guided self-reflection to enhance teachers’ instructional planning and enactment, as well as nurture more consistent technology integration.
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As with any complex, long-term project, many people contributed to its successful outcome. First and foremost, the faculty members of the Programs of Teacher Education and Educational Studies have been encouraging and expressed interest in my work during the six years I have invested as a doctoral student and as a novice researcher. The collegiality the faculty extended to me over time provided me with direction, as well as a sense of where future paths may lead.

The members of my committee contributed to my success. Dr. James Basham, chair, reminded me time and time again of the study’s potential impact, as we discussed the findings and its ramifications for teachers’ grasp of instructional design and the role of technology in teaching and learning. Dr. Holly Johnson correctly insisted on revisions to increase the integrity and rigor of this study and often suggested more effective phrasing to communicate ideas. Dr. Cathy Maltbie guided me through research design and methodology as I changed topics and revised the focus of my research. Cathy has been a guiding force as she helped me structure my ideas during the course of data analysis. Dr. Kay Seo reminded me of the need to explain assumptions and the rationale for my decisions as a researcher.

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Finally, my family’s patience and love made it all possible. My husband, James, has been a real trooper through all of this process. My almost adult children, Adina and Jared, accepted the few times that I was not as available to help them with their studies and discussions of life’s concerns when someone is a teenager. My parents, who wondered if I completely lost my common sense to return to school in this economic climate, now realize that my goal to help teachers empower themselves as reflective instructional designers has merit and potential.

Concluding that effective teaching and technology use is supported by critical reflection or cyclical evaluation of what happens in classrooms, documented through an instructional planning tool (such as the ITIG), may seem like an over-simplistic proposal to nurture consistent technology integration. I look forward to the opportunities to empower teachers as our role as educators has become increasingly challenging in the past decades.
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Chapter 1
Introduction

We’re now dealing with unprecedented and accelerated increases in the rate of change – change that is happening not only quickly but also pervasively. Change that is happening so quickly that it’s hard to understand what’s going on or even recognize all of the implications (Jukes, 2007, p. 6).

In a recent online essay, Jukes (2007) provided evidence of the accelerating pace of societal changes in the use of technology and forms of communication within educational settings. Technology’s rapid penetration into the field of education however, often leaves teachers overwhelmed and seeking guidance for optimal use. It has been shown that teachers and students underutilize the technology in classrooms (Bebell, Russell, & O’Dwyer, 2004; Cuban, Kirkpatrick & Peck, 2001; DiBenedetto, 2005) and that technology integration is stymied due to numerous interacting factors. Teachers’ reconciliation of their beliefs about technology’s usefulness in classrooms and their needs as facilitator of instruction may encourage or limit experimentation and frequent use of computers and related technology (Zhao & Frank, 2003). Beliefs concerning the benefits of technology use in classrooms have impacted technology use levels and have been measured in technology use surveys for the past three decades (Becker, 2000; Moursund & Bielefeldt, 1999; Ringstaff & Kelley, 2002). The level of support teachers experience within their classrooms and schools often impacts the degree to which they will innovatively use or avoid computers and related technology (Zhao, Pugh, Sheldon, & Byers, 2002).
An ongoing challenge emerges for teachers to have adequate time to match optimal uses of technology, locate or create digital resources to support content area instructional goals, in addition to all of the other tasks of teaching. Since teachers may not receive needed technical support, time or training to effectively integrate technology, such barriers to consistent technology use in classrooms may persist. This challenge is magnified by the changing expectations and capacities for how we learn and communicate due to frequent upgrades and enhancements to our technological tools and devices (Dede, 2005) and yet remain technically competent to model and anticipate technical competency for students who are to function successfully using technology in the 21st century workplace and culture.

Research on technology integration increasingly provides evidence that teachers need varying levels of technology support, conducive settings, and opportunities to collaborate in order to design and implement relevant and effective technology use by teachers and students (Kanaya, Light, & Culp, 2005; Levin & Wadmany, 2006; Nachmias, Mioduser, Cohen, Tubin, & Forkosh-Baruch, 2004; Wells, 2007; Wild, 1999). Several researchers have created and tested frameworks to enhance teachers’ capacities to integrate technology (Fitzallen, 2004; Glazer, Hannafin, Polly, & Rich, 2009; Hixon & Buckenmeyer, 2009; Koehler & Mishra, 2008; Mouza, 2006; Orrill, 2001) with the promise of more widespread and consistent technology integration in classrooms. Preliminary findings from testing the use of such frameworks and the establishment of collaborative, supportive settings for technology integration demonstrate increasing comfort in using technology and teachers’ increased motivation to learn more skills to incorporate technology more frequently in their work with students (Brinkerhoff, 2006; Dawson, 2006; Mouza, 2006, Orrill, 2001; Pugach, Staples, & Himes, 2005). Other studies’ outcomes indicate the need to systematize and institutionalize technology integration supports to increase the
frequency and consistency of technology use in classrooms (Dexter, Doering, & Riedel, 2006; Dickard & Education Development Center, 2003; Kopcha, 2008; Ludwig & Taymans, 2005).

**Statement of Problem**

Some researchers have investigated technology use among teachers and identified several barriers to effective technology integration. Ertmer (1999) provided examples of the complex interrelatedness of several barriers that impede effective technology integration based on her analysis of teachers’ struggles to use technology in classrooms. She described incremental, institutional, fundamental and personal barriers that occur over time and in varied levels of intensity for teachers. Zhao and Frank (2003) identified logistical, technical, pedagogical, and managerial uses of technology, interacting with a range of teachers’ beliefs and shared experiences using technology as factors determining technology use levels in classrooms. Researchers have yet to create and test a process designed to increase teachers’ capacity to effectively integrate technology that is aligned with instructional planning practices, to institutionalize and systematize documented technology integration practices. Bauer and Kenton (2005) noted skill levels, dependable equipment, access to the Internet and adequate numbers of computers, and time as barriers impeding teachers’ consistent and effective use of instructional technology.

This study pilots an instructional planning tool to support and enhance teachers’ capacities to integrate technology. Using existing research on reflection-in-action (Schön, 1987), critically reflective teaching (Brookfield, 1995) and the impact of ongoing communication and reflection to encourage transformative teaching practices (Cranton, 2006; King, 2002; Schifter, 2008), this study intends to explore teachers’ use of an instructional planning tool that guides teachers’ internalized self-reflection to increase their capacity to integrate technology effectively.
and to evaluate the outcome of these instructional activities. Internalized self-reflection depends on critiquing what occurs in the classroom to ascertain a fuller perspective of classroom activity (Brookfield, 1995). Through this critique, teachers can determine if the instructional activity and use of technology has provided benefit to students, which is the ultimate goal of their efforts to plan and deliver instruction. Critical reflection helps teachers identify “the rationale behind [teachers’] practice” (Preskill & Brookfield, 2009, p. 45), guiding the evaluation of selected strategies’ and resources’ benefit for students.

**Questions Guiding the Study**

To explore how an instructional planning tool impacts teachers’ thinking about and usage of technology in their instruction, the following questions guided this study and the research design:

1. What happens when teachers utilize guided self-reflection to document their instructional planning practices and decisions regarding technology use? In what way did the utilization of the instructional planning tool (Informed Technology Integration Guide, or ITIG) impact teachers’ instructional planning practices and decisions concerning technology use?

2. What happens to teachers’ instructional behaviors when guided self-reflection is utilized prior to delivering technology-supported instruction? In what ways did teachers’ instructional behaviors differ when the ITIG is utilized prior to delivering technology-supported instruction?

3. What additional issues, surrounding technology use, impacted these teachers’ instructional planning practices and instructional behaviors?
Definition of Terms

Terminology used in educational research often needs to be clarified for the readers, due to a range of definitions used in professional conversations and the literature. This section shares definitions of key terminology so all readers comprehend and visualize the context of my study and share in a commonly understood vocabulary.

**Collaboration** is a process where teachers choose, as a group, to discuss their selection of resources and strategies in order to enhance instruction and interaction with students. These teachers appreciate brainstorming and idea exchange in order to solve challenging educational problems. This discussion is quite intentional and focused, frequently a “talk often about their professional work … for the improvement of instruction … professional discourse about their own learning and instruction.” (Goddard, Goddard, & Tschannen-Moran, 2007, p. 880)

**Emergent technology** is a categorical name for innovative and recently introduced applications and devices that facilitate communication and creation of modifiable resources teachers use with students. Often “knowledgeable users [are] customizing their tools, services, sources of information, methods of communication and networks of people to suit their personal needs.” (Becta, 2007, p. 4) Both teachers and students are using emergent technology tools and applications to customize their lessons, activities, instructional resources and the products representing student academic growth.

**Good use of instructional technology:** Describing what is good can be a challenge, as this concept changes and is contextual. The acronym, ICT, is often used in the literature to mean information and communication technologies. Citing a definition from the research that provides desirable characteristics of instructional technology use:
“...very good use of ICT involved: making varied use of ICT (e.g. with both teachers and pupils using ICT for learning); regular use of ICT (more than a lesson a week); and the ability to focus on the use of ICT to support subject teaching. ... the ability to reflect on the use of ICT constituted another characteristic of the very good user.”
(Hammond, Crosson, Fragkouli, Ingram, Johnston-Wilder, Kingston, Pope & Wray, 2009, p. 62)

*Guided self-reflection* is a cognitive process underlying the framework created and tested in my study. The process of guided self-reflection provides practitioners opportunities to practice the strategy of posing questions to evaluate the benefit and determine any shortcomings or suggested changes in the implementation of instructional planning with a group of students; the model intends to document the decisions, options, benefits and recommended enhancements to the instructional plan.

This process of guided self-reflection is based on the work of Schön (1987 – reflective practitioner) and Brookfield (1995 – critically reflective teaching). Brookfield anticipated that through critical reflection, teachers become increasingly aware of their decisions, preferences, biases, and stance. Brookfield defined good teaching as “a continuous and critical study of our reasoning processes and our pedagogic actions.” (Brookfield, 1995, p. 42).

Note: The process of guided self-reflection is encouraged and documented through the use of an instrument, Informed Technology Integration Guide (ITIG), which is the tool being piloted in my study.

*Informed Technology Integration Guide – ITIG* – is the name of the instructional planning tool being piloted in this study – the tool provides for: (a) systematic documentation of instructional planning decisions, (b) definitions of effective technology use, (c) categorization of
various uses of selected technology referencing two taxonomies found in recent literature, and (d) evaluation of resources and technology’s impact as it related to the instructional activity, instructional goals, and student learning.

*Instructional behaviors* are verbalizations, actions and routines established and enacted by teachers so students experience success in learning information and adopting specific skills.

Discussing teachers’ behaviors and messages to promote student autonomy, Reeve and Jang (2006) provided a table of 21 instructional behaviors, such as (a) offering informational language, (b) creating opportunities for students to work independently or complete specific tasks, (c) being responsive to student-generated questions, (d) establishing a teaching agenda, (e) holding or monopolizing learning materials, (f) exhibiting or uttering solutions or answers, (g) uttering directives or commands, (h) praising or criticizing student performance, and (i) providing hints to correct or attain desirable responses.

This list of instructional behaviors from educational psychology aligns with a coding system of instructional activities, shared by Cassady, Speirs-Neumeister, Adams, Cross, Dixon, & Pierce (2004) that is incorporated within the observational protocol designed for my study.

*Instructional planning practices* are teachers’ actions and decisions pursued in the creation, selection and development of activities and related materials, for teacher and/or student use during classroom instructional activities or supplemental activities (enrichment and remediation).

This definition is influenced by recent research analyzing the relationship between instructional design models and teachers’ actual instructional planning processes. Lim and Chai (2008) pointed out that “teachers need to critically examine their existing [instructional planning] practices and explore new ones that take up the affordances of technology… to approach
learning situations of uncertainty and complexity” (Lim & Chai, 2008, p. 2004). Lim and Chai acknowledged Schön’s (1983) description of the messy or complex environment where such decisions are often made. The ITIG instructional planning tool is designed to document and facilitate a critical examination of instructional planning practices and processes, with recognition of the affordances of technologies and consideration of the messiness and complexity of educational settings.

*Instructional technology* is the collection of innovative objects and strategies selected for use in educational settings or for use by students. Liu and Johnson (2001) encouraged the use of “technologies as tools to improve classroom teaching and learning through integration of instructional technology into the curriculum” (Liu & Johnson, 2001, p. 81). The use of technologies to improve classroom teaching and learning is described as a decision-making process to determine the quality of the outcome of students interacting with the selected instructional technologies, understood as a dynamic event due to the complex and varying contexts of classrooms.

*Technology* is the collection of innovative objects and strategies that enhance and facilitate communication and completion of necessary tasks. This definition is grounded in the “evolving knowledge to adapt and improve systems” (Hooper & Rieber, 1995). Reigeluth (1989) described the systematic development and evaluation of applications, theories and procedures that impact instructional design and determine educational technology’s role in the classroom. Technology is also viewed as a “process and a way of thinking” (Finn, 1960, p. 6) and that “technology should begin to extend into the instructional process itself” (Finn, 1960, p. 11). Technology is more than the innovative objects; recognition of the process and decision
factors impacting the use of innovative objects should be the focus when educators design instructional activities.

*Technology integration* is the decision to include and anticipate use of a range of digital, emerging and traditional technologies to enhance instructional activities. “Technology integration occurs when we design lesson segments, lesson units, and entire courses”… so students complete and understand instructional tasks (Liu & Johnson, 2001, p. 87). It is more than mastery of technology; technology integration facilitates and enhances the completion and presentation of outcomes of instructional activities.

*Traditional instructional technology* categorizes the innovations that have been introduced in the past, which are regarded as necessities or taken for granted due to their long-term or ubiquitous use (i.e., textbooks, posters, writing implements, audiotapes, etc.). Keeler (2007) described varied and creative uses of technology that are representative of transparent technology integration methods. As Bruce and Hogan (1998) explained, through increased use, technologies develop a transparency of perception as they have become commonplace and their innovative nature has disappeared. It is intended that over time digital technologies develop transparency due to increasing and consistent use in classrooms and in day-to-day circumstances. Traditional technologies developed transparency through repeated past usage. Digital and emerging technologies are gaining transparency through individuals’ repeated use and increasing dependency.

**Background**

Most observers of classroom activities anticipate innovative and varied forms of technology (traditional and emerging) used by teachers and students. As a former practitioner, I recognized the successes, challenges and barriers associated with the use of diverse forms of
traditional and emerging technologies as noted in the literature on technology integration. Numerous studies of how these forms of technology have impacted teachers and students still yield numerous questions as to their value and the circumstances under which technology’s benefit can be gleaned. As Vrasidas and Glass (2007) emphasized, researchers and teacher educators may not be able to identify effective practices of technology integration in classrooms. Literature describing the results of technology integration studies noted that teacher and student use of technology falls along a continuum of options or possibilities (inferring multiple effective uses of technology exist grounded in contextual factors), and that this continuum encourages an evolution in the manner in which technology can be used in classrooms (Mills & Tincher, 2003; Rakes, Fields, & Cox, 2006; Sandholtz, Ringstaff, & Dwyer, 1997).

The need to document and facilitate practitioner-evaluation of the ongoing evolution in how teachers and students use technology in classrooms underlies the purpose of my study. Testing the use of guided self-reflection within an instructional planning tool (to document and evaluate selected uses of technology and resources) is the primary purpose of my study. I noticed that teachers have much to gain when supported and encouraged to recognize this continuum of effective technology use via documentation, exploration, experimentation, reflection and evaluation. Documenting the outcome of collaborative planning and increased understanding of how technology supports instructional planning and student learning provides practitioners a sense of where they have been, what they have learned, and how they can continue to enhance their work as teachers. Through documented experimentation, evaluation and reflection of technology use in classrooms, we can start to identify effective uses of technology (noting contextual factors), as Vrasidas and Glass (2007) suggested. Ubiquitous use of technology and significant changes in our contemporary society necessitate students’
expanding cognitive development through effective deployment of technology as tools. These observations and ideas for ongoing research are also shared in the literature on instructional technology use and integration in classrooms (Dede, 2007; Fitzallen, 2004; Lajoie, 2005; Pellegrino, Goldman, Bertenthal, & Lawless, 2007; Szabo, 2002; Wilson, Sherry, Dubovolny, Batty, & Ryder, 2002).

**Theoretical Framework**

Essays and prior research, through analyses of technology use in classrooms, create a theoretical foundation for future research. Three theories provide a framework for my study, technology as a thought process, technological determinism or the social shaping of technology. Recognition that technology is more than the devices that we associate with the concept ‘technology’ has ramifications for how teachers and students employ technology. Acknowledging and assessing the negative and positive outcomes when using technology can guide teachers in their decisions surrounding these questions. What technology can I use? In which way should I use technology(s)? How should students use technology(s)? How will I recognize that this use(s) of technology has been beneficial/detrimental? How should I respond when students suggest a use for technology that I did not anticipate or uncover during my instructional planning?

**Technology as a thought process.** One group of researchers and theorists focused on the need to encourage technology users to contemplate and determine how to extract technology’s benefits and simultaneously minimize its shortcomings. Finn (1960) provided such a foundation in his analysis of the benefit gained when using technology (i.e., television, audiovisual materials, and computer-based assessments) in classrooms. He felt that teachers (educationalists) should select and control technology and determine how best to use it to
implement curricular goals. Technology was defined as a thought process that extends and considers the use of innovations and machines to benefit instructional processes occurring in classrooms. Most individuals conceptualize technology as the tools (online resources, devices and applications), and not the thought process defining the use of these tools. The purpose of the ITIG instructional planning tool is to document and support practitioner-evaluation of the nature and results of this thought process and specified technology use. Clarifying how selected tools or resources are used by teachers and students and the contextual factors surrounding its use may have as great an influence on the outcome of instructional planning and delivery as the design and content of traditional or commonly-found resources found in classrooms.

Heinich (1984), recognizing the increasingly sophisticated uses of technology in classrooms (i.e., mini-computers with specific applications and instructional games), emphasized that higher levels of decision-making by teachers were required to maximize the impact of technology-supplemented instructional materials introduced by curriculum planners. Heinich understood that thinking how we can use resources and increasingly sophisticated forms of technology should be the focus of instructional planning. He further elaborated how “technology is additive, … aiding the teacher when the teacher deems it appropriate. … As technology becomes more sophisticated, it incorporates more operational actions into the design stages, reducing the necessity for ad hoc decisions at the point of use” (Heinich, 1985, p. 11). Understanding and clarifying how we (both teachers and students) process information and solve problems through the enhancements of increasingly sophisticated technologies facilitates our control of technology, as well as determines how technology can be effectively managed in educational settings. Heinich also noted the value in identifying the conditions in classrooms tending to shape practitioners’ use of technology.
To further develop this perspective, Januszewski (1994), in a discussion of Finn’s ideas on technology, discussed how technology is a process facilitating (a) problem solving, (b) reflection on classroom events, (c) critical evaluation of materials, and (d) creation of visualizations of abstract concepts to enhance instruction. Acknowledgement of technology as a thought process (that teachers employ to encourage students to develop cognitive skills and problem solving abilities) supports teachers’ creativity and critical role in schools. Enabling teachers and students to problem solve and to define how anyone individually learns/applies information and acquire skills contributes to one’s personal sense of control over technology. Providing practitioners with supportive frameworks to ascertain if the additive value of technology meets these requirements aligns with this theoretical perspective.

As the options surrounding innovative devices, strategies and resources continually evolve, many educators increasingly discover instructional technology for nurturing students’ capacity to problem solve, communicate, create and extend their cognitive thinking abilities. More recently, Gura and Percy (2005) noted how technology facilitates access to richer, intellectual environments and non-linear paradigms for presenting and processing information. This use of technology is most present when teachers create flexible, personalized instructional materials (i.e., texts with graphics, slide presentations, web sites, pod and vodcasts, wikis, blogs, mash-ups) or expect students to use these repositories and formats of information to complete school assignments, or even create projects using flexible, uniquely designed tools dependent on creative problem solving. Gura and Percy (2005) perceived teachers as “mediators of technology … as technology changes the learning paradigm” (pp. 64-5). In addition, they advocated that teachers become “astute in the ways to take advantage of it [hardware, applications, software, etc.] to support learning” (Gura & Percy, 2005, p. 68). Technology’s benefit is understood as a
process and realized through critical thought and recognition of how a device or resource facilitates problem solving, communication and creativity. Teachers mediating student exploration and experimentation with tools/resources (digital, emergent and traditional instructional technologies) facilitate the process of technology developing critical thinking and problem solving acuity. Through enhanced awareness of technology as the development of a thought process, teachers’ instructional planning can yield sought-after outcomes for students.

In their work, Heinich (1985, 1984), Januszewski (1994), and Gura and Percy (2005) emphasized that teachers have the responsibility to develop and apply a critical eye and informed capacity to incorporate technology (thought process) and resources supporting the demands of the learning paradigm within a rich, intellectual environment so students develop desirable skills and extend their knowledge of relevant topics. Use of the ITIG as a tool (for instructional planning and implementation) provides practitioners a systematic process to document: (a) their role as a mediator of technology, (b) their rationale for selecting technology that is additive and facilitates decision-making, (c) the process of guided self-reflection determining how technology facilitated instructional activities and student learning, and (d) a practitioner’s evaluation as to the effectiveness of this specified technology use in classrooms.

An updated definition of educational technology (often used interchangeably with instructional technology and technology in the research literature and by practitioners) connects effective communication strategies to appropriate instructional strategies so practitioners provide students opportunities to “experience ever-increasing fidelity between learning space and performance space” (Branch & Deissler, 2008, p. 202). This 2008 definition pinpoints the contemporary need for school experiences to mirror future adult or professional experiences. Branch and Deissler (2008) emphasized the expectation of multiple process models of
technology use and management, to acknowledge the political, economic, social and psychological decisions and actions within schools and society. Due to contextual factors unique to communities and schools, teachers increasingly need to document what has been effective in matching the school experience (learning space) to the adult or professional experience (performance space) that serves as the goal of instructional experiences. Documentation and self-reflecting on specific uses of technologies in classrooms can help us define effective technology use mindful of contextual factors and “unlearn the old ways of thinking about teaching and learning” (Vrasidas and Glass, 2007, p. 91). Through time and supports (potential use of self-reflection and the ITIG), teachers can increasingly use various forms of technology to create learning activities and environments to meet students’ needs to become collaborative problem solvers within authentic contexts.

It is critical to acknowledge that defined uses of technology and selected strategies and resources which work in one setting may require modification in order to work in other settings. These circumstances force the realization that there are multiple process models or solutions for addressing educational problems through the additive power of technology, since teachers serve as mediators of instructional resources, strategies and technology. My study’s instructional planning tool (guided self-reflection embedded within the ITIG), documents and evaluates these circumstances and use of a thought process when selecting resources, strategies and technology to meet students’ educational needs.

**Technological determinism.** The prior section’s emphasis on a teacher’s thought process in the selection and design of instructional technology aligns well with other ideas found in the literature concerning ethical use of technology. Kurzweil (2003), the developer of technology that facilitates users to access information, communicate and overcome disabilities,
noted that technology can be a double edged sword, necessitating educators to systematically evaluate how technology will impact students. He, among others, felt that educators have an ethical responsibility to determine the “right level” (p. 252) so the benefits can mitigate the dangers of 21st century technologies.

Prior observers of the impact of technology on individuals and society have also suggested the need for ‘technical thinking’ to define technology use and design. Ellul (1964), in coining the term, la technique, often translated as ‘technical thinking’, pointed out the need for an individual to question “at every step his use of his technical goods, able to refuse them and to force them to submit to determining factors, [so that]… he must be able to exploit all these goods without becoming unduly attached to them.” (Ellul, 1963, p. 96). Most importantly, Ellul acknowledged in several essays (since World War II through the 1980’s) the unforeseeable social effects and price the use of technology had on people. Ellul (1988) expressed concern that society chooses technology for its immediate economic benefit (increasing efficiency in the workplace), without consideration of long-term effects and potentially harmful social implications. He noted how society tolerated technology gradually “becoming the creative force of new values” (Ellul, 2003, p. 396). The impact and choices to be made when teachers select technology to support instruction need to be identified in order to neutralize or minimize the unintended consequences.

This decision-making and assessment of tasks’ benefits and shortcomings (a thought process) is often associated with the term technological determinism (Bimber, 1995; Chandler, 1995; Pannabecker, 1991). In a critique of technological determinism, Ropohl (1983) proposed systemic actions so technology facilitates the production and application of knowledge and goods, to address social concerns (as identified by Ellul). In other words, there is a definitive
need to (a) be mindful in how we choose to use technology, (b) have an enhanced awareness of the impact of technology on the individual and on society or groups, and (c) adjust for the negative impact or unforeseen consequences to control or neutralize potentially harmful long-term effects.

**Social shaping of technology.** This concept of technological determinism is similar to Finn’s (1960) notion of technology as a thought process due to the potential benefits that technology (as devices or machines) offers instructional design. Salomon (1998) shared these perceptions of promises and dangers of technology use in educational contexts. He stated that “clever and imaginative employment of today’s technology” impacted the design of effective learning activities. Praising the power of multimedia to facilitate communication, knowledge acquisition and utilization, and “the social distribution of cognition” (Salomon, 1998, p. 7), he also noted several undesirable effects, such as (a) intellectual shallowness, (b) information overload, (c) devaluation of information, and (d) social alienation. Educators are expected to identify technology’s capacity to facilitate students’ active participation in the process of knowledge acquisition and utilization within the social context of classrooms or connections through the Internet. Once these uses of technology are identified, educators are to orchestrate these technological affordances to maximize its benefits and reduce the undesirable side effects.

The social shaping of technology is a concept that can frame the nature of teachers’ decisions surrounding technology use in classrooms. Williams and Edge (1996) recognized that through exploration of innovations and the content of technologies, teachers developed patterns as to their creative use of technology. These patterns became embedded over time and were defined by contextual factors, established conditions and an identified social use of technology. These different options of technology use were eventually assessed as either solutions or
consequences in meeting students’ educational needs. Wajcman (1991) also noted the role of
technical thinking in discerning the socially desirable values technology design can support.
How people design technology is an indicator of technical thought. The design of technology
can be sensitive to individual and societal needs, or be viewed as culturally relevant. Often
technical thinking and technology use are interrelated within a defined social context, especially
when there is a goal to equalize and extend individual access to technology and information.

Bruce and Hogan (1998) also expanded their discussion of technology transparency to
emphasize the nature of “embedded systems” (p. 271) and the potential loss of control that we
may perceive as we become increasingly dependent upon various forms of technology. This
perceived loss of control can be mitigated through increasing awareness of technology as a
thought process. With the increasing degree of technology transparency in our lives in the 21st
century, many of us lose our sense of who is in control of technology and if indeed we are able to
reduce or manage the unanticipated and less desirable consequences of embedded technology
use. School environments have much to gain once teachers are mindful, through engaging in the
critical technology thought process, to discern the desirable, unanticipated and potentially
harmful consequences of our decisions as educators to integrate varied formats of technology for
student learning.

Williams and Edge (1996), as well as Wajcman (1991), pinpointed that technology use is
defined within a social context. With increasing mindfulness of the social context, teachers can
design instruction with technology that reduces the undesirable side effects and maximizes its
benefits. Through reflection and awareness of these interrelationships, cognitive and social
impacts, teachers’ level of empowerment to use technology effectively and more consistently can
be achieved. Teachers’ efforts to create technology supported instructional activities can be culturally relevant and responsive to students’ educational needs.

My study provided participants with an instructional planning tool to document the identification and orchestration of the technological affordances they selected so their students could socially engage in exploration, development and utilization of specific topics from the adopted curricula. The tool encourages the thought process (guided self-reflection) that Finn, Ellul, Kurzweil, Salomon and Ropohl suggested as necessary steps for effective and ethical use of instructional technology. The tool of guided self-reflection can document the types of patterns teachers establish as they use technology, as Williams and Edge (1996) described and Vrasidas and Glass (2007) viewed as desirable and much in need. The tool can facilitate teachers’ capacity to recognize if the specific use of technology yields solutions or consequences and how the social context and use of technology impacts students’ needs.

Models of adoption and taxonomies. This study is defined by several efforts to analyze and describe the process through which innovative practices are adopted or become institutionalized within organizations or social groups. Rogers (1995) explained his theory of the diffusion of innovations as he and others observed how some innovative practices were either accepted or rejected through a predictable process of exploration and implementation. Analysis of the decisions teachers make when selecting forms of technology to support delivery of content and encourage students to develop technology skills (through the lens of innovation adoption and other models of technology adoption) provide the research community and these practitioners a clearer sense of what has been accomplished, as well as potential options for future instructional planning.
Within psychology, there are theories that explain why people accept and espouse specific attitudes and beliefs and adopt innovations. In particular, Fishbein and Ajzen (1975) explained their Theory of Reasoned Action (TRA) where an individual’s intentions, attitudes and the prevailing subjective norms contribute to a prediction and explanation of future behaviors. Subsequently, in the business community, Davis (1989) explained the Technology Acceptance Model (TAM) to emphasize the role of specific factors (perceived ease of use and perceived usefulness) impacting the use of innovations, as it applies to the use of computer applications for the business world. Additional analysis of the phenomena of computer application use and adoption led to an extension of TAM, as defined by Venkatesh and Davis (2000), renamed as TAM2. They identified other critical factors impacting individuals’ use of computer applications: (a) relevance, (b) ability of the innovation to demonstrate results, (c) the quality of the outcome, (d) the experience in using the innovation, (e) and the degree of personal willingness to use the innovation (that individuals are not coerced). When rereading or analyzing the participants’ comments explaining why they selected specific resources for instruction, we can recognize the factors impacting innovation adoption as identified in TAM2.

Other groups of researchers have developed models of technology adoption based upon Rogers’ Diffusion of Innovation Theory. These models of technology adoption are equally influenced by the Theory of Reasoned Action and the Technology Acceptance Model 2. They provided a basis for situating and defining the study participants’ technology use levels. Participants’ self-ratings and my observation data contributed to ascribing technology adoption categories (within the following models) at this point in time. Sherry (1998) developed an Integrated Technology Adoption and Diffusion Model, through her evaluation of several educational technology initiatives. Sherry, Billig, Tavalin and Gibson (2000) further revised the
Technology Adoption and Diffusion Model to identify four stages, a cycle of (a) adopter, (b) co-learner, (c) reaffirmer or rejecter, and (d) learner. Dwyer, Ringstaff and Sandholtz (1991) recognized five phases or stages of technology adoption: (a) entry; (b) adoption; (c) adaptation; (d) appropriation; and (e) invention during their study of Apple Classroom of Tomorrow Program participants. Both Hooper and Rieber (1995) and Rieber and Welliver (1989) explained a hierarchy or pattern of adoption in education, often referred to in subsequent literature as Welliver’s Instructional Transformation Model. These five stages of adoption are: (a) familiarization; (b) utilization; (c) integration; (d) reorientation; and (e) evolution. All of these models emphasize the ongoing transformation or evolution of teachers’ behaviors and grasp of how technology can be optimized for instructional delivery and student learning.

Other researchers have created taxonomies of technology use to serve as a guide for instructional planning decisions. These taxonomies were incorporated within the tool designed for my study. Maddux, Johnson and Willis (1997) analyzed various uses of technology in educational settings and categorized them into two types of use, based on the cognitive demand and relative sophistication of technology’s facilitation of task completion. Subsequently, Small (2005) updated this continuum of technology use into three tiers of technology integration strategies and uses. As progressively more innovative devices and applications are developed, these continua evolve. These changes or novel uses of technology become the catalyst for ongoing professional development and experimentation to ascertain effective uses of technology by teachers and by students. Framing participants’ use of technology within these models and taxonomies of technology use connects my study to prior research. New research – such as my study – intends to extend and elaborate upon prior knowledge of technology use in classrooms, representing the voice of practitioners who agreed to participate in my study.
**Researcher Bias**

Researchers’ descriptions of their beliefs and perspectives related to the purpose of the study impact the scientific quality or rigor of their research. Having integrated technology when I was a practitioner, as well as my review of the literature surrounding technology use in classrooms both contributed to my beliefs and perspectives. As already indicated, teachers could benefit from a tool that nurtures technology as a thought process and should be empowered to determine if their decisions as instructional designers, planners and enactors are well-suited to the educational needs of students who participate in these instructional activities. There is also a need to refocus the purpose of instruction to include opportunities to develop skills and knowledge that is relevant for the 21st century workforce and society (incorporating Branch and Deissler’s (2008) suggestion to create learning spaces that replicate performance spaces).

Research from the past two decades offered examples of how technology can be used to nurture cognitive development, though it is limitedly done (Angeli, 2008; Lajoie, 2005; Salomon, 1993). This study hoped to determine if participants were starting to use technology in these cognitively extending ways, and to document these strategies and activities often linked to transformative teaching practices. Reflection about teaching practices has been associated with transformative pedagogic practices (Cranton & King, 2003; King, 2002; Schifter, 2008), an ultimate goal of professional development and technology integration. Since instructional activities to develop cognitive skills are viewed as more desirable, observing for and documenting its presence is desirable. Notating when students were provided opportunities to use technology will be of keen interest to the researcher, as it is documented in the research (Cuban, *et al.*, 2001; Norris, Sullivan, Poirot, & Soloway, 2003) as being underused or
minimally used by students. It is desirable to find evidence of changes in such patterns of instruction through this qualitative study.

There are variations in the definition of technology as used in educational settings in the literature on technology integration and professional development. In my study, both traditional instructional and emerging or digital forms of technology are considered as instructional resources to be documented as to their impact on student learning. The inclusion of traditional instructional technology alongside emergent technology recognizes several realities. Often traditional instructional technologies continue to provide instructional benefit and may be the only resources teachers may have to enhance and facilitate instructional activities. Often schools may lack the economic base or infrastructure to introduce emerging technologies to benefit students and teachers (see Kemker, 2007; Warschauer, Knobel, & Stone, 2004). Teachers often lack training, competence and confidence in using emerging technology for educational purposes, as well as need guidance to recognize how emerging technology can support content area instruction and students’ skill development (see Ertmer, Ottenbreit-Leftwich, & York, 2007). Tolerance for varied formats of technology and recognition that teachers require a sense of confidence and competence and guidance in the use of emerging or digital technologies are major factors impacting my perspective and willingness to simply document what I observe and learn from these participants’ perspectives, experiences and decisions.

**Significance**

Much of the research investigating teachers’ technology integration focused on the benefits gleaned from specific professional development initiatives and described barriers which impede consistent and effective technology use in classrooms. This study will build on existing literature as it tests an instructional planning tool and process to support teachers’ capacity to
effectively integrate technology and evaluate the outcome. Moreover, if deemed successful, this study can provide a cost-effective and ultra-scalable instrument for bringing forth more effective practice and use of technology for instruction. Through guided self-reflection, teachers can identify effective strategies for integrating technology aligned to their instructional goals and their students’ needs.

Creating a research-based design to test a tool aligns with recommendations for educators to monitor district vision statements and technology plans (Hew & Brush, 2007). Culp, Honey and Mandinach (2005), through an analysis of educational technology policy influencing the contents of the National Education Technology Plan, noted the concern and need to support and advance effective technology integration strategies contributing to students’ cognitive growth and development of 21st century skills. Means, Cuban and Kerr (2008), in a description of technology’s role in designing curriculum, commented that technology researchers and developers recognized that the success of technology depends on effective implementation of all the elements of instructional activities (classroom management, communication, pedagogy, and accurate, relevant content). They also noted the pivotal role teachers have as gatekeepers and orchestrators of the complex interactions and activities in classrooms. While investigating technology integration, researchers also need to examine how teaching practices are transformed. This study’s proposed piloting of an instructional planning tool aligns with this suggested research agenda or focus in respect to describing the impact of the ITIG tool on teachers’ decisions, instructional planning and behaviors, describing any transformation of teaching practices, and documenting teachers’ role as gatekeeper and orchestrator of instructional activities.
Conclusion

My study documented how teachers defined effective technology integration and self-reflected on the outcome of the resulting instructional plan and activity. The tool piloted in this study facilitated each teacher’s capacity to assess technology’s value and benefit. It should not be up to an outside researcher or only an administrator or curricular supervisor to assess the value of technology-supported instructional planning and delivery. Teachers should be empowered to reflect upon and evaluate the quality of their instruction. Within the literature, there is increasing evidence that through collaboration and self-reflection teachers start to transform their decisions and behaviors integrating instructional technology (Cranton & King, 2003; Fitzallen, 2004; Kopcha, 2008; Sandholtz & Reilly, 2004). The outcome of this study revealed the potential for a self-reflection instructional planning tool as a vehicle to promote more effective and consistent technology integration to meet students’ instructional needs.

Subsequent chapters of this dissertation provide the reader with anticipated details regarding this study. Chapter 2 presents a literature review covering several related areas linked to technology use in classrooms: teachers’ integration of technology, varying levels of technology integration, the design of technology integration training and its evaluation, barriers to technology integration, perspectives for promoting technology integration, reflection’s capacity to transform instructional practices, systematizing technology integration, and the connection between technology and cognitive development. Conclusions from this literature review influenced the design of the instructional planning tool and instruments used to collect data. Chapter 3 explains the methodology of this study and the research design. Chapter 4 presents the findings of this study, while Chapter 5 summarizes the implications of these results for future research.
Chapter 2
Literature Review

As briefly described in the previous chapter, classroom observations have identified the tendency to underutilize, misuse or inconsistently use technology (Bauer & Kenton, 2005; Bebell, Russell, & O’Dwyer, 2004; Cuban, Kirkpatrick, & Peck, 2001; NEA, 2008). Traditionally, the lack of effective technology integration has been countered with either the increase of actual technology (devices and applications) in schools or with increased skill training for teachers (Ching, Basham, and Pianfetti, 2005). Neither the additional technology nor the increase in skills has led to sustainable systemic change in technology use in schools. Realistically, numerous barriers have contributed to the lack of effective technology integration (Bauer & Kenton, 2005; Ertmer, 1999; Hixon & Buckenmeyer, 2009; Warburton, 2009). This chapter provides a detailed understanding of the literature associated with technology integration and concludes with a proposed instructional planning tool for increasing consistent and purposeful effective technology integration in schools. As you will read, so much of the literature reveals the need for some action or procedure to nurture more consistent and intentional technology integration that is aligned with instructional goals and students’ needs. To create a desirable outcome and impact, the research provides clues as to a procedural design and systematic actions to support teachers as technology integrators.

Modern instructional technology by way of computers has penetrated classroom since the 1980’s (Murdock, 2004). Since that time, research has identified several diverse variables associated with the lack of technology use and its minimal impact on student outcomes (Becker, 2001; Office of Technology Assessment, 1995; Kozma, 2003; Law, Pelgrum, & Plomp, 2008; Moursund & Bielefeldt, 1999; NEA, 2008; Pelgrum, 2001; Smerdon, Cronen, Lanahan,
Billions of dollars have been invested in hardware and software training so teachers gain competence and confidence in technology use (Belson & Larkin, 2004; Dickard & Education Development Center, Inc., 2003; Sivin-Kachala & Bialo, 2000). Varying levels of technology use (by teachers and by students) and such large levels of investment encourage investigation of what can be done so teachers can increasingly integrate technology effectively. As discussed in the previous chapter, the focus of this study is to develop and test an instructional planning tool grounded in guided self-reflection to increase the level of effective technology integration. To accomplish this goal, this chapter provides an overview of the literature in this area and is structured on the themes of why teachers integrate technology, variable levels of technology integration, a focus on training, the interrelationships of barriers to technology integration, the development of a taxonomy of technology integration, and the relationship of cognitive development and technology use.

**Why Teachers Integrate Technology**

In the 1990’s, United States Congressional Committees determined that the Office of Technology Assessment (OTA) would investigate why so many teachers were not using emerging technologies (often computers) in their teaching, despite the presence of such devices in classrooms for the past decade. At the time it was thought by both Congress and the business community that educational technology would support teachers’ work, impact the manner in which teachers teach and that technology would become a key component for future success in society (OTA, 1995). The final OTA Report pinpointed several key issues and suggestions for increasing the benefit technology offers instructional settings. This report’s issues and suggestions are often echoed in more recent studies of technology integration: teachers need (a) more training and support, (b) guidance to integrate technology in creative ways, (c) time to
experiment with technology, (d) more experiences using technology and employing technology to facilitate learning, and (e) the formation of communication networks so novel and successful strategies and outcomes could be shared among interested teachers (OTA, 1995).

Beyond OTA, the President’s Committee of Advisors on Science and Technology (PCAST) (1997) recommended that teachers and students focus on learning with technology, where curricula are adapted to make effective use of technology. This policy statement also supported adequate fiscal investments for equitable and universal access to technology and encouraged experimental research programs to design and investigate how technology supports students’ academic growth. These policy recommendations set the stage for increasing expenditure on technology infrastructure and teacher training and expectations that students would use the technology more effectively to acquire skills for future success in society.

A few years later, the Milken Foundation and the International Society for Technology in Education (ISTE) administered a 32-item survey to recent graduates of teacher college programs representing 416 institutions. The resulting report by the lead researchers (Moursund & Bielefeldt, 1999) indicated that schools’ technology infrastructure is expanding at a faster pace than the skillset of teachers who are expected to work in technology-enhanced educational settings. The report also identified specific factors contributing to increased levels of technology use. Key to these factors was the need for integration of instructional technology (IT) within content area instruction and teachers’ personal skill in using applications. Several areas of concern were also identified including: (a) the lack of technology planning, (b) university faculty not modeling IT use or knowing how to recommend effective IT use, (c) lack of master teachers who use IT effectively, and (d) some noted deficiencies in IT infrastructure. By the end of 1999, researchers had pinpointed a connection between integrating technology within content area
instruction and successful instructional practice predicated upon effective modeling and technology planning. (Berg, Benz, Lasley, & Raisch, 1998; Moursund & Bielefeldt, 1999). Policy makers and the business community also recognized the need for technology to penetrate instructional practice so students experience success and are prepared for the workforce (CEO Forum, 2001; OTA, 1995; PCAST, 1997).

A decade later, the term, “21st century skills” has been used to describe the need for students to develop specific skills, often through effective use of modern technology. For instance, Sawchuk (2009) discussed how several researchers and policy makers (Darling-Hammond, Ravitch, Duncan, Obama, Hirsch, and Kay) incorporated the concept of 21st century skills to emphasize the focus instructional planning should have, whether on core knowledge, critical thinking skills, technology skills, collaboration, communication, creativity, problem solving skills, and potential combinations of all of these skills. The Harvard Family Research Project (2008) also presented an analysis of ten years of research on after school programs’ capacity to support students’ development of skills for future success as community members in a global world in the 21st century, which described the same skills Sawchuk identified. Kay (2009) argued that the middle school is an ideal point along the continuum of instruction to emphasize and encourage students’ development of 21st century skills in addition to mastery of core academic subjects. Kay’s list of 21st century skills are critical thinking, problem solving, communication, collaboration, creativity, financial and health literacy and global awareness. These skills directly overlap the list promoted by policy makers and corporate leaders through the 21st Century Skills Partnership. Researchers have also found the need for students to use technology effectively to facilitate the development of these 21st century skills (see Dede, 2000; Krajcik, McNeill, & Reiser, 2008; Kress, 2003; Schachter, 2009; Tatar, Roschelle, Knudsen,
Schectman, Kaput, & Hopkins, 2008). With educators creating effective curricular activities so students develop 21st century skills through the use of technology encouraged by stakeholder and societal expectations, there is evidence that these skills and related uses of technology can serve as the foundation for instructional planning that guides students to successful school experiences. Through the effective integration and use of multiple technologies these recommended goals for 21st century skill have been attained in limited educational settings (see Field, 2009; Rivet & Krajcik, 2004; Tatar, Roschelle, Knudsen, Schectman, Kaput, & Hopkins, 2008).

In addition to studying how technology supports curricular design and student achievement of 21st century skills, the research on educational technology has also focused on the degree of use of various forms of technology in classrooms. Over time, several surveys of technology use have been administered and the collected data have been analyzed. A preliminary report, Teachers’ Use of Educational Technology in U.S. Public Schools: 2009, A First Look, provided data collected through three survey instruments in 2008-2009 (Gray, Thomas, & Lewis, 2010) from a randomized sample of 4,133 teachers and school district administrators throughout the United States (with a 65% return rate). Eleven data tables summarizing percentages of teachers who use specific formats of technology at various levels of use are shared in this report. Recently, the NEA (2008) completed a telephone survey of 1,934 teachers and support professionals (members of a stratified sample) on technology use in public schools during the summer of 2006. Despite the infusion of technology into the instructional process in recent years, the results indicated that access to technology remains uneven across the United States and teachers may not be able to use technology effectively. The preliminary findings, released earlier this year, reveals that access exists, but usage levels vary. The rhetoric seems to remain constant despite the passing of a decade. Students and teachers are expected to
use technology more effectively and there is a lack of both technology (devices and applications) and ability to meet this expectation (understanding of and comfort in how to creatively use technology). These reports do not address how well-matched the use of technology can be to the instructional needs of students in these classrooms.

Policymakers and the public, due to the ubiquity of technology in our daily lives, still anticipate that technology use will have a significant role in classrooms. It is thought that further studies on technology use in classrooms and teacher technology training initiatives will provide clarity as to how this increasing level of technology use can be attained. Research has yet to define a process and an evidence-based intervention that can support identification, documentation and evaluation of how technology is used effectively for specific content area instruction within defined contextual factors.

**Variable Levels of Technology Integration**

Within the past decade, researchers have interviewed, observed, conducted focus groups and administered surveys to determine the degree of technology use in classrooms. The purpose of this research has been to understand the contextual factors impacting the degree of technology use. For instance, Becker (2000) administered the *Teaching, Learning and Computing Survey*, with a sample of teachers, technology coordinators and administrators who participated in school reform initiatives. The research team also selected teachers from a database to create a stratified probabilistic sample of teachers to complete this same survey instrument. This database, provided by Quality Education Data (QED), Scholastic’s marketing division, yielded teachers associated with 898 public, private and parochial schools, from 109,000 potential schools. Becker’s survey instrument collected data to measure technology use and identify teachers’ beliefs and pedagogical practices. This data determined how supportive these practices are of
technology integration, and identified an array of contextual factors impacting technology use. Becker (2001) shared additional findings gleaned through analysis of this same large dataset. Becker noted that the placement of computers in classrooms and the subject and context of instruction influenced the level of use by teachers and by students. Computers were often used in computer classes and in business classes. Another key finding noted a correlation between technology usage and allocation of instructional time with access to the technology. Other areas of instruction were associated with less or hardly any consistent technology use by teachers or by students.

Similarly to Becker (2000), Ronnkvist, Dexter, and Anderson (2000) analyzed data regarding technology support collected through the *Teaching, Learning and Computing Survey*. Data revealed the importance of technology coordinators in guiding teachers as technology integrators, even though this task did not consume much of the technology coordinators’ time (average of 3.6 minutes per week for a full time technology coordinator). Major findings of this report pointed to the need for instructional and communication technologies to serve as pedagogical tools for instruction and assessment and noted the connection between teachers’ computer expertise and regular and varied technology use in classrooms. The focus of this significant study of teachers’ technology use did not identify or suggest processes to increase the frequency, consistency or quality of technology use in classrooms.

Some research on the use of instructional technology yielded proposed frameworks describing key elements to ensure effective use of technology. Dickard and the Education Development Center (2003) reviewed data on technology support levels and examined technology plans. In 2002, they hosted several roundtable discussions with foundation, corporate and governmental representatives in New York, Chicago and Washington, D.C., and
interviewed teachers and stakeholders in Chicago, Cleveland and Milwaukee. Their analysis of these data led to the conclusion that the level of technology support varies from adequate to inadequate. The need for a clearly defined and articulated vision, supported with infrastructure, planning and a culture of innovation, would be enhanced with technical training linked to pedagogical integration skills. Gülbahar (2007), in her analysis of how one K-12 school in Turkey developed and enacted a technology plan, noted the importance of planning and periodic review of technology plans to ascertain needs for equipment, training and instructional decisions. Through interviews, artifact analysis and analysis of questionnaire data of students, teachers and administrators in grades 5-9, Gülbahar shared findings to influence the revision of this school’s technology plan. She noted that teachers in this school had a different perception of the degree to which they were integrating technology than their students. Her study pinpointed specific aspects of technology use that can define the direction a school would take when revising a technology plan. The benefit of enacting “continuous evaluation” (Gülbahar, 2007, p. 955) of the impact of a technology plan, through information gathering and analysis (as described in her study) is encouraged. Leadership is needed to strategize how to evaluate integration efforts, through exploration, reflection and collaboration and the institutionalization of educational technology in schools. These recommendations inform the design of and need for the instructional planning framework grounded in guided self-reflection as piloted in this study.

A highly focused, qualitative analysis of technology use in technology-rich high school classrooms in California has often been cited in instructional technology studies. Cuban, Kirkpatrick and Peck (2001) observed instruction in these classrooms and interviewed 21 teachers and 26 students to determine to what degree technology was used in these classrooms. Twelve students and eleven teachers were shadowed by this research team during a 7-month
interval. Students and faculty completed brief surveys. Artifacts concerning technology use in these two high schools were collected and examined for details related to technology usage levels. Through anecdotal excerpts and frequency data, Cuban, Kirkpatrick and Peck (2001) provided evidence of how the technology in these two sets of high school classrooms was not used as consistently or as frequently as the infrastructure and training investment would support. Demographic data describing these two high schools indicated these two institutions were similar in characteristics categorizing schools. Computer use in these classrooms varied, not simply by content area, but also by the degree to which teachers decided to use the computers (a few teachers were categorized into each level or degree of use: heavy, occasional, rare, nonuse).

Determining a process for stimulating and guiding these types of transformations and increasing the consistency of technology use in classrooms seem desirable, since these changes happened in a small proportion of the teachers who participated in Cuban, et al.’s study.

As a result of these often-cited studies by Becker (2000) and Cuban, Kirkpatrick, and Peck (2001), other educational researchers noted the increasing complexity of measuring technology use in classrooms. Bebell, Russell, and O’Dwyer (2004) described their study using a multifaceted approach to measure technology use to account for increasing complexity and variation of use across settings. During a 3-year study of 22 school districts, Bebell, et al., (2004) determined that teachers use technologies for seven various purposes with different degrees within this use. Technology was used most often for preparation of instructional materials, and least often by students to create products of their learning. Technology use across these seven purposes “varied considerably” (Bebell, Russell, & O’Dwyer, 2004, p.55). Analyses of these measures of technology use through the lens of content area instruction and school environment also revealed variation in frequency of use. The focus of Bebell, et al.’s study was
to demonstrate the need to acknowledge that technology is used at varying levels for diverse purposes and that it is misleading to measure technology use with a single measure or percentage, as has been done in prior studies. Further recommendations for increasing or extending technology integration were not the intended focus of this study, nor addressed.

Additional studies of teachers using technology have measured varying levels of technology use. Pierson (2001) completed a case study (with cross case analysis) to document exemplary technology use strategies and practices. Her qualitative study of three elementary teachers in self-contained settings revealed the relationship between effective technology integration and sound teaching practices. Pierson recognized that these three teachers’ observed behaviors and described decisions (through interviews and analysis of planning artifacts) could be categorized as either adequate or exemplary. She noted how these three teachers shared varying definitions of technology integration and often chose to integrate technology in various ways, often aligned with levels or stages of adoption (see Hooper & Rieber, 1995 or Rieber & Welliver, 1989). Pierson’s study emphasizes the need for defining effective technology integration and connecting technology use with exemplary instructional strategies and practices.

In another study, Bauer and Kenton (2005) observed and interviewed 30 teachers in four urban schools regarding their use of technology. These teachers, who were recommended for this study by administrators and viewed as proficient IT users, completed a 48-item survey instrument. These 30 teachers were described as “occasional practitioners” and the survey data revealed that “80% of these teachers used computers less than 50% of the time” (Bauer & Kenton, 2005, p. 535). Additionally, only two of these 30 teachers used computers more than 75% of the time. Bauer and Kenton identified and noted the degree to which specific barriers stymied these teachers’ capacity to use technology. Again, these two studies focused on
describing and measuring technology use in specific classrooms, and did not suggest or test an evidence-based intervention to nurture consistent technology use in classrooms.

Another recent study of technology use in 19 schools collected evidence of varying levels of computer use for various purposes by teachers and by students. Zhao and Frank (2003) administered a 33-item survey instrument to the teachers and the 15,948 students in these 19 technology equipped rural and suburban schools in Michigan. They also observed (in one school per district) technology and instructional practices and interviewed the teachers and administrators in these 19 schools (representing four school districts). Zhao and Frank noted that prior research on technology use in schools identified many factors impacting levels of technology integration, which were often studied in isolation. Zhao and Frank studied the interrelationship of these factors impacting technology use levels and tested a proposed framework that described the interrelationship of factors impacting technology use levels in schools. They noted how each of the four districts established different practices for selecting and organizing technology for its infrastructure and determining the focus of its technology professional development initiatives. The different practices to develop technology plans impacted the levels of technology use in these schools and districts. The interaction of the various factors impacting technology integration levels explained the varying degree of technology use as measured through the survey instrument, observations and interviews. Zhao and Frank emphasized that the level of technology use aligns with a progressive evolution of technology adoption, a concept highlighted within the Pierson (2001) study. Zhao and Frank found technology adoption to be dynamic and often defined by social, political, ecological and collegial influences.
A very recent longitudinal study of forty teachers in Australia provided a proposed framework to examine technology’s impact on teaching. Orlando (2009) qualitatively analyzed five years of interview, observational and artifact-based data of only five teachers within this group. She pinpointed the benefit of implementing a recursive, contextualized, reflective analysis of how technology is used in classrooms by teachers, administrators and students. Orlando questioned the value of continuums of technology use (such as the adoption models to be discussed in a subsequent section of this chapter) as her evidence acknowledged that teachers experience different modes of change over time. Orlando suggested that effective use of technology to meet students’ needs is attainable through teachers’ retrospective analysis of how they have been using technology. Facilitating teachers in making the connection between their practice, the context and the teacher’s identity as a technology-user serves as the catalyst for desirable changes in how teachers use technology in classrooms. Devising a structure or process for facilitating Orlando’s suggested thought process was not described in her study.

These selected studies intended to describe how teachers are using technologies in classrooms at varying levels, often delineated by school district infrastructures and supports. Additionally, they reveal the need for a mechanism or intervention to increase the consistency and frequency of technology use in schools, especially to encourage pedagogically appropriate uses of technology, evaluation of technology integration and increase technology use by students to develop 21st century skills. To discuss the impact of a core contributor to the rate of technology adoption, the next section discusses research studies on professional development programs designed to increase teachers’ capacity to effectively integrate technology.
Focus on Technology Training

A review of recent research investigating professional development programs designed to impact technology integration revealed two different research goals. One set of articles focused on the design of these professional development programs and how the design pinpointed specific characteristics intended to support change in teaching practices. The other set of articles focused on evaluating the impact of a professional development program as state or federal funding covered the cost of these training initiatives. Outcomes of these investigations on technology training programs provided evidence contributing to the design of the instructional planning tool piloted in this study. These studies also demonstrate the ongoing need for additional research to determine how teachers’ integration of technology can be enhanced and aligned with effective instructional practices and curricular goals.

**Designing technology integration training.** Determining an effective design for professional development may be a challenging task, especially if educators and researchers acknowledge the multiple intervening variables and the complexities of educational settings (Guskey, 1997). The studies included in this literature review section collected evidence intended to demonstrate a relationship between the design of a professional development program and the desirable outcomes, in these cases, teachers integrating technology more effectively. A discussion of these studies reveals characteristics that informed the design of the instructional planning tool piloted in this study.

Through a detailed case study and systematic collection of data during an academic year, Mouza (2006) investigated the impact of two professional development models intended to support eight urban teachers’ computer skill development, pedagogical knowledge and pedagogical content knowledge so teachers’ practices would change regarding technology
integration. These eight teachers did not possess any technology acumen prior to this study. Data were collected through the administration of a survey instrument (before and after the completion of the professional development experiences), three interviews per teacher, observations of lessons, meetings, workshops (total of 57 hours), and analyses of various artifacts documenting planning and class interactions. Mouza acknowledged that teacher beliefs and practices regarding technology integration would reflect stages of adoption, such as those discussed in Sandholtz, Ringstaff and O’Dwyer, (1997). The workshops and meetings provided these educators opportunities to reflect, discuss and collaborate, as Mouza served as the staff developer. The intense level of interaction, data collection and analyses provided evidence of changes in teachers’ beliefs and practices. Some teachers described a sense of empowerment as they developed increasing skill using various applications and started to transfer their new skills and knowledge to their practice. Survey data measured the percentage of growth in capacity to use specific applications (e.g., Word 48%, PowerPoint 88%, and Excel 48% from October 2000 until February 2001) in one model of professional development. The other model of professional development (Curriculum Technology Theme Training) yielded similarly strong increases in use of specific applications (word 57% and the Internet/email 52% October 2000 until February 2001). PowerPoint was not emphasized in the Curriculum Technology Theme Training.

Mouza (2006) did note that these teachers demonstrated varying uses of technology for professional uses (creating instructional materials) and that there were examples of conventional and integrated uses of technology for instruction. These two professional development models did challenge these teachers’ established patterns of instruction and management of resources and time. Over time, six of the eight teachers realized gains in technological confidence and skill and attempted to plan more complex activities so their students would learn with the technology.
and develop technology skills. Mouza documented, through anecdotal description, the increasing sophistication of implemented technology-infused instruction due to the teachers’ newly acquired skills in various applications, devices and understanding of pedagogical approaches to integrate technology for students’ use. Mouza categorized these anecdotal examples of changes in teacher practices as either additive or transformative. Mouza noted that successful pedagogical changes often elicit desirable changes in teachers’ beliefs, which can be used to ascertain if professional development programs provide benefit for participants (see Guskey, 2003, Richardson, 1990, regarding desirable characteristics of professional development initiatives).

The INTEL Corporation, through its Foundation, launched a free professional development program, *INTEL Teach to the Future* (2000), as part of the Intel Innovation in Education initiative. Its goal was to help teachers “integrate technology into instruction to enhance student learning” (INTEL Foundation, 2000). Kanaya, Light and Culp (2005) conducted the study for Intel and analyzed survey data to evaluate this professional development program. The survey data was collected from American teachers between 2001 and 2003. Statistical analyses of these data were run to determine the predictive value of this professional development program on classroom practices. Of the web-based surveys collected, 237 participants’ responses were analyzed. The web-based survey instrument measured five predictor variables: (a) intensity of the training (40 hours within a 3-month interval); (b) teachers’ perceptions of their level of preparedness to use the pedagogy and training in specific tools used in these classes (if training goals were met); (c) student work; (d) pedagogical relevance; (e) prior technology knowledge.
Participating teachers indicated if they had either used with students at least one application in which they were trained (basic outcome) or if they used “new technology-integrated lessons or activities” (optimal outcome). Of the 228 participants who provided responses to use of applications, 66% met the basic outcome, while 235 participants responded to the item asking about implementing technology-integrated lessons, with 78% meeting this optimal outcome (Kanaya, Light & Culp, 2005, p.320). Kanaya, Light and Culp concluded that different combinations of the various factors of this professional development program influenced the outcomes for these teachers. Three factors were isolated: (a) perceived relevance of pedagogical topics; (b) intensity of the training experience (not all participants experienced the same number of training hours); (c) perceptions of preparedness to use technology. The influence of pedagogy in understanding how to use technology effectively and the impact of intensive experiences reflect the value attributed to content and pedagogical knowledge and the allocation of adequate time during effective professional development (Guskey, 2003). Kanaya, Light, and Culp also emphasized that the INTEL Teach to the Future professional development program is predicated on the participants selecting applications and devices for their training, based on their knowledge, needs and interests. A positive outcome of these intensive training sessions is the establishment of collegial, coherent communities of practice within schools, to help participants focus on their personal goals. Kanaya, Light and Culp recommended ongoing efforts to collect empirical evidence of the benefits of professional development programs for technology integration. It is to be noted that Culp has continued to analyze additional data on the INTEL Teach to the Future initiative, collected in other countries.

The next study of a professional development model to impact technology integration capacity describes a multi-year study with the same group of participants. Pope, Hare and
Howard (2005) repeatedly used a survey instrument to measure at various points these participants’ confidence and technology proficiency levels during and after course work and student teaching experiences. Two self-report instruments were administered to 26 pre-service teachers to determine if the combination of methods courses, modeled technology use and student teaching experiences influenced participants’ perceived levels of confidence and technology proficiency. The validated instruments were administered at four different intervals during the course of this study: (a) prior to any methods courses; (b) after the methods courses; (c) after the first student teaching experience; and (d) after the second student teaching experience. The statistical analysis of these dichotomous data provided evidence that these participants’ technology proficiency levels increased and were maintained over time.

Since the uses of technology were associated with content in specific methods courses and were used or observed in multiple settings, the participants reported high levels of confidence. Through exposure, practice, modeling and observation, these participants demonstrated transference of technology skills to other potential and effective uses. Over time, the reported confidence level continued to increase, especially for specific technology uses: (a) authoring programs; (b) integration of web and CD-ROM resources; (c) use of drill and practice; and (d) use of networked communication resources. These participants came to recognize that technology is a means to learn and this teacher training experience extended their exploration of technology to multiple applications and devices. The responses regarding more sophisticated and emerging forms of technology indicated a need for further training and opportunities to observe how these applications are used by teachers.

An emphasized finding of this study is the importance of pre-service teachers’ exposure to “exemplary practicing teachers who model the appropriate use of technology” (Pope, Hare, &
Howard, 2005, p. 605). This finding is similar to Moursund and Bielefeldt’s (1999) recommendation to identify technology-using role models for novice teachers. The researchers collected evidence that this design of professional development met its goals. Subsequent case studies influenced by Pope, Hare and Howard’s findings investigated two other approaches to impact pre-service teachers’ technology use levels through professional development. Dawson (2006) employed reflection to facilitate pre-service teachers’ planning of content area instruction through intentional use of technology’s affordances. During a 4-year study of thirty pre-service teachers during their field experience, these participants and their mentoring teachers were provided a schema of decision points to facilitate selection of resources and purposeful ways to use technology by teachers and by students. The participants’ technology use “replaced, improved or extended traditional instruction” (Dawson, 2006, p. 285) and the compilation of reflective journals revealed how participants focused on logistics and management concerns. Dawson’s study revealed pre-service teachers’ need for ongoing supports to use reflection to note and interpret the significance of their classroom experiences and their impact on decisions to implement strategies and select technology tools supporting curricula-based instructional goals. Dawson had hoped that reflection would guide teachers to explore and identify exemplary practices or effective uses of technology worthy of exploration and emulation.

In a Canadian study of pre-service teachers’ field experience, Mrazek and Meadows (2007) used videoconferencing technology and web-based course content and communication tools so these participants would have a supportive community to share ideas as they designed and implemented technology-supported content area lessons. Mrazek and Meadows discovered that participant, faculty and mentor motivation was critical for pre-service teachers to integrate technology, especially when the pre-service teacher understood or believed in the importance of
integrating technology. A challenge for subsequent research of these similar models of pre-service teachers’ development of technology would be to identify an adequate number of exemplary practicing teachers, motivated to serve as mentors, after generating consensus as to what constitutes exemplary practice of technology-infused instruction.

Analysis of the research literature focused on professional development led Wells (2007) to pinpoint ten key design factors of effective professional development: (a) evaluation driven; (b) contextual; (c) learner centered; (d) duration of process; (e) engagement; (f) inquiry based; (g) theory/research based; (h) collaborative; (i) support; and (j) sustainability. Due to his recent work with colleagues to evaluate the outcomes of the federally funded Preparing Tomorrow’s Teachers to Use Technology (PT3) 3-year program in West Virginia (Mitchem, Wells, & Wells, 2003), Wells was able to analyze the data collected during this 3-year interval to determine the value of the ten key design factors of effective professional development. Wells analyzed the qualitatively collected data in relationship to the sequence of events during the PT3 one-year long cycle to determine which five of the ten key design factors contributed to the success of this PT3 program: (a) duration of process; (b) learner centered (theory, pedagogy and content driving effective technology integration); (c) engagement (experiential and analytical of innovative practices and devices); (d) collaborative; and (e) support (technical and pedagogical). The impact of these design factors resonates with the findings of other studies included in this literature review (Kanaya, Light, & Culp, 2005; Mouza, 2006; Pierson, 2001; Pope, Hare, & Howard, 2005). The impact of key design factors (West, 2007) supports the design of the instructional planning tool piloted in this study (to be discussed in detail in Chapter 3).

As a participant observer, and through a cross-case analysis, Orrill (2001) also developed and tested a framework for a professional development model to enhance teachers’ capacities to
integrate technology effectively. Orrill’s framework, supported by the impact of efficacy (Bandura & Schunk, 1981), is defined by the interaction and support of theoretical and exemplar readings, collegial work, the exchange of feedback, reflective practice and the establishment of proximal goals. Contextual issues and analysis of multiple sources of data (observations, interviews, discussions during meetings, video-captured interactions) revealed the degree of interdependence of reflection, enactment of activities and proximal goal development. The two teachers who participated in this case study were guided by five reflective questions to analyze and understand how to use simulations effectively with their students during the 4-month interval of this case study. Orrill (2001) credited peer group interaction and collaboration to reveal the issues or topics of concern or interest for these teachers, thus increasing engagement and teacher ownership of discussions of theoretical and exemplar readings. One teacher recognized the need to encourage student understanding of content material and not simply respond as if memorizing basic details gleaned from the simulation. Orrill provided additional evidence that collaboration, reflection and meaningful discussion of theory, practice and technology use could promote more effective technology integration. Investigation of a framework, with more than two participants, that demonstrates the connection between reflection and instructional decisions or practices seems worthwhile.

A summary of the findings from this research of professional development models to enhance teachers’ capacity to effectively integrate technology pinpoints the need for the ongoing presence of specific elements of these models, which contributed to the demonstrated effectiveness of these models. Collegial and collaborative discussions to analyze experiences with technology undergird the decisions and future actions of these studies’ participants (Dawson, 2006; Kanaya, Light, & Culp, 2005; Mouza, 2006; Mrazek & Meadows, 2007; Orrill,
2001; Wells, 2007) to establish a pattern of reflection (Orrill, 2001). The analysis of innovative practices (Wells, 2007) as described in research can enhance teachers’ understanding of pedagogy (Mouza, 2006) and extend their awareness of appropriate uses of technology (Pope, Hare, & Howard, 2005). This analysis and reflection can provoke transformative changes in teachers’ practices (Dawson, 2006; Mouza, 2006) as they rethink personal or proximal goals for instruction and management of these diverse and empowering resources (Kanaya, Light, & Culp, 2005; Orrill, 2001). The design of the instructional planning tool piloted in this study incorporates the processes of reflection, analysis of innovations, collaboration and goal setting to stimulate transformative changes in practice when integrating technology in classrooms.

**Evaluation of technology integration training.** The prior section focused on technology integration professional development models and their impact on teachers’ practices and their plans for future professional development focused on technology integration. Additional research on technology integration training has focused primarily on how effective a specific technology integration training program was for a defined group of teachers. Five studies were selected for discussion within this section of the chapter. These studies investigated the impact of technology integration training programs within a specific state (Brinkerhoff, 2006; di Benedetto, 2005) or the study evaluated the benefit of *Preparing Tomorrow’s Teacher to Use Technology* government-funded programs (Doering, Hughes, Huffman, 2003; Ludwig & Taymans, 2005; Staples, Pugach, & Himes, 2005) and pointed out characteristics and activities which contributed to teachers’ increasing capacity to integrate technology.

*Integrate Technology* was a staff development program to extend technology skills and use by K-6 teachers in Louisiana. Di Benedetto (2005) gained access to the database of responses these teachers provided via a web-based survey instrument, which collected details
related to this 56-hour long staff development program. Four hundred teachers’ responses (half intervention, half control group) to this validated survey instrument were statistically analyzed to conclude that *Integrate Technology* did not significantly change these teachers’ practices.

Analysis of specific variables uncovered that there were measurable differences in pedagogy and in teachers’ attitudes toward the use of technology in classrooms. The training was determined to focus more on quantity than on quality as technology in these teachers’ classrooms was underutilized. Teachers were not guided to personalize or modify technology to create student-centered learning. The time invested by these teachers during this staff development program reduced their anxiety and increased their confidence. Di Benedetto (2005) suggested that follow-up or additional training provide guidance for integrating technology to stimulate research-based desirable changes in teachers’ technology-infused instructional practices.

Since Di Benedetto and other researchers suggested that a longer duration for technology training would potentially yield desirable outcomes, Brinkerhoff (2006) documented the impact of technology integration professional development for teachers in a southwestern state that consisted of 40 in-service days during a 2-year interval. Brinkerhoff designed this professional development program to address identified barriers to effective technology integration. Through interviews of six teachers and analyses of responses to a self-rating validated survey instrument, *Technology Beliefs and Competencies Survey* from 19 participants, Brinkerhoff noted that during the second year of this professional development program teachers perceived greater growth in their development of technology skills and greater confidence in the use of technology (reminiscent of Di Benedetto’s recommendations). During this second year, participants worked collaboratively to create and implement tele-cooperative projects and used digital video cameras. These projects unfortunately were of poor quality, which reflected a lack of guidelines and
direction. The survey instrument was administered at three points during this study, and the collected data from these 19 participants were analyzed for the reliability of the survey’s constructs (measures of 0.69 for beliefs; 0.96 for technology skills and for technology integration). Eta squared values were calculated to reveal that “49 to 77% of the variance in the three scores for each section of the computer skills survey is attributable to participation in the two year professional development program” (Brinkerhoff, 2006, p. 32). Interview data revealed that teachers had varying definitions of technology integration, similar to observations shared by Pierson (2001), who also noted how teachers should establish personal goals for their development of technology skills.

Critiquing the professional development model he tested, Brinkerhoff (2006) suggested the need for clearly defined goals to guide teachers’ project creation and evaluation of the quality of their work. In order to provide teacher training that addresses participants’ interests and needs, adequate time should be invested to provide varied instruction or supported collaborative exploration of specific technologies. Di Benedetto (2005) and Brinkerhoff (2006) provided evidence of the need for personalized and collaborative investigation of technologies and integration strategies over extended intervals of time, without offering a process or evidence-based tested framework or process to reach this goal.

Additional studies of technology integration professional development initiatives were undertaken to evaluate the benefit these teachers gained through Preparing Tomorrow’s Teachers to Use Technology funded programs. Staples, Pugach, & Himes (2005) conducted a 3-year qualitative study of three urban elementary schools’ use of resources to improve technology integration. Within this study, observations, interviews of school personnel, a chronicle of technology events, teacher-created and student-created artifacts and monthly collaborative
meetings were coded and analyzed. A cross-case analysis identified three scaffolds which supported teachers’ increased use of technology: (a) alignment of technology use with curricular instructional goals – or a contextualized use of technology; (b) teacher leadership and administrative support; (c) public and private celebration or recognition of student and teacher accomplishments as technology users. Additionally, teachers needed to recognize and understand the distinction between technology used for productivity and technology used to enhance learning and the curricula. Staples, Pugach and Himes (2005) noted the complexity of this process to increase competency with technology use and integration strategies. They also noted a connection between increasing an awareness of technologies, innovative practices and resulting changes in curricular goals.

Another 3-year study of a Preparing Tomorrow’s Teachers to Use Technology funded professional development program focused on technology skill development of teams of educators from K-12 schools, graduate students, and university faculty. Ludwig and Taymans (2005) described the outcome of forming “Technology Transformation Teams”, which provided a collaborative model to solve problems, created a virtual curriculum lab and integrated technology into university courses and classroom instruction. Nearly two thirds of the faculty within the George Washington University’s Graduate School of Education and Human Development and 286 student teachers came together as teams of three to collaboratively address identified problems surrounding the integration of technology to achieve instructional goals. Due to this level of participation, and through the alignment of curricular goals with content and technology standards, amid team interactions and reflective analysis of past efforts, a sustainable team instructional design initiative was established. Ludwig and Taymans indicated that teams continued to collaborate and explore uses of technology to address instructional needs after the
conclusion of the 3-year program. Faculty members have been forming additional teams for this purpose. Collaboration facilitated the identification of resources to support attainment of instructional goals and the creative, responsive and contextualized activities that embrace increasingly sophisticated and diverse uses of technology for 21st century instruction.

An earlier, similar study of effective classroom technology integrators who were selected to train faculty members of a teacher education program revealed the challenges in nurturing discriminating thinking about technology. Doering, Hughes and Huffman (2003) included pre-service teachers and the respective faculty members and technology integrator in their investigation of a newly developed structure for combining content area methods and technology integration methods courses. Despite this study’s 15-month duration, these participants shared changing perceptions about the role and purpose of technology use to support learning. Doering, Hughes and Huffman, in their focus on pre-service teachers, noticed a shift from skepticism, to superficial concerns or basic uses of technology to concerns of malfunctions and availability of devices. These pre-service teachers struggled to think with technology, or to see technology’s power to do more for students beyond facilitating presentation of information. Findings from this study pinpointed the need to encourage teachers to think about technology use as well as to identify supports so technology thinking can occur more frequently.

These studies of technology integration training models and programs provided evidence of the impact of collaboration (Brinkerhoff, 2006; Ludwig & Taymans, 2005), reflective practice (Dawson, 2006; Doering, et al., 2005; Ludwig & Taymans, 2005; Orrill, 2001), contextualization of technology usage within curricula and instructional standards (Ludwig & Taymans, 2005; Staples, et al., 2005) and provision of guidance and support to identify appropriate technology use to enhance instruction (di Benedetto, 2005; Pope, Hare, & Howard, 2005; Staples, Pugach, &
Himes, 2005). Through the development of personal goals (Kanaya, Light, & Culp, 2005) and personalized investigations of technology (Brinkerhoff, 2006), transformative changes in pedagogical and instructional practices were documented (Mouza, 2006). The instructional planning tool, grounded in guided self-reflection, piloted in this study was designed considering the collective evidence of these studies.

**Barriers to Technology Integration**

Research on technology integration initiatives and conditions also identified barriers and documented the challenges teachers and technology coordinators experienced in their attempts to use technology consistently and effectively. The impact of barriers is often addressed in technology integration studies. These studies often ask teachers to measure the extent to which specific barriers impact their instructional planning (Bauer & Kenton, 2005; Ertmer, 1999; Hew & Brush, 2007; Law, Pelgrum, & Plomp, 2008; Pelgrum, 2001). A discussion of the complex interrelationship of barriers to effective technology integration follows.

In a frequently cited analysis of technology integration barriers, Ertmer (1999) described first-order barriers (incremental and institutional) and second order barriers (fundamental and personal) and their interaction with prior practices and systemic or cultural norms within schools. Her analysis of qualitative and quantitative data from several prior research studies led to her determination of first-order and second-order barriers. Ertmer also proposed strategies to circumvent these barriers, practices and norms, which have hindered teachers’ efforts to integrate technology effectively. Pelgrum (2001) analyzed data on 38 obstacles to instructional and communications technologies (ICT) use identified through an analysis of the *Second Information Technologies in Education Study* (SITES) Report – Module I, with the goal of identifying any co-variation between these identified obstacles and contextual factors. The SITES Report
collected qualitative and quantitative data on ICT usage for mathematics and science instruction for eighth grade students in 26 countries in 1998-1999. The International Association for the Evaluation of Educational Achievement launched this major international study. Pelgrum (2001) focused on three specific obstacles: (a) insufficient number of computers; (b) teachers’ lack of knowledge and ICT skills; and (c) inadequate number of computers with simultaneous, functional Internet connectivity. Pelgrum proposed further collaboration to optimize practitioner use of available hardware and software. Equally important is the assurance that ICT-support staff members (i.e., technology coaches) have adequate qualifications to support teachers’ professional development in ICT integration.

The International Association for the Evaluation of Educational Achievement launched a follow-up study to the SITES Report – Module I in 2005-2006. Law, Pelgrum and Plomp (2008) noted variable levels of technology integration and identified three categories of obstacles: (a) five school-related obstacles; (b) five teacher-related obstacles; and (c) two student-related obstacles. These five teacher-related obstacles were most often noted: (a) lack of ICT-related skills; (b) lack of ICT-related pedagogical skills; (c) insufficient confidence to independently try new approaches; (d) lack of time to develop and implement ICT-using activities; and (e) inability to identify which ICT tool will be useful (Law, Pelgrum, & Plomp, 2008, p. 199). Further analysis of the survey data indicated that teachers identified a “lack of support as the most significant obstacle” (p. 276) – later clarified as technical and pedagogical support. Additionally, national curriculum policies impacted the extent of ICT use in the schools selected for this international study. These analyses of barriers impacting ICT use indicated the extent to which specific barriers persist over time. Systematizing evidence-based interventions to reduce the impact of barriers remains elusive.
Additional large-scale collections of survey data on teachers’ technology use and contextual factors were launched in the United States. Norris, Sullivan, Poirot, and Soloway (2003) analyzed data collected via the *Snapshot Survey*, multiple times between 1997 and 2001. Four thousand participants, consisting of teachers who worked in urban and rural schools, located in 4 states (California, Florida, Nebraska and New York), and teachers who attended a national technology conference, completed the survey. Norris, Sullivan, Poirot and Soloway (2003) performed a regression analysis to determine the predictive power of the variables they measured. The study’s emphasis was on collecting and analyzing data surrounding specific factors impacting teachers’ technology use and students’ access and opportunity to use the technology. Norris, Sullivan, Poirot and Soloway sought to demonstrate that students are unable to benefit from technology’s potential affordances, if barriers remain that impede effective integration of these digital tools and often undermine the design of instruction and specific activities to benefit students. Collected data revealed the extent to which (66%) teachers reported minimal or limited access to technology. Correspondence mapping of computer access as it related to amount of time teachers used these computers confirmed that access to technology impacted teachers’ use of technology for curricular purposes.

More recent studies collected similar data for analysis and described the impact of barriers on technology use in classrooms. During 2003 and 2004, the *Effective Access Research Project* collected data focused on the technology needs and experiences of high school Science Technology Engineering Mathematics (STEM) educators (Hanson and Carlson, 2005). In all, 236 STEM teachers from 35 states and the District of Columbia completed survey instruments (at four different points in time), representing seven urban schools, eight rural schools and seven suburban schools. Each launch of the online survey attempted to identify more participants and
gather more data. Data checks on these completed surveys provided useful data from 197 surveys. During the summer of 2003, the report indicated that a focus group was organized to collect additional data to allow participants to elaborate upon details elicited through survey items. In fall 2004, 26 teachers who had already completed an online survey, were interviewed by telephone. Analyses of all of these data sets identified seven key themes: (a) benefits and changes in practice; (b) school or district infrastructure; (c) time; (d) search strategies; (e) technology environment; (f) content for planning and instruction; and (g) professional development. Hanson and Carlson (2005) identified these five barriers: (a) lack of time; (b) frustration resulting from inadequate infrastructure; (c) unsatisfying results from teachers’ search strategies; (d) a technology environment that does not meet STEM high school students’ and teachers’ needs; and (e) frustrating lack of quality on-time training. The lack of access, as already identified as a significant barrier by Norris, Sullivan, Poirot and Soloway (2003) had been examined more closely in Hanson and Carlson’s (2005) study of STEM high school teachers’ use of technology. The need to train teachers and help them match appropriate forms of technology which align with curricular and instructional goals still needs to be addressed, based on the findings of the Effective Access Research Project.

Beyond these focused analyses of data on technology integration collected through surveys and interviews, Hew and Brush (2007) reviewed 48 empirical studies of technology integration in K-12 settings (dated from 1995 until 2006) and noted 123 barriers, which were classified into six categories (including percentage of frequency of their mention in these 48 empirical studies): (a) resources 40%; (b) institutions 14%; (c) subject culture 2%; (d) attitudes and beliefs 13%; (e) knowledge and skills 23%; and (f) assessment 5%. Hew and Brush (2007) also noted that the definition of technology integration was not clearly communicated and
suggested the need for schools to develop a technology plan and vision, for teachers to document and analyze the benefits gained from integration strategies, as well as examine any drawbacks they have experienced. These recommendations informed the design of the instructional planning tool piloted in this study.

Some of the empirical studies analyzed by Hew and Brush (2007) provided clarification of these six categories of barriers to effective technology integration. Hinson, LaPrairie and Heroman (2006) described the barriers that undermined a Department of Education funded one-year professional development initiative for teachers in one rural school district in Louisiana. These 12 teachers were provided web-based tools as resources for students in their classes. After a paid, two-day summertime training session, these teachers still struggled to use these web-based tools. Due to the rural location of these teachers, they were provided access to a broadband-based communication network, to share concerns and to communicate with students and with parents. Infrequent use of the web-based tools and varying low levels of comments (shared to seek further guidance in the use of these web-based tools) and interview data revealed the lack of success of this educational initiative. Hinson, LaPrairie and Heroman (2006) identified eight barriers: (a) nonexistent or unreliable Internet access; (b) lack of equipment and technical support; (c) lack of teacher expertise; research team and trainers were at a significant distant from the teachers in this rural school district; (d) lack of collaboration within the local rural community; (e) mixed messages from administration; (f) communication between researchers and teachers not always used; and (g) inadequate professional development. The description of this federally funded initiative revealed a lack of planning, basing the training design on assumptions instead of gathering basic information (context, infrastructure, teachers’ experience with technology, etc.) about the educational setting and context to influence the
training design, and matching needs to the implemented intervention, which undermined the potential impact educational technology can have for students.

Hew and Brush (2007) also analyzed the qualitative study of the first year of the Maine Learning Technology Initiative, a laptop or one-to-one computing initiative. Garthwait and Weller (2005) presented a narrative based on their study of two middle school teachers. Garthwait and Weller observed, interviewed and examined various artifacts over time to determine patterns in two teachers’ planning, instruction and interaction with students. Garthwait and Weller identified various barriers due to time constraints, policies and procedures, a problematic infrastructure design, access issues, impact of external pressures and the reality that the district level technical support was not versed in the type of computer used for this initiative (the PC/Apple debate). Despite these barriers, incremental pedagogical changes were observed and documented, as these two teachers possessed a desire to integrate laptops (motivation) and recognized its potential to support instructional needs of students (relevance or value).

Hew and Brush (2007) also noted the barriers described in a year-long evaluation of ten teachers’ implementation of a state-funded technology grant program. Zhao, Pugh, Sheldon, and Byers (2002) collected survey data (at two intervals – before and midway) from 118 technology-grant recipients. They also surveyed and interviewed 32 of these 118 teachers. Analysis of these data facilitated the selection of 10 teachers who were additionally interviewed and observed once per month. Teachers also submitted bi-weekly electronic journal entries to the researchers. Zhao, Pugh, Sheldon and Byers (2002) isolated eleven factors which interact and can contribute to the success or the failure of innovative, technology-rich projects. Conclusions from this study identified these three barriers: (a) low quality or interrupted access to functional infrastructure;
(b) teachers’ lack of awareness of the affordances, constraints and enabling conditions of technologies for instructional use; and (c) lack of awareness of the social, cultural and organizational aspects of schools and how these aspects impact introduction of innovative practices. Zhao, Pugh, Sheldon and Byers observed a relationship between distance and dependence of the innovation as it relates to established school culture and practices. They noted how innovation has greater success when implementation of the innovation is closer to established instructional practices, resources and cultural norms. Incremental, evolutionary changes in pedagogically-matched technology use had greatest success in its implementation.

This study’s evidence-based instructional planning tool is designed to document and manage the implementation of incremental, evolutionary changes, as suggested by Zhao, et al. (2002). Using the evidence-base instructional planning tool would address the weaknesses or barriers observed in several of these studies, whether to encourage collaboration (Hinson, et al., 2006; Pelgrum, 2001), or facilitate training and rethinking how technology can align with instructional goals and strategies (Dawson, 2006; Doering, et al., 2003; Garthwait & Weller, 2005; Hanson & Carlson, 2005; Law, et al., 2008; Zhao, et al., 2002). Successful implementation of innovative technology training initiatives occurred when teachers were “highly reflective” and “consciously use(d) technology in a manner consistent with their pedagogical beliefs” and students’ activities represented an “intimate connection between technology and the curriculum” (Zhao, et al., 2002, p. 492).

The focus on training of teachers does not go without merit. Various studies have indicated that for more technology to be integrated into the classroom teachers require more training (See: Law, et al., 2008; Moursund & Bielefeldt, 1999; OTA, 1995; PCAST, 1997; Schaffer & Richardson, 2004), especially training that focuses on “electronic pedagogical
content knowledge and skill” (Franklin, 2007, p. 284), or training that identifies “content-area specific uses of technology” (Dexter, Doering, & Riedel, 2006, p.341), or training that “provide(s) access to many technology tools that connect with curricular interests and problems of practice” (Hughes, Kerr, & Ooms, 2005, p.377).

Educating Teachers

The need for training, guided by state or federal funds, has focused almost solely on providing teachers specific skills for using technology (e.g., how to use presentation software, word processing software, web browsers and email clients) (Brinkerhoff, 2006; Hinson, et al., 2006; Ludwig & Taymans, 2005; Pope, et al., 2005; Wells, 2007). Some of these funds have also been used to determine the effectiveness of technology skill development (Mouza, 2006, 2002-2003; Pierson, 2001; Pope, et al., 2005, 2002). Data collected through observing, interviewing and surveying teachers have contributed to the identification and understanding of multiple barriers that impede technology integration (Ertmer, 1999; Hanson and Carlson, 2005; Hew & Brush, 2007; Pelgrum, 2001). Research has also identified the impact of reflection or the need to encourage teachers to think about technology (Dawson, 2006; Doering, et al., 2003; Orlando, 2009). A primary finding of these analyses identified a need to provide teachers contextualized training in technology use related to instructional planning and evaluating subsequent outcomes.

Perspectives for Promoting Effective Technology Integration

The prior section of this literature review focused on findings of research studies that investigated training so teachers become effective technology users. The literature also contains discussions of the basis for anticipating that effective technology integration arises from incremental evolution or gradual changes in practices. Several studies noted that effective
technology integration requires long-term time investment (Bauer & Kenton, 2005; Di Benedetto, 2005; Fleming, Motamedi, & May, 2007; Hughes, et al., 2005) so teachers have opportunities to investigate technologies and employ appropriate strategies in order to alter their practices and beliefs. This section will focus on a discussion of the various models of technology adoption, then discuss transformative instructional practice, the systematization of technology integration, and finally the connection between the use of technology and cognition.

Models of technology adoption. Today, technology represents a vast array of devices and resources that provide benefit to individuals, whether facilitating or completing tasks to meet our needs and wants. Additionally, technology can be strategies or processes, which change the manner in which we communicate, think, learn from experiences, and respond (Finn, 1960; Heinich, 1984, 1985; Sternberg & Preiss, 2005). Rogers (1995) formulated a theory, the diffusion of innovations, to explain why there is such variance in the use and acceptance of novel strategies and devices within communities. Even though his preliminary research focused on farmers’ interest to adopt the use of weed spray, the theory of diffusion of innovations has been applied to other fields, such as the adoption of technology in educational settings. Rogers noted a pattern that among a community there are members who embrace innovation (innovators and early-adopters), as well as those members who prefer to review evidence that the innovation has merit (early majority) or that the innovation has demonstrated considerable benefit (late majority). In all communities there are laggards or traditionalists (members who are reluctant to use the innovation). Rogers’ identified stages of adoption that set the stage for other researchers’ explanations of the various observed uses of technology in classrooms and how specific teachers, students and administrators change their usage patterns over time.
Psychological theories explain why people accept and espouse specific attitudes and beliefs and adopt or reject innovations. In particular, Fishbein and Ajzen (1975) explained their Theory of Reasoned Action (TRA) where an individual’s intentions, attitudes and the prevailing subjective norms contribute to a prediction and explanation of future behaviors. Subsequently, Davis (1986) explained the Technology Acceptance Model (TAM) to identify specific factors (perceived ease of use and perceived usefulness) impacting the use of innovations within the business world. Additional analysis of the phenomena of computer application use and adoption led to an extension of TAM, as defined by Venkatesh and Davis (2000), and renamed as TAM2. Over time, evaluation of training or professional development – to understand the benefits of a specific innovation – led to the formulation of the Concerns-Based Adoption Model (CBAM).

The CBAM is based upon an individual’s need to ask questions when they are in the midst of change, as introducing innovative practices and devices can promote changes in experiences and attitudes. Hall, Rutherford, Huling-Austin and Hord (1987) recognized that there are seven stages of concerns, which can impact the manner in which individuals embrace change and innovation. Additionally, Hall, Rutherford, Huling-Austin and Hord extended this concept by identifying seven levels of use (LOU) of an innovation, with accompanying behavioral indicators. Similarly to Rogers’ realization that there are degrees to which people adopt innovations, Hall, Rutherford, Huling-Austin and Hord associated specific behaviors as evidence of people’s interest and willingness to use specific innovative devices and practices. These levels of use are: (a) non-use; (b) orientation; (c) preparation; (d) mechanical; (e) routine; (f) refinement; (g) integration; and (h) renewal. The CBAM and LOU models have been applied to technological innovations in classrooms (textbook adoptions, curriculum implementations and instructional strategies) and to business and other scenarios where innovations are introduced and
some investigation is needed to determine why the innovation may not be accepted or readily adopted.

Hooper and Rieber (1995) described how educational technology and innovation are frequently misunderstood as synonymous. They defined technology as the use of “evolving knowledge to adapt and improve the system to which the knowledge applies” (Hooper and Rieber, 1995, Model of Technology Adoption in the Classroom, ¶ 1). Reigeluth and Merrill (1978) defined technology as “applied knowledge” or “the development of application procedures for the principles of instruction” (p. 58). Extending this definition of applied knowledge within an educational setting, educational technology is viewed as the “important link between the search for a basic understanding of the learning process and subsequent instructional applications” (Rieber and Welliver, 1989, p. 23). These conceptualizations of the interrelatedness of technology, thought and knowledge can be traced to Finn (1960), who recognized technology as a way of thinking.

How teachers and students use technology to express their thoughts and apply their knowledge to new situations remained a focus of researchers intrigued in this thought process, as it relates to teachers’ technology use and adoption. Both Hooper and Rieber (1995) and Rieber and Welliver (1989) explained a hierarchy or pattern of adoption in educational settings of instructional technology, often referred to in subsequent literature as Welliver’s Instructional Transformation Model. The five stages of adoption are: (a) familiarization; (b) utilization; (c) integration; (d) reorientation; and (e) evolution. Hooper, Rieber and Welliver acknowledged that frequently most uses of educational technology reflected earlier stages of adoption (familiarization, utilization and integration), which often led to misuse or abandonment of these uses of educational technology in classrooms.
Hooper and Rieber (1995) explained how teachers often undergo a transformation in their learning philosophy. Considering instructional planning practices, teachers adopt processes, devices and resources that will reorient and evolve the manner in which instruction (the system) is designed for student interaction (application of knowledge). If effective technology integration is the goal, then educators are to be encouraged and supported to pose questions about potential innovations and current knowledge. Questioning the connected use of innovations and knowledge acquisition can promote these transformations in instructional planning and use of knowledge, devices, and processes.

As these ideas were being formulated, in 1985, an investigation in the use of individual computers in schools, the AppleClassrooms of Tomorrow Project (ACOT), was launched. Many individuals expressed great interest in this program and several articles documented what occurred. Dwyer, Ringstaff, and Sandholtz (1991) documented and analyzed observations, collected documents and artifacts, and interviews with teachers, students, parents and program facilitators who were provided a full array of state of the art technology tools at that time. These ACOT classrooms reflected various grade levels and geographic locations, providing students and teachers the opportunity to change their practices and ideas of what could happen in classrooms over time. After analyzing several years of data, Dwyer, Ringstaff and Sandholtz concluded that teachers experience five phases or stages they called the Supports for Instructional Evolution in Technology-Intensive Environments: (a) entry; (b) adoption; (c) adaptation; (d) appropriation; and (e) invention. Additionally, Dwyer, Ringstaff and Sandholtz identified specific expectations and supports with each of these phases and noted how specific pedagogies were observed during phases that aligned with specific technologies. Teacher and students roles were changing during the course of this study. Once teachers and students gained
skill in using these technologies, appropriation of specific devices (dependent on acquired skills) was observed. Teachers reflected on the use of these technologies and realized how their choice of pedagogies and strategies changed over time.

Sandholtz and Reilly (2004) reviewed subsequent analyses of ACOT program experiences and noted how teachers’ perception of needing to be very competent with technology tended to trap teachers in the entry and adoption stages, much like Hooper and Rieber (1995) and Rieber and Welliver (1989) mentioned. Sandholtz and Reilly (2004) shared their analyses of four years of case study collected data (journals, interviews, focus groups, surveys, observations, documents – to include teachers’ professional growth plans) to investigate this tendency for teachers to be stuck at a specific phase or stage of technology adoption. Findings revealed that when teachers’ use of technology was connected to the curriculum and more frequent use of technology was noted, over time there was more rapid movement through the five stages or phases of technology use evolution. Teachers sought supports so they could continue to integrate and align the use of technology to meet curricular goals, and in turn reach the more sophisticated phases (appropriation and invention) of technology use evolution.

In a related analysis of the evaluations of two instructional entities’ teacher technology use development programs, Sandholtz (2001) noted common elements that contributed to the success of these technology development programs. These two technology use development programs increased teachers’ technology skill levels and impacted their decisions to use technology in classrooms. Specific noteworthy elements of these two programs were: (a) flexibility of the goals of these sessions, (b) the use of collaboration and reflection to guide interactions, and (c) administrative and financial support. The findings emanating from these analyses of ACOT professional development programs demonstrated the benefit of incorporating
collaboration and reflection when focusing on how to align the use of technology to meet curricular goals.

**Transforming instructional practice through thought and reflection.** Building on these models where teachers’ skills as technology integrators develop over time, some researchers have studied what kind of professional development is needed to promote these gradual changes in teachers’ practices and beliefs. King (2002a) examined the findings gleaned from a 3-year study of 175 teachers enrolled in an educational technology course. King (2002b) extended the timeframe and sample of this study (six years and 205 teachers, both pre-service and in-service) to demonstrate that through a funded, nurturing and safe learning environment, collaborative teams invested time to determine how to integrate educational technology to transform their practices and link technology to curriculum development. Most importantly, King (2002a) noted how reflective interaction among the members of established and ongoing communities of practice (Wenger, 1999) promoted transformative changes in teachers’ methods and perspectives on technology’s impact on teaching and learning.

In a related essay, Cranton and King (2003) pinpointed specific strategies (so teachers gradually reformulate their instructional practices), which applied the theory of transformational learning (Mezirow, 2000, 1991). Through appropriation of three forms of reflection [(a) content reflection, (b) process reflection, and (c) premise reflection] teachers can transform their perspectives and practices so as to more successfully integrate educational technology. Beyond incorporating reflective activities, transformational professional development encourages the analysis of case studies and critical theories to formulate action plans to focus on curriculum development. Cranton (2006) emphasized the role of critical reflection, authenticity and skillful communication for transformative learning to yield desirable outcomes. Mezirow and
Associates (2000) explained how critical reflection develops over time so adults can acknowledge and understand the desirable outcomes of transformative learning. In an essay, Merriam (2004) posited that advanced levels of cognitive development are pre-requisite for teachers to self-reflect, critically reflect and think dialectically so desirable transformational learning processes can impact technology integration and change in teaching practices. As this body of literature described the need for and impact of various forms of reflection to support transformation of teachers’ practices and perspectives over time, it seems plausible that nurturing self-reflection to enhance teachers’ skills with technology integration (on a large scale) can mitigate the continual presence of barriers to effective technology integration.

As the International Society for Technology in Education (ISTE) and the National Council for Accreditation of Teacher Education (NCATE) established national technology standards for students and teachers, Mills and Tincher (2003) developed a framework embodying “best practices for expert teaching and student learning with technology” (Mills & Tincher, 2003, p. 384). This framework was influenced by local expectations and the educational context of these teachers and students. It also reflected a developmental approach as teachers’ decisions to integrate technology can transform instructional practices and teachers’ and students’ use of technology. Mills and Tincher implemented a technology professional development initiative and measured its benefit through self-rated performance assessments (documented through a validated configuration matrix) over time with 46 participating teachers in one school district (N= 147). These self-rated performance assessments provided evidence that the technology professional development initiative did move more teachers into facilitating and integrating roles, while novice technology users became more readily identified. Mills and Tincher also collected and analyzed qualitative data that confirmed the developmental nature of technology
integration. They also provided evidence of the need to expose teachers over time to descriptors of increasingly sophisticated technology uses to conceptualize how personal growth and change in practices of integrating technology and effective instruction can be attained.

A more recent study of teachers’ professional development for increasing technology use in schools offers evidence of how transformative change developed over time. Schifter (2008) engaged in a 2-year qualitative study of 57 teachers in Philadelphia Public Schools, who participated in a technology professional development program, *Continuous Practice Improvement of Classroom Teaching and Learning*, supported by IBM and focused on how the use of technology can support good teaching and classroom management. This study collected evidence that Schifter’s technology professional development program led to institutional changes and teachers found the innovative practices easy to understand. The program encouraged teachers to progress at their own pace and focus on applications and devices aligned to their individualized instructional needs and goals. Through full-day classroom visits and ongoing experimentation with devices and applications, teachers began to embrace suggested changes and incorporate technology into their classroom practices. Time and ongoing supports increased the benefit these teachers experienced through this technology use development program and nurtured these teachers’ changing perceptions and behaviors concerning technology use in classrooms (by teachers and by students). Schifter (2008) documented sustained changes to these schools’ structures and these teachers’ practices due to this long-term technology use professional development program.

These analyses of successful technology professional development programs (Brinkerhoff, 2006; Ludwig & Taymans, 2005; Mouza, 2006; Pope, Hare, & Howard, 2005; Schifter, 2008) pinpointed the need to allocate adequate time and offer supported experiences so
teachers can experiment and determine which forms of technology match their educational settings and promote student learning. The role of critical reflection and self-rating or identifying technology use along a continuum of potential uses can empower teachers to adopt these uses of technology for sustainable changes in instructional practices. Due to the relative sophistication of process, premise and critical reflection, it seems necessary to provide guidance and opportunities to collaboratively understand and apply these levels of reflective thought (or critical thought process) more consistently, if sustainable changes and adoption of technological innovations are desirable goals for school settings.

**Systematizing technology integration.** With each successive wave of technology innovations, the range of options for integrating technology effectively expands and can overwhelm teachers and lead to frustration and rejection of technology and innovative practices (King, 2002a). Ellsworth (1997) noted that educational technology is interdependent with all the other elements of education systems that periodically change in response to stakeholder and public demands. This interdependence necessitates a systematic and analytic approach to track the impact of technology use within educational settings. Research and analysis of teachers’ level of technology use contributed to the formulation of several parallel frameworks and models of technology adoption or technology integration (see Dwyer, Ringstaff, & Sandholtz, 1991; Fitzallen, 2004; Mills & Tincher, 2003; Rieber & Welliver, 1989; Sherry, Billig, & Perry, 1999; Trinidad, Newhouse, & Clarkson, 2005). To facilitate teachers’ grasp of these levels of technology adoption and how instructional practices can be transformed over time, researchers and practitioners recognized the need to systematize the process of technology integration through the development of taxonomies (Maddox, Johnson & Willis, 1997; Small, 2005).
Maddux, Johnson, and Willis (1997) noted that teachers need supports in the development of value judgments and rationales for their decisions in effectively using specific technologies for instruction. The proposed taxonomy of technology, into two categories – Type I applications and Type II applications – can guide teachers in these decisions as well as expand teachers’ awareness of the diverse uses of technologies within educational settings.

Type I applications provide teachers ways to be more efficient as they prepare or deliver instruction. Type I technology uses provide teachers opportunities to focus their energies on more creative and complex instructional roles. Type I applications have users passively engaged with predetermined levels of interactivity, due to limited options and the goal to nurture rote memory. Type I applications have often been profitable for the software design industry.

Type II applications tend to be more innovative and provide students opportunities to develop higher order thinking skills through active intellectual involvement. The user is encouraged to be creative and in control of the interaction, the interface, and tasks to be completed while using the application. Type II applications have not been distributed as widely, nor have demonstrated its value within the educational technology marketplace (i.e., specific educational games or simulations that are not ubiquitous in schools). As technologies have become increasingly sophisticated, Type II applications have expanded to reflect the power of these applications to support communication and creative representation of ideas (often applications that support the creation of hypermedia or multimedia).

Maddux, Johnson, and Willis (1997) commented that focused use of Type I applications is less desirable, as effective use of technology should promote development of creative solutions to problems, extend students’ cognitive development, as well as facilitate effective communication. According to Maddux, Johnson and Willis, when teachers integrate Type II
applications effectively, the financial investment in technology infrastructure and training can be justified. Students and teachers using Type II technology would be increasingly mindful of societal goals and needs in the 21st century, due to technology’s ubiquitous presence in almost all aspects of our lives.

As school districts and state education departments responded to the dissemination of ISTE and NCATE technology standards in 1999 and in 2001 (respectively), some states recognized the need to provide professional development and guidance to their teachers, so that these standards are met. Federal mandates to “encourage the effective integration of technology resources and systems with teacher training and curriculum development to establish research-based instructional methods that can be widely implemented as best practices by State educational agencies and local educational agencies” within Title II, Part D of the No Child Left Behind Act of 2001 (NCLB) were the catalyst for school districts to develop, implement and review technology plans. Small, as Washington State’s Educational Technology Director, provided the school districts and teachers with a taxonomy of technology use, the Tiers of Technology Integration in 2005 as part of the State Technology Plan. There are three tiers of technology use to guide teachers in their decisions and evaluation of technology integration strategies and outcomes.

Tier I focuses on teacher productivity, facilitating the work of teachers, much like the Type I uses developed by Maddux, Johnson and Willis (1997) to produce, find, store, retrieve, and organize documents and data, as well as to communicate effectively and in a timely manner. Tier II focuses on how teachers present large group instruction and how students produce or create documentation for assessment of their learning. Tier III focuses on facilitating students to use technology individually and collaboratively to demonstrate their learning. To support
teachers’ use of this taxonomy, Washington State’s educational technology web site provides teachers a free self-assessment tool, PILOT, and a draft observation tool (*Integration of Technology Observation Tool*), which has been used by a few districts (D. Small, personal communication, March 20, 2009). With the ever-expanding uses of technology to support teacher and student communication and creativity, the need to organize these uses into three categories becomes necessary. These taxonomies will continue to change as innovative and newer forms of technology enter educational settings to meet learners’ needs or to facilitate tasks. If teachers become skillful users of such taxonomies (and related instruments) to evaluate and reflect on their decisions to integrate technology, effective use of technology could increase. This study intends to explore this premise through an instructional planning tool that supports documentation of an effective instructional design to integrate technology appropriately and evaluate the outcome through self-reflection. The tool incorporates these taxonomies to serve as a guide for teachers’ decisions and judgments.

**Technology and cognition.** As Maddux, Johnson and Willis (1997) indicated, desirable uses of technology intentionally develop or support cognitive thinking, creative production and effective communication (required 21st century skills). Small (2005) recognized and included uses of technology that develop cognitive thought and effective communication in the *Tiers of Technology Integration*. Numerous researchers have provided evidence of how technology can support cognitive thinking.

Jonassen (1996) recognized that computer-based tools and learning environments provide teachers and students an intellectual partner to support cognitive thinking and higher-order learning. He used the concept of technology as a mindtool to facilitate construction or representation of knowledge so mental processes can be effectively harnessed to advance and
engage learners in their exploration of concepts. Mindtools facilitate scaffolding to increase understanding and student reflection on what has been gained through this exploration and representation of knowledge. Jonassen (2006) elaborated upon the described benefit of technologies as a mindtool where students create models to represent evolutionary changes in their conceptual understanding as they learn new ideas and develop their cognitive thinking.

Derry and Lajoie (1993) emphasized that well-designed cognitive tools found in educational settings serve as scaffolds, facilitate problem solving, assessment, the development of procedural knowledge, self-regulatory skills, higher-order thinking skills, meta-cognitive and motivational states. Through discussion of several studies of specific applications designed for cognitive skill development, the manner in which computers serve as cognitive tools is clarified for educators. Through replications of these exemplar uses of computers and related applications in other studies and settings, more students can develop these skills as they use computers as cognitive tools. Azevedo (2005), in his introduction to a special issue of Educational Psychologist, noted that if students are to gain much from conceptually rich content lessons, effective use of computers as cognitive tools can help represent the interrelationships of cognitive development, affective development, motivational, meta-cognitive and social processes. When computers and applications are used effectively, technology as a cognitive tool has the potential to impact all of these aspects of personal growth within students, not just the content knowledge development often associated with schooling. Examples of creative and cognitively demanding uses of technology to support dynamic visualizations of content and simulations to promote problem solving offer potential benefit for students and are continually evolving (Dede, 2007).
Pea (1985) noted how computers can support students’ capacity to reorganize their thoughts and understandings of the world as they learn and explore its richness. This process of representing ideas and shared understandings has been described as cognitive amplification. Lajoie (2005) extended the power of technology-supported cognitive amplification as she explained the benefits of specific software applications. Cognitive amplifiers were designed to provide students scaffolded-supports so they could locate, collect and apply information and various skills to develop solutions. Lajoie emphasized that cognitive tools facilitate students to reorganize their thinking, to extend their knowledge, and to hypothesize and solve problems. Nickerson (2005) discussed several ways that information technology is a cognitive amplifier, whether to support individuals with disabilities, or to meet our need to locate information, to reliably store information for later retrieval, and to facilitate communication, collaboration and problem solving. Nickerson also explained the risks or concerns society has when cognitive amplification tools are used to promote propaganda, brainwash or manipulate individuals, and invade personal privacy.

Once practitioners have identified specific cognitive amplifiers, it is equally critical that appropriate and balanced use of these resources is defined to address students’ needs. Salomon and Perkins (2005) suggested that educators are to coordinate technology-enabled cognitive activities and evaluate the intellectual consequences of these activities in order to avoid these risks. Several of these described and suggested innovative uses of instructional technology to stimulate cognitive development align with the Type II uses of technology (Maddux, Johnson and Willis, 1997) and the Tier III level of Washington State’s Technology Plan’s Tiers of Technology Integration (Small, 2005). Enhanced awareness of using cognitive tools effectively also aligns with the concerns of technological determinists (see Bimber, Ellul, Pannabecker,
Williams and Edge), where benefits and shortcomings of technology are to be recognized and managed. As Angeli (2008) explained in her introduction to a special issue of the *Journal of Research on Technology in Education*, distribution of cognitions offers us the benefit of a conceptual and analytical framework to interpret and assess the value of how technology is used to nurture cognitive development. Documenting and analyzing the intricacies of classroom interactions, contextual factors and the interdependent interaction of individuals and a range of cognitive tools within classroom settings can help researchers and practitioners realize the value and recognize how students have learned in technology-rich environments. Interpreting technology’s effects to augment and amplify the content and skills can also distill the benefits and shortcomings, and hint at useful techniques for the management of a diverse range of technologies and cognitive tools teachers select or customize to address students’ needs.

Technology has been described as a cognitive partner (Salomon, Perkins, & Globerson, 1991), where individuals gain from effects *with* the technology (amplified cognitive functioning) and there are outcomes that add to individual experience due to mindful engagement *in the cognitive partnership with* the technology. The benefit is gained from working *with* the technology of choice (word processing application, digital camera, etc.). Salomon, Perkins and Globerson (1991) extended the concept of a cognitive partnership in that there are long-term, residual cognitive *effects of* the interaction with computer tools. The *impact of* technology is recognized through the transfer of generalizable, lasting use of newly acquired skills and knowledge to other appropriately matched situations. As Salomon and Perkins (2005) explained, the *effects of* technology allow individuals to shed the scaffolds or rules learned so they can apply knowledge and skills automatically. Due to the transformative impact of technologies, Salomon and Perkins (2005) noted the qualitatively different effects people gain *through* the use
of technology. If indeed the transformation of classroom practices is desirable (as noted by Cranton, Guskey, King, Kopcha, Schifter, among others), then perhaps teachers may require an instrument or schema to guide the orchestration of such effects through the use of technology. These distinctions regarding the use of technology require educators to apply sophisticated and varied levels of reflection (as noted by Brookfield, 1995; Mezirow and Associates, 2000, and Merriam, 2004). When teachers have opportunities to delve into these exemplar studies, investigate or experiment with forms of technology and computers as cognitive tools, document, reflect upon and evaluate their observations and outcomes, teachers may start to use technology in more desirable ways, effectively and more consistently (see Derry & Lajoie, 1993; Gibson, 2006; Lesgold, 1993; Salomon, 1993).

Richardson (1990) discussed at length a connection between personal cognitive development and increased capacity for teachers to acknowledge and adopt change or innovative practices influencing how they teach students. This connection is examined in the research literature on learning to teach. This literature is defined as focusing on “individual teacher’s cognitions, beliefs, and other mental processes” (Richardson, 1990, p.12). Shulman (1986), in his research on teacher knowledge, explained the goal of notating the “intellectual biography” (p. 8) of novice teachers to identify the nature of pedagogical knowledge, how it interacts with content knowledge, and the role of strategic understanding and pedagogical content knowledge. Brown (1992) summarized her efforts to describe the role of meta-cognition and reflection through the identification of classroom activities and instructional strategies that support student learning and advantageous changes in teacher practices. Jonassen (2006) emphasized how computers – when used as cognitive tools – facilitate students’ concept map development and
thought processes yielding meaningful learning. These researchers’ messages demonstrate the inherent connection between cognitive development and effective, long-term learning.

Effective technology integration requires time and opportunity for teachers to experiment and evaluate uses of technology as they pass through various stages of innovation adoption (see Bauer & Kenton, 2005; Newhouse, Trinidad, & Clarkson, 2002; Strudler, Archambault, Bendixen, Anderson, & Weiss, 2003). The diverse models of technology adoption and technology use professional development programs presented in this chapter represent what researchers observed in classrooms and were described by teachers in surveys and interviews. More advanced levels of adoption were associated with the transformative impact technology can bring to instructional practices. Additionally, the manner in which students learned was changed through effective technology integration. Accomplishing transformative practices in classrooms through professional development depends on collaborative and reflective interventions. Systematic taxonomies of technology uses, aligned with what is understood of cognitive development facilitated by effectively-used technologies, can support teachers’ increasing awareness of options for using technology. Increasing teachers’ understanding of the effects with technology, of technology and through technology, the power of mindtools, and the role of critical reflection can serve as the foundation of better decision-making when planning how to integrate technology and evaluating the outcome.

Defining the Instrument or Tool

This study pilots the use of an instructional planning tool nurturing guided self-reflection. It is designed to increase teachers’ capacity to integrate technology aligned with more desirable uses of technology. The previous section of this chapter described how technology can be used as a cognitive tool to nurture higher level thinking skill development. This present section
clarifies how a systematic process and document (taxonomy embedded within an instructional planning tool) offers support for increasing teachers’ capacity to integrate technology effectively and more consistently. The piloted instructional planning tool documents a thought process for notating, categorizing and evaluating technology integration. It has the potential to transform instructional practice. The instructional planning tool encourages teachers to reflect and collaborate on decisions concerning resources, strategies and options for how to use technology (by teachers and by students). Research on technology integration recommended the formation of communities for technology discourse (Keller, Bonk, & Hew, 2005), collegial support (Sandholtz, 2001), and collaboration (Gülbahar, 2007; Kopcha, 2008; Means, Haertel, & Moses, 2003; Radinsky, Lawless, Smolin, & Newman, 2005). Collaboration is further enhanced when linked with the concepts of reflective practitioner (Schön, 1987), critical reflection (Brookfield, 1995), and frameworks including the reflection process (Dawson, 2006; Fitzallen, 2005; Orlando, 2009; Orrill, 2001; Schulman, 2000; Trinidad, Newhouse, & Clarkson, 2005).

Prior research demonstrated the benefit of guiding teachers to periodically self-assess their use of technology and how this use of technology and interdependent resources changes over time due to several factors (Fitzallen, 2004; Mills & Tincher, 2003; Sherry, Billig, & Perry, 1999; Trinidad, Newhouse, & Clarkson, 2005). Sherry, Billig, Tavalin, and Gibson (2000) developed a cyclic process so teachers can evaluate their use of technology and can ascertain their location along a “learning and adoption trajectory”, the Integrated Technology Adoption Model, much as Kopcha (2008) and Gülbahar (2007) advocated. This study’s piloted instructional planning tool intends to build upon this body of knowledge and bring together processes that can reinforce and move technology integration toward an automatic, internalized element of effective instructional planning. The instructional planning tool is designed to
provide opportunities for educators to understand and apply the process and power of critical reflection (*in* our practice and *on* our practice, Preskill & Brookfield, 2009, p. 41) [italics added]. Using the structure and thought process of the instructional planning tool (Informed Technology Integration Guide – ITIG), teachers can evaluate the outcomes of technology-supported instructional activities and student performance and products.

**Instructional Planning Tool – Why it Deserves Piloting**

Reading several segments of the literature on the use of educational technology by teachers yielded more than one direction for selecting the focus and purpose of a research study. Studies focused so much on the process of training pre-service or in-service teachers to use technology, without mention of a system of documentation and self-evaluation of the resulting instructional design and its impact on students. Experiences as a classroom teacher contributed to my desire to explore the benefit of an instructional planning tool for teachers in classrooms, who are encouraged to use technology as one of several resources at their disposal. The broad and thorough investigation of the literature contributed to the design of this piloted instructional planning tool. The prior examination of the intended benefits of frameworks and approaches to provide professional development or technology training to teachers (often pre-service teachers) suggests further exploration of a tool to facilitate technology-supported instructional planning, problem solving and strategizing. Prior research’s indication of the power of reflection and systematizing technology usage (to encourage innovative technology adoption to develop cognitive skills) pointed out the need to incorporate definitions, reflective questions to encourage cyclical evaluation, and checklists of technology use options within the instructional planning tool piloted in this study. Systematic and consistent use of an instructional planning tool, like the ITIG, has the potential to facilitate teachers’ automatic and embedded use of technology as a
critical element of daily instructional activities in classrooms. Determining the benefit of the
instructional planning tool (the ITIG) influenced the focus of the research questions defining this
study.

Research Questions

To explore how an instructional planning tool impacts teachers’ thinking about and usage of technology in their instruction, the following questions guided this study and the research design:

1. In what way did the utilization of the instructional planning tool (ITIG) impact teachers’ instructional planning practices and decisions concerning technology use?
2. In what ways did teachers’ instructional behaviors differ when the ITIG is utilized prior to delivering technology-supported instruction?
3. What additional issues, surrounding technology use, impacted these teachers’ instructional planning practices and instructional behaviors?
Chapter 3
Methodology

Introduction

In a review of the research for the U.S. Department of Education, Ringstaff and Kelley (2002) concluded that it is critical to identify the conditions under which technology is used effectively to meet the needs of students. This study is designed to investigate these conditions based on six participants in five classrooms through providing them with a tool to document and evaluate specified conditions and approaches to integrate technology to meet their students’ instructional needs. This study’s research questions seek to identify and systematically describe strategies and behaviors (surrounding technology use supportive of content delivery and student learning) through observations over time and revealed or described by the participants in this study.

The remaining sections of this chapter will present details explaining key elements of the study’s methodology to include its paradigm, design and rationale. Sections are organized to share the following aspects of this study: research design and methodology, Institutional Review Board (IRB) requirements, gaining access, participants, the context of the study, categorizing the participants, data collection, the role of the researcher, researcher stance, a variety of data sources (the tool design, the interview protocol, the observation protocol, the survey instrument), data management practices, data analysis methods, coding and the emergence of themes. Discussion of practices to ensure the collection of trustworthy, reliable and valid data will conclude this chapter.
Rationale for Research Design and Methodology

Qualitative methods are best suited to document, collect, analyze and describe evidence of strategies, behaviors and contextual factors observed in naturalistic educational settings (Bogdan & Bicklen, 2003; Merriam & Associates, 2002). Gaining participants’ trust and entering classrooms and interacting with teachers to collect evidence of teachers’ behaviors surrounding technology use can best be accomplished through the ethical, systematic, sensitive and thorough documentation of actions, decisions, and contextual factors. Qualitative methodology affords researchers a process and guidelines for collecting data for this type of research goal in a scientifically acceptable manner. To ascertain the viability of using the ITIG instructional planning tool, my study employed a heuristic qualitative methodology (Merriam, 1998) to illuminate and confirm what is known about technology integration strategies (the thought process guiding decisions surrounding technology and resource use). The teachers utilized this instructional planning tool to provide them opportunities to understand and apply the process and power of critical reflection, as espoused by Preskill and Brookfield (2009), Brookfield (1995) and Schön (1987). The reflective section of the ITIG facilitated teachers’ evaluation of the outcomes of technology-supported instructional activities they employed in their classrooms.

The use of qualitative methods aligns with prior research literature on technology integration professional development strategies. For instance, researchers have repeatedly introduced various designs of professional development to enhance teachers’ capacity to integrate technology and increase teachers’ competence and confidence in using technology, without offering teachers a mechanism to document and evaluate these episodes of technology integration within the documentation of lesson planning (see Brinkerhoff, 2006; Dexter, et al.,
2006; Franklin & Sessoms, 2005; Mouza, 2006; Orrill, 2001; Pierson, 2001). This study’s
design addressed the concerns shared in prior research such as the inclusion of observations to
emphasized the need to assess or evaluate efforts to integrate technology continually or
cyclically, much as instructional designers revisit the benefit and shortcomings of their designs,
during implementation or delivery of instruction, or deciding how to reuse the activities the next
time when implementing them. This evaluative feedback is to be “situated in the context of the
teachers’ classrooms” (Kopcha, 2008, p. 282). The instructional planning tool piloted in this
study facilitates the situating of evaluation within the context of instruction and encourages
cyclical reflection for how technology supported curricular goals and students’ needs.

**Institutional Review Board requirements.** The IRB reviewed the protocol for this
study, consent form, survey instrument, observation protocol, interview protocol and the
framework for this study in late October 2009, granting permission to launch this study on
November 2, 2009. This study has been assigned the identification # 09-10-21-04E. The school
district provided provisional permission via email on December 2, 2009, and written, formal
permission to collect data from the six participants on December 14, 2009. The six participants
granted and signed informed consent letters on December 9, 2009, and on December 16, 2009.
Shortly thereafter, data collection began.

**Gaining Access**

Two groups of three teachers were recruited through contact with a curricular coach for
this school district. The increasing role of collaboration among teachers influenced the
recruitment of six participants to reflect this typical structure for teacher assignment to teams of
4-6 practitioners. The power of collaboration, mentoring and reflection in supporting adoption
of innovative practices as discussed in prior studies of pre-service teachers and university faculty (Dawson, 2006; Doering, Hughes, & Huffman, 2003; Fitzallen, 2004; King, 2002; Kopcha, 2008; Mrazek & Meadows, 2007; Wells, 2007) demonstrated the benefit of designing a tool where collaboration is key to encourage increased use of technology through guided self-reflection (also an emerging element of most of these cited studies) with a sample of in-service teachers. Focusing on in-service teachers’ experiences extends the scope of prior studies which described pre-service teachers’ or education faculty’s use of technology to plan and deliver instruction.

Once the curricular coach shared contact information, I communicated with the potential participants using electronic mail and snail mail. Recruitment materials that explained the purpose and structure of this study were mailed to the potential participants. Further electronic communication established a time and place to meet to clarify the study design and purpose, respond to questions and secure signed informed consent letters in December 2009. Participants also received a data disk containing all related documents (tool, survey instrument and protocols) of this study.

Participants

This study relied upon the work of six participants, all female, who made up two groups of teachers who collaborate as they plan instruction and interact with students. Each group of these teachers works in a different school within the same school district, in schools populated by students enrolled in grades two through six. Table 1 summarizes the years of experiences these teachers brought to their classrooms. Group A consisted of two novice teachers, where one of these teachers demonstrated and shared a strong dependence and preference for using technology on a consistent basis in her instructional planning and interactions with her students. This was
also true of the novice teacher in Group B. Both of these young teachers used technology readily and often encouraged students to use devices as technology assistants (turning on or off devices, controlling volume) and to complete assignments.

Table 1  
*Participants’ Years of Experience*

<table>
<thead>
<tr>
<th>Participants</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>2, 6, 15¹</td>
</tr>
<tr>
<td>Group B</td>
<td>4, 17, 19</td>
</tr>
</tbody>
</table>

*Note.* 1. The teamed participants had 2 and 15 years experience.

The more experienced participants also used technology as they felt that their choice of technology would enhance the students’ learning experiences. Traditional instructional technology was used as often or more often than emergent or digital technology during instructional activities, in addition to the selection of multiple instructional strategies, which supported student learning as well as maximized the impact of instructional activities and technology usage. All six participants selected familiar devices and applications for use in the classroom and used these technologies with confidence and competence, noted through observations and documentation of instructional planning. These details about the six participants provide a baseline for who these teachers were and how they used technology to support their work with students.

**Context of This Study**

The setting of this study was in a suburban public school district (formerly rural), providing students and teachers a relatively technology-rich classroom setting. The district has provided classrooms filled with traditional instructional and digital or emergent technologies. These teachers are incorporating opportunities for students to think and apply problem-solving
strategies to core knowledge. Factual information is presented within its context and is often used to solve a problem or deduce a solution. Preliminary observations were scheduled to discover these participants’ levels of technology use and competence, and to extend my understanding of the contexts under which these teachers interacted with students. These observations occurred on January 6, 11, 12, 13, and 21, 2010. Data from these observations provided a baseline that facilitated data analysis as to the impact of using the ITIG on teachers’ instructional planning practices and behaviors.

Emerging technologies (interactive whiteboard -3M model, a projector and a document camera integrated with a laptop) and commonly used applications from the Microsoft Office Suite were in use during preliminary observations of all six teachers. In conversation, the teachers indicated that they have access to computers on a cart and one computer lab, (in use by Group B members) which are shared by groups of teachers and need to be reserved for use by students.

Classrooms are in recently constructed school buildings (within the past two decades), with space allocated so teachers can use technology to share information and teachers and students are able to use technology to support their work. The wall that serves as the primary focal point for student attention has a dry-erase or white board along four fifths of its width. Part of the dry-erase or white board (approximately 3.5 feet wide) served as the screen for images projected through a document camera or from a laptop, so this section of the whiteboard facilitated the projection and editing of interactive images. The document camera took up minimal desk space, as did the laptop. The laptop was used only from the teacher’s desk, adjacent to the dry erase or white board and close to the panel for activating and controlling the projector, document camera and the interactivity of information (graphic and text) from the
laptop. Students were often invited to sit closer to the dry-erase or white board when information was projected for discussion or analysis in all of these classrooms. Lighting was easily adjusted to improve the quality of the projected image.

Each classroom also had one desktop computer, placed on a table at the rear of the room. This table often served as a staging area for other resources and instructional materials. In one of these classrooms, a laser jet printer was on this table. This printer was connected through the network to many computers, for use by teachers and students in a cluster of rooms on this floor and in this wing of the school building.

Two of the teachers in Group A were team teachers. They worked together in a double-sized classroom with 45 students. At times during observations, a third adult was in the classroom to wander through the room and either help redirect students or to complete some task for these two teachers. The space in this double-sized classroom was organized into meeting space, a space to gather and view images from the dry-erase or white board, and circular tables or rectangular tables where students worked in either pairs or small groups of four or five students. They followed specific routines to manage classroom activities and increase time on task and students’ instructional focus. Students were often paired to work as supports for one another as they completed activities during observed class activities.

Teachers in Group B also guided students to increase their time on task through classroom management strategies and frequent monitoring of student progress and the teacher’s awareness of time. These teachers used specific phrases to regain students’ focus during partnered or group time to complete assignments. Students responded immediately to these strategies. Traditional instructional technology was located within easy access for student use. When teachers accessed the Internet to share online resources, the network was responsive.
Twice I observed students using (up to 29) desktop computers in the school’s one computer lab. Students once used the laptops from a recharging cart during one observed lesson. These students had familiarity with correct use of these password-protected devices (laptops and lab desktops). The majority of one group of students did not demonstrate the memorization of passwords when using the computer lab to access a mathematics activity on a website produced by the publisher of the adopted mathematics textbook. Even the teacher acknowledged the challenge to facilitate student recall of passwords, as the system she thought would suffice did not.

These teachers (from both Groups) planned activities for mathematics, social studies, science and language arts content and skill development. Meeting students’ needs and addressing instructional goals were the focus of instructional planning for these teachers. They recognized the need to offer scaffolded lessons or activities so students experience success as learners. These teachers demonstrated and elicited problem-solving techniques through think aloud or explanations to the entire class of the thought process to respond to a question, determine correct options or solutions, or complete an activity.

Due to rapid, recent growth, these schools have benefited from good quality resources, facilities and infrastructure. Teachers still shared concerns about: (a) limited funds and the need to prioritize goals and potential needs, (b) being creative as to the use and acquisition of resources, and (c) increasing demands on their time to do more with the same or less. Parental support was obvious as specific resources (for science instruction) were acquired through parent support groups or through parent donations. Class sizes varied from 20 – 32 students in the Group B classes, (45 students in the team-taught class in Group A, 26 in the other Group A class), influenced by ability grouping or the presence of students who receive supportive services.
to address their individual instructional needs. All six teachers repeatedly demonstrated an awareness of the importance of effective planning, classroom management and instructional methods and the need to encourage students to develop critical thinking and problem solving skills.

**Categorizing the Participants**

All six participants completed a pre-study survey to measure their beliefs and use levels of technology for instructional purposes. These participants were observed for a 30-35-minute interval to determine their technology adoption level (please refer to Dwyer, Ringstaff, & Sandholtz, 1991; Mouza, 2006; Newhouse, Trinidad, & Clarkson, 2002; Pierson, 2001; Rieber & Welliver, 1989) resulting in a purposeful and self-selected sample of in-service teachers. Data from the survey and the preliminary observations were used to describe these six participants and ascribe technology and innovation adoption level to these two groups of participants, as summarized in Table 2. Three of these participants were assigned to the group that would use the ITIG for a sequence of three observed instructional activities (of varied content area) through self-selection. Assignment to each of these groups was influenced by the participants’ interest in the study, as they admitted a willingness to learn more about guided self-reflection and varied uses of technology through participation as members of the ITIG-using Group B. These two groups of participants represented most individuals’ varied levels of adoption of innovative objects and practices. When compared to descriptions of teachers’ technology usage levels as presented in prior technology use studies, we can conclude that these two groups of participants were rather similar in their understanding and experience in using technology to support their work as teachers and their students’ learning. As will be explained in Chapter 4,
these six participants demonstrated varied behaviors and shared their perspectives surrounding the use of technology in classrooms.

Table 2  
Technology and Innovation Adoption Levels of Study Participants  

<table>
<thead>
<tr>
<th>Research Team and Terminology of Technology Adoption Levels</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rieber &amp; Welliver (1989)</td>
<td>Integration moving toward Reorientation (^1)</td>
<td>Utilization (^1)</td>
</tr>
<tr>
<td>Familiarization – Utilization – Integration – Reorientation – Evolution</td>
<td>Integration (^1)</td>
<td>Reorientation (^1)</td>
</tr>
<tr>
<td>Dwyer, Ringstaff, &amp; Sandholtz (1991)</td>
<td>Appropriation &amp; Invention (^1)</td>
<td>Adoption &amp; Adaptation (^1)</td>
</tr>
<tr>
<td>Entry – Adoption – Adaptation – Appropriation – Invention</td>
<td>Appropriation (^1)</td>
<td>Appropriation &amp; Invention (^1)</td>
</tr>
<tr>
<td>Sherry, Billig, Tavalin, &amp; Gibson (2000)</td>
<td>Co-learner (^1)</td>
<td>Learner &amp; Adopter (^1)</td>
</tr>
<tr>
<td>Teacher as learner – Adopter – Teacher as co-learner – Reaffirmer/rejector – Leader</td>
<td>Reaffirmer or Rejector (^2)</td>
<td>Reaffirmer or Rejector (^1)</td>
</tr>
<tr>
<td>Roger’s Adoption of Innovation Continuum – modified by Basham (2010) (Rated in professional and in personal life)</td>
<td>Professional life – Early Majority</td>
<td>Professional life – Innovator Personal life – Late Majority (^1)</td>
</tr>
<tr>
<td>Innovator – Early Adopter – Early Majority – Late Majority – Traditionalist</td>
<td>Personal life – Early Majority (^1)</td>
<td>Professional life – Early Majority</td>
</tr>
<tr>
<td></td>
<td>Professional life – Early Majority (^1)</td>
<td>Personal life – Early Majority</td>
</tr>
</tbody>
</table>

\(^1\)One participant demonstrated these characteristics.  
\(^2\)Two participants demonstrated these characteristics.

**Similarities revealed through survey data.** Analyses of the self-reported survey data confirmed the degree to which these teachers had similar technology use levels, technology competencies and beliefs, while revealing specific concerns as to ongoing barriers to their consistent use of technology in school. If these teachers had access to the devices and applications, they used these items if not daily (computer, interactive whiteboard), then more often than once a week (digital camera, scanner, MP3 recorder). These teachers’ competence
level in the use of applications, graphics, desktop publishing and troubleshooting was quite high; often indicating that they can teach these skills to others. More sophisticated skills, such as web page development, were indicated as an area where they would need assistance.

Many of the technology belief statements received the same rating (strongly agree) when they focused on the ways teachers use technology in the classroom. There were some belief statements where each Group disagreed: (a) Most students have so many other needs that technology use is a low priority; (b) There isn’t enough time to incorporate technology into the curriculum; and (c) Technology might interfere with “human” interactions between teachers and students. There were also varying perceptions of having adequate access to technology. Highest levels of agreement were found in statements focused on the benefits of using technology to improve teaching and learning and access to mentoring in the use of technology. These teachers’ technology beliefs differed most when we consider the social interaction aspects of schooling and learning, much as the theorists who wrote about technological determinism.

**Data Collection**

Several forms of data were collected to facilitate methodological and data triangulation (Denzin, 1978). Data were collected during observation and interview sessions between December 2009 and May 2010. Observations of classroom activity (public space) and interview and survey data (private space) were collected. The six teachers, who participated in this study, provided multiple voices or perspectives in the decisions for selecting and using technology in classrooms for a sequence of student activities. In addition to interview, survey and observational data, teachers submitted their completed ITIG documents (tool), which recorded their decisions for instructional planning and their reflection as to the effectiveness of the
observed lessons. These data provided the basis to create a rich, robust, comprehensive narrative of findings and conclusions as shared in Chapters 4 and 5.

**Role of the Researcher**

As the researcher, my primary role involved periodic observations of and interviews with participants related to the detailed analysis of completed tools (ITIG’s) the participants submitted as evidence of instructional planning strategies and preliminary evaluation of technology integration decisions. These data provided the evidence of the complex conditions under which technology was selected to support instructional activities. My role in this capacity was threefold: (a) to systematically collect and analyze these data, (b) to describe the educational setting where these six teachers integrate technology, and (c) to document what had been successful for the two groups of participants, as well as what remained as challenges to their ability to integrate technology in their relatively technology-rich classrooms. A subsequent role, during data analysis, was to review comments that could indicate the benefit and appropriateness of the design of the instructional planning tool (ITIG) and its viability as a tool to document technology use and evaluate its alignment with curricular goals and students’ needs. My final task as researcher is to synthesize and structure the findings to create a coherent narrative and report to tell the story of these participants and their approach to use technology to support instruction.

Another critical aspect of being a researcher is to safeguard the data and protect the identity of participants. Presenting the data as a series of episodes or vignettes is intentional. All participants taught more than one content area and were interested in using technology to support students’ learning of content area material. All participants had introduced classroom management procedures, which the students followed. The impact of using the ITIG, to
document technology use and decisions, and to self-reflect about the impact of technology, as defined and selected by these participants, may be easier to isolate, considering all of these comparable contextual factors which could impact the purpose of my study.

**Researcher Stance**

Much of what is already known about technology integration reveals that there will be great variance in how teachers use technology and conceptualize its use in classrooms (Brinkerhoff, 2006; Orlando, 2009; Pierson, 2001; Zhao et al., 2002). Additionally, if technology use is selected to align with curricular goals and is responsive to the needs of students (acknowledging the planning process of differentiation), additional levels of variance and complexity will be observed and will require documentation. This degree of anticipated variance and complexity in use raises several issues when designing a qualitative study of technology use in classrooms. The anticipated variance and complexity can influence decisions as what to document and how best to categorize what has been observed over time during the course of this study. This complexity is reflected in the coding system presented within the data analysis section of this chapter. Additionally, effort to notice and document the varied and complex activity in classrooms requires the researcher to be vigilantly observing events and reviewing the field notes (in a timely manner) for accuracy and inclusion of details that represent the complexity of the interactions and behaviors (devolving on technology use) observed in the classroom.

Recognizing the need to document and describe what is happening in specific classrooms serves as the catalyst for the design of the instruments used in my study. A taxonomy of technology uses as observed in these settings and a research-validated list of instructional behaviors (while avoiding judgment of the quality of the activity) are two elements within the
observation protocol to document these behaviors, in addition to data typically collected using observation and interview protocols designed for this study. Designing the tool along with interview and observation protocols to collect data focused on specific constructs (technology use along a continuum of potential uses, purpose of technology use, duration and frequency of technology use) creates a basis for triangulated data that can reveal trends and themes. Survey data also reflects these constructs, providing for another layer of descriptive data to clarify the presence and intensity of trends and themes of these teachers’ observable technology use practices.

Teachers are to be empowered to recognize how their decisions on the use of technology and instructional strategies are interrelated and can become the basis of their personal professional development and maturation as educators. Teachers’ pedagogic efforts are enhanced once they determine if their selection of technology and instructional strategies are best suited to address students’ needs and can meet curricular goals and objectives (see Sandholtz, 2001; Schifter, 2008). There is the potential for teachers to recognize other options for instructional planning and delivery once guided self-reflection and collaboration become systemic and embedded professional practices within their schools.

**Data Sources**

As is common in qualitative research, data were collected from multiple sources. Sound and thorough collection and analysis of data can qualitatively determine if the instructional planning tool grounded in guided self-reflection can systematically document instructional planning practices and decisions (related to technology integration), describe these practices, and encourage evaluation of instructional activities. Analysis of data collected to ascertain patterns and rationales has the potential to reveal fine distinctions regarding technology use within the
context of these classrooms. This evidence and related findings extends our understanding and definition of theories supporting the effective use of technology for the varied contextual needs and purposes observed in suburban public schools.

**Instrumentation**

Instruments used in this study to collect data are the completed versions of the tool, *Informed Technology Integration Guide (ITIG)*, an interview protocol, an observation protocol and a survey instrument, *Technology Beliefs and Competencies Survey*. The following sections clarify how the design of these instruments facilitated the collection of evidence in response to the three research questions of my study. Please note that the instruments used in this study were modified or created for this study, using instruments shared in the research literature from the past eight years (2002, 2004, 2009).

**Informed Technology Integration Guide.** Guided self-reflection was documented through the use of the *Informed Technology Integration Guide (ITIG)* (Appendix A). ITIG-users documented the what, when and how of technology use for specified instructional purposes and then categorized their technology use within two taxonomies, and then evaluated this described use of technology for instruction (using guided self-reflection). Participants were provided with space to define effective technology integration. If teachers and students do not identify what they intend to accomplish, then how will they know that they have accomplished their goal? As some researchers have noted, technology use strategies are not uniform as they are often influenced by multiple and varied factors (Bebell, *et al.*, 2004; Hennessy, *et al.*, 2005; Becker, *et al.*, 1999; Russell, O’Dwyer, Bebell, & Tao, 2007). Defining how technology is to be used in a specific lesson or activity provides a focus or target for the students and for the teacher, facilitating the accomplishment of these goals.
There are many acceptable strategies and approaches to integrate technology effectively; it seems realistic to encourage teachers to annotate the strategies and described uses of technology selected for a specific lesson or sequence of instructional activities. Identification of technology integration goals – before the instructional activity begins – supports teachers and students in the use of technology and sets the foundation to ascertain if this identified use of technology is as effective as conceptualized.

Another key element of the ITIG is the inclusion of two taxonomies (Maddux, Johnson, & Willis, 1997; Small, 2005) so participants determined how the selected technology use is categorized based on the research literature. Noting how technology usage is categorized has the potential to increase teachers’ awareness of other viable uses, possibly piquing curiosity and impacting professional development options. Once teachers become increasingly aware of the full range of technology uses, other uses can be considered as viable strategies for meeting students’ instructional needs. As Rieber and Welliver (1989) described the ongoing transformation of technology adoption in classrooms, teachers may need reminders of these options, as depicted in these two taxonomies, to jumpstart the transformation of their personal technology adoption patterns.

A third key element of the ITIG is the inclusion of a sequence of reflective questions focused on assessing the benefit and ease of using the technology as described in this tool. Through guided self-reflection, teachers can begin to consider and recognize any unanticipated or undesirable outcomes from this defined use of technology, if indeed teachers are thinking through the lens of technological determinism. These reflective questions, adapted from prior research to stimulate novice teachers’ effective technology integration (Newhouse, Trinidad, & Clarkson, 2002), have yet to be validated and tested for reliability. Shulman and Shulman (2004)
argued for teachers to reconsider their perspectives of classroom experiences through ongoing reflection, so teachers adopt more effective strategies to reach students. Through reflection, teachers determine which strategies and resources are aligned to instructional goals and contextual realities while being responsive to student needs. Through critical reflection (Brookfield, 1995), curricula are constructed and given shape to benefit students, incorporating a variety of resources and perspectives to enrich all students’ educational experiences. Through the ITIG’s reflective questions, participants assessed if indeed the intended use of technology contributed to goal attainment and if there were potential changes to further enhance the instructional activity, while stimulating teachers’ development of technological pedagogical content knowledge (Koehler & Mishra, 2008). The ITIG design brings together the varied elements (collaboration, reflection, documentation, definition) intended to enhance and extend technology use in classrooms.

**Interviews.** To collect insight of teachers’ instructional planning decisions, an interview protocol was designed for this study (See Appendix B). Data collected through interviewing participants has the potential to enhance and enrich the quality of the data collected through other methods. Completing the instructional planning tool, or ITIG, encouraged participants to reflect upon their instructional planning decisions (in response to my study’s research questions) and these decisions, strategies and thought processes were clarified during the interview process. This richly layered sequence of data sets can provide evidence and clarification of any observable changes and patterns or trends of technology use among Group B members. The interview protocol collected feedback as to the benefits and shortcomings of the ITIG (its design and use).
The questions in the interview protocol were adapted from prior research to enhance teachers’ technology integration capacity. The *Teacher Professional ICT Attributes: A Framework* (Newhouse, Trinidad, & Clarkson, 2002) (Appendix C) included several guiding questions to help participants reflect on their decisions surrounding technology use to plan instruction, to deliver instruction, and for student use of technology to demonstrate their learning. Some questions offer another opportunity to indicate the frequency of technology use, in order to match or confirm this response with comparable data collected through the survey instrument and the completed and submitted ITIG. Out of respect for participants’ time, some items from the 2002 interview protocol were omitted so the interview could be limited to 30–40 minutes of their time. The interview items retained for my interview protocol focused on teachers’ decisions regarding technology use to support curricular goals and students’ needs and sought clarification of observed participant behaviors. Questions sought several kinds of details: (a) rationales for the selection of instructional resources and strategies, (b) descriptions of roles assumed by teachers and students when technology is used, (c) technology and pedagogical skills participants bring to the classroom, (d) feelings and focus regarding the use of technology by participants and by students, (e) future steps for participants’ technology skill development, and (f) participants’ concerns regarding ongoing technology use in classrooms. Data collected through interviews helped elucidate why the members of Group B selected and promoted the use of technology for a variety of content area activities. Additionally, interview data provided insight as to Group B’s identified benefits and challenges in using technology during class activities. Interview data confirmed or contrasted with comparable evidence shared within the completed ITIG.
The interview was scheduled after the observation; either at the end of the school day, or the next day at a time selected by the participant. As is the nature of fieldwork, additional questions to clarify responses were posed. Participants noticed how some interview questions aligned with elicited comments of the reflective questions section of the ITIG. Follow up questions provided participants opportunities to expand on their feedback concerning the use of self-reflection and the ITIG, as well as their decisions, strategies, feelings and influential experiences surrounding technology use in classrooms.

**Observations and field notes.** Measuring teachers’ technology use has been accomplished primarily by collecting self-reported data through survey instruments and interviews (For example: Becker, 2000; Gray, Thomas, & Lewis, 2010; Moursund & Bielefeldt, 1999; Smerdon, *et al.*, 2001, among many others). Confirming the self-report data with observed data offers the research community clearer evidence of the types and purposes of technology use in classrooms. The observation protocol (See Appendix D) takes its basic structure from field notes as collected in qualitative methods. After describing the classroom environment and activity and describing instructional behaviors, two charts are included to notate evidence of technology use along the continuum of use defined in the two taxonomies used in this study (Maddux, *et al.*, 1997; Small, 2005). In this way, I can compare and contrast my observations with the participant’s notated use of technology (a checklist of the two taxonomies in the ITIG). Space is allocated if indeed there is a use of technology to be described that is not listed within the taxonomies, and to determine if there is a changing use of technology as observed over time.

The observation protocol also includes a coding system to facilitate the categorization of classroom activity and teacher interaction regarding specific instructional behaviors. This coding system, adapted from a *Differentiated Classroom Observation Scale* (See Appendix E) (Cassady,
Speirs-Neumeister, Adams, Cross, Dixon, & Pierce, 2004), provided a structure to identify instructional behaviors during ITIG-documented instructional activities. Observations collected during my study provided the rich description of field notes and some categorized and quantitative data to gain a sense of how these participants used technology to support student learning.

**Survey instrument – Technology Beliefs and Competencies Survey.** The survey instrument (See Appendix F) is divided into four sections: background information, technology skills, technology beliefs, and perceived technology barriers. This survey instrument is adapted for use with in-service teachers from a survey instrument used to measure pre-service teachers’ developed by Brush, Simons, and Hew (2009). Their instrument yielded desirable reliability values: 0.95 for the Technology Skills subscale; 0.85 for the Technology Beliefs subscale; and 0.81 for the Technology Barriers subscale. Their instrument’s construct validity was established through use of established concepts revealed through an extensive literature review. Brush Simons, and Hew also asked teachers and teacher educators, with expertise in technology integration in K-12 settings, to review the survey instrument to establish construct validity.

Survey items linked to university coursework were altered to reflect technology use for curricula planning and elements of the instructional process. The inclusion of specific applications or web–based tools was maintained if indeed still accessible or used within most school districts. Please note the constructs of this survey in Table 3. Since there are various ways and purposes to use technology in classrooms, the section to measure (the construct) technology use skill level contains 32 items to reflect a range of uses: basic operation, productivity software, communication, seeking information from online references, navigating the World Wide Web, and using multimedia to create resources. The construct – frequency of
digital technology use – includes items about the emerging devices or tools that are used to create resources and share information: scanner, MP3 player, digital camera, and interactive whiteboard. Pinpointing the degree to which these participants self-rated their frequency of use and their skills in using specific applications and tools clarified these participants’ confidence and competence in using technology. Comparison of survey data with observed and described (through interviews) levels of technology (application and device) use provided clarification of the degree to which these instructional planning practices and behaviors align with participants’ self-ratings and perceptions.

Table 3
Constructs of Technology Beliefs and Competencies Survey

<table>
<thead>
<tr>
<th>Construct</th>
<th>Which Items</th>
<th>Number of Items in this Construct</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demographics</td>
<td>1, 2, 3</td>
<td>3</td>
</tr>
<tr>
<td>Frequency of Digital Technology Use</td>
<td>4, 5, 6, 7, 8</td>
<td>5</td>
</tr>
<tr>
<td>Ways to Use Digital Technology to Measure Skill Level</td>
<td>9,10,11,12,13,14,15,16, 17,18,19,20,21,22,23,24, 25,26,27,28,29,30,31, 32,33,34,35,36,37,38, 39,40</td>
<td>32</td>
</tr>
<tr>
<td>Beliefs About Technology Use in Classrooms</td>
<td>41,42,43,44,45,46,47,48, 49,50,51,52</td>
<td>12</td>
</tr>
<tr>
<td>Barriers to Consistent Technology Use</td>
<td>53,54,55,56,57,58,59, 60,61,62</td>
<td>10</td>
</tr>
</tbody>
</table>

The identification of barriers and beliefs through the survey instrument provides further insight as to the expectations of these six participants as well as reveals contextual factors that impede or support technology use in these classrooms. Contextual factors exist within schools (such as infrastructure, access to resources, community expectations, and teachers’ experiences and mastery of pedagogical strategies), which inform teachers’ decisions during instructional
planning and implementation. Information about the perceived barriers can clarify decisions concerning instructional planning and behaviors, responding to the research questions of this study.

More items could have been added to this survey instrument. Respect for participants’ time suggested that this instrument focus on specific technology tools and uses, and led to the exclusion of other emerging or specialized technologies (handhelds, personal response systems, probes, videoconferencing, course management systems, assistive technologies). Participants completed the survey instrument within the anticipated interval and did not indicate that the instrument was challenging to complete or understand.

**Data Management Practices**

Keeping track of all of these forms of data, scheduling observations and interviews, and tracking progress with this research plan required the creation of spreadsheets to notate receipt and analysis of specific data. A research cycle was developed and shared with the participants in graphic format so they could track their role in my study. Participants received a data disk containing electronic versions of several study protocols and documents (research cycle, summary of the purpose of my study, the ITIG, survey instrument, interview protocol, observation protocol).

A password-protected laptop computer facilitated the collection and storage of data files. Data files were also saved in a designated folder within university-provided, password-protected, electronic storage space. Participants were comfortable with submitting completed documentation as attachments to email messages. All files were renamed to use a code number for each participant and identifying vocabulary was deleted to respect participants’ anonymity.
Data from completed and submitted ITIGs and interview protocols were transferred to
spreadsheets for analysis. Data from observation protocols were transferred to a series of tables
(Appendix G) to notate the frequency of instructional behaviors and to compare and contrast
teacher and researcher categorization of technology use based on the two taxonomies within the
ITIG. All of these spreadsheets and charts were also stored on the password-protected laptop
and within university-provided, password-protected, electronic storage space. Any hard copies
of data were secured in a locked cabinet, either at my home or in study space I can use at the
university. Field notes were transferred into NVivo 8 source documents for coding using this
application. These electronic files were also stored in university-provided, password-protected,
electronic storage space.

Data Analysis Methods

Qualitative analysis of collected data depends on a thorough and thoughtful collection
and analysis of multiple forms of data over time, with the involvement of the participants in my
study. Member checking of collected data to ascertain the data’s veracity, repeated analysis for
coding (to check the coding scheme’s accuracy and relevance) and checking as to the frequency
of specific aspects of technology use, (instructional planning practices and instructional
behaviors) intend to create a qualitative analysis of these teachers’ technology use. During
interviews, participants were asked to check the accuracy of my note taking before the
conclusion of the conversation. Artifacts and observations were collected electronically (as word
documents) to increase text readability. Field notes were reviewed prior to leaving the school
building, and a second time the next day, to check on the accuracy of the description and
categorization of observed behaviors and events. Involving other researchers to check the coding
scheme and frequency counts intended to maintain the accuracy and relevancy of these analyses.
The goal of data analysis is to create a meaningful and relevant description of technology use as observed in these five classrooms. The narration of these teachers’ experiences and ideas (developed through a sensitive analysis of the collected data) can ‘talk’ or trigger newer understandings of instructional planning practices and behaviors focused on technology used for teaching and learning.

Using comparable questions in more than one instrument to collect data on participants’ technology integration levels and decisions and then repeatedly reviewing this qualitative data for recurring themes enriched the story my research tells. Ascertaining themes and trends of observable and documented instructional planning practices and behaviors yielded a narrative and conclusions as to how technology use was depicted through these teachers’ experiences. Differences and similarities were noted between these two groups of teachers: (a) different schools in the same district, (b) similar access to technology and command of classroom management and instructional strategies, (c) all participants used collaborative planning, and (d) participants were teaching two of four content areas.

Keeping in mind the purpose of this study and its research questions, the data collected about these teachers’ use of technology were analyzed using the constant comparative method (Glaser & Strauss, 1967, as cited by Merriam, 1998). The comparison of details recorded in field notes, interviews and within the submitted ITIG (instructional planning tool), revealed categories and contextual factors impacting technology use in these classrooms, potentially not included in prior research. Through microanalysis, insights, nuances and ascribed meaning to classroom events and activities surrounding technology use in classrooms are isolated. Pinpointing the purpose, rationale, and benefit of technology use for curricular goals and for students along with relevant strategies to manage instructional activities to capture and richly describe examples of
technology-supported instructional activities is the goal of this study. Through constant comparative method of analysis, both the property (actual or direct technology use and access) and the dimensional level (benefits resulting from technology use) are captured to create the rich description found in Chapter 4.

**Stages in the coding process.** In reviewing the quantity and depth of the data I was collecting during the course of the study, I decided to use NVivo 8 to code the field notes developed during observations. This included the baseline data as well as subsequent observations as three teachers used the ITIG to plan and reflect upon their instructional activities. I reviewed the data in NVivo 8 several times to restructure the coding scheme that I initially developed after a re-reading of all of my field notes.

I used Excel to create spreadsheets to categorize the data collected in the submitted ITIGs as well as the interview data. I printed out these spreadsheets and created large charts to review this data over time. I used post-it notes to indicate code words and themes as they emerged through repeated analysis of these spreadsheets (side by side). The questions within the ITIG and the interview protocol created the structure of these parallel spreadsheets, as specific items in both of these instruments isolated specific aspects of technology integration (i.e., technology’s match to the content and students’ needs; how students would use technology; access and ease in using technology, among others).

I finally created a table in Word to triangulate the data according to the themes that emerged over time during analyses. With each reading or analysis of the data, this triangulated data table was modified to reflect changes in themes, much like the coding structure that I had devised for the observational data in NVivo 8. Segments of the triangulated data table are included in Chapter 4 as the emerging themes are presented with their supporting details through
rich description. NVivo 8 facilitated the creation of models to visualize the relationships among the thematically structured observation data. These models are also shared in Chapter 4.

**Coding structure of field notes.** Coding terminology within *NVivo 8* was divided into four main categories: (a) infrastructure; (b) types of technology used during observations [traditional instructional and emerging]; (c) pedagogic uses of technology, and (d) purposes of technology use. The codes for pedagogic and purposes of technology use, and their definitions, are presented in Tables 4 and 5. There are subtle distinctions to be noted in these four categories. Technology, especially if we consider it to be a thought process (Finn, 1960) facilitates idea exchange or creation, in day-to-day living. This concept supports the list of codes and definitions in the category, purposes of technology use, which are the various ways technology facilitates and supports teaching (i.e., finding and projecting information, using devices and applications, encouraging communication) and many aspects of daily life. The category, pedagogic use of technology, isolates unique teaching behaviors that clarify the thought process for successful completion of specific tasks (often scaffolding strategies or designing resources to focus on the how-to-do process).
**Table 4**  
*Coding Terminology and Definitions – Pedagogic Use of Technology*

<table>
<thead>
<tr>
<th>Coding terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedagogic use of technology</td>
<td>Use of technology to employ pedagogic strategies</td>
</tr>
<tr>
<td>Explaining concepts to students</td>
<td>Teachers document explanation of concepts or the process completed to employ a skill – either teacher directed or student supplied explanations during the lesson or activity</td>
</tr>
<tr>
<td>Add information to image or text</td>
<td>Provide details for increased understanding – often during the course of a lesson or activity</td>
</tr>
<tr>
<td>Correct misunderstanding</td>
<td>Use technology to explain misunderstanding or edit projected image or text to clarify or correct student error – during the activity or lesson</td>
</tr>
<tr>
<td>Representing concepts to students</td>
<td>Technology creates resources and documents how we can represent concepts to apply skills</td>
</tr>
<tr>
<td>Capture prior knowledge</td>
<td>Technology is used to share student work for discussion or to document students’ solutions</td>
</tr>
<tr>
<td>Discuss misunderstanding</td>
<td>Present prior misunderstanding for student discussion and correction within projects or assignments</td>
</tr>
<tr>
<td>Create or edit resources and add information</td>
<td>Provide details for increased understanding – often during the creation of resources to share with students</td>
</tr>
</tbody>
</table>
Table 5  
*Coding Terminology and Definitions – Purposes of Technology Use*  

<table>
<thead>
<tr>
<th>Coding terms</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purposes of technology use</td>
<td>Potential use of technology for instructional delivery</td>
</tr>
<tr>
<td>Communicating</td>
<td>Technology and applications facilitate the communication of ideas</td>
</tr>
<tr>
<td>Control or manage device use</td>
<td>Teacher uses technology to control use of device or application or flow of instruction</td>
</tr>
<tr>
<td>Directing student technology use</td>
<td>Students are using technology to complete assignments or to practice skills</td>
</tr>
<tr>
<td>Documenting learning</td>
<td>Technology is used to collect evidence that students are learning or mastering specific content or skills</td>
</tr>
<tr>
<td>Explaining</td>
<td>Technology facilitates the explanation of a concept – to demonstrate or to clarify the thought process associated with the content or skill highlighted in the instructional activity</td>
</tr>
<tr>
<td>Modeling</td>
<td>Technology is used to show how to do some task or skill – as follow up or additional explanation</td>
</tr>
<tr>
<td>Seeking information</td>
<td>Locating information relevant to the activity – often using reference materials or online sources</td>
</tr>
<tr>
<td>Laptop used to project images or text</td>
<td>Online sources or teacher-created digital resources are projected through the laptop to facilitate instruction or discussion</td>
</tr>
<tr>
<td>Demonstrating how to do a task</td>
<td>The first instance of showing how to do a task</td>
</tr>
<tr>
<td>Eliciting student response and thought</td>
<td>Nurture cognitive development and problem solving – posing questions and prompting students to participate in relevant conversations</td>
</tr>
<tr>
<td>Management of activity</td>
<td>Technology is used to engage students and increase on-task behavior</td>
</tr>
<tr>
<td>Projecting equations</td>
<td>Demonstrating how to solve or express number problems</td>
</tr>
<tr>
<td>Projecting images</td>
<td>Technology provides visual props for learning</td>
</tr>
<tr>
<td>Projecting text for analysis</td>
<td>Facilitating grammar or reading or language development activities</td>
</tr>
<tr>
<td>Providing feedback or redirection</td>
<td>Teacher or technology prompts or comments to correct or re-engage student</td>
</tr>
<tr>
<td>Sharing information</td>
<td>Using projector, web sites, resources</td>
</tr>
</tbody>
</table>
The other two main coding categories used within NVivo 8, infrastructure and type of technology used in classrooms, were used to describe the context of this study and to determine that these participants were indeed working in a technology-rich environment. These data also provided another source to notate and check the frequency and incidence of technology use, to reflect conventions of calculating levels of access in prior research literature. The NVivo 8-coded data on infrastructure and type of technology used in these classrooms confirmed my analysis of these same elements of the context when I reread the field notes several times during data analysis and development of the chart of triangulated data.

Coding structure of interviews and submitted ITIGs. In my discussion of how I devised the instruments for my study, I intentionally composed questions that would seek details and explanations of the process of instructional planning and how technology supports instructional goals and content delivery. Some questions focused on contributing factors impacting teachers’ decisions to use technology, such as access or availability, expertise or competence in using technology, students’ use of technology, etc. The focus of these questions structured the spreadsheet where the data were transferred for analysis.

Emerging themes. The responses to these questions (interview and ITIG) with the field notes’ data yielded three themes that focused around (a) teachers’ decisions and use of technology, (b) teachers’ decisions concerning students’ use of technology, and (c) thoughts and hopes surrounding technology integration supporting teachers’ work. As you will see in Chapter 4, specific sub-themes emerged that suggest how teachers determine what to incorporate as they design instruction to address students’ needs as learners. These teachers recognized their students’ interests, weaknesses and strengths as learners and individuals and used these details to design instructional activities, which I observed over time.
**Trustworthiness**

The integrity of qualitatively analyzed research is established through an explanation of how the collection and analysis of data would meet the criteria of confirmability (being shaped by respondents), creditability (confidence in the findings), dependability (consistency), and transferability (applicable in other similar contexts) (Lincoln and Guba, 1985). Analyses were supported by participants’ voices, through quoted comments collected through interviews and reflective comments in artifacts (submitted ITIGs). This section of the chapter provides an explanation of the processes I undertook to demonstrate this study’s trustworthiness.

**Confirmability.** To ascertain the confirmability of a qualitative study, Lincoln and Guba (1985) indicated that researchers should engage in a confirmability audit, develop an audit trail, triangulate the data, and be reflexive as to the nature of the findings. To communicate what is happening as these teachers used technology in their classrooms, a pair of critical incident charts (Miles and Huberman, 1994) (Appendix H) were constructed to represent the decision process in which these participants (Group A and Group B) engage as they enact instruction, to isolate instructional decisions and behaviors. These critical incident charts were contrasted to isolate how technology supported the instructional plan of these six teachers. Tracing the decision pathways these two groups of teachers enacted can elucidate how teachers effectively select and use technology to support content delivery and skill development. Through this additional level of analysis, I searched for evidence of bias and distortion as to the data’s interpretation.

As mentioned in the prior section on data analysis and emerging themes, the triangulation of data reveals the participants’ voices and the basis for their decisions in using technology for and with students. Triangulation also affords the researcher a chance to check for bias and accuracy – am I indeed seeing what the data reveals or am I too eager to find evidence of my
argument about technology use? This deep analysis and effort to reflect on the reasonability of the interpretation of the data ascertains the study’s confirmability.

Creditability. This criterion of qualitative research focuses on the participants’ acknowledgement that as a researcher I represented their thoughts and actions appropriately and honestly. Through member checking at the conclusion of interviews and confirming my observations of lessons and submitted ITIGs, efforts were made to represent these teachers’ voices. As data was analyzed, I contacted two of the teachers to confirm that I interpreted their comments correctly.

The observations often lasted 45 minutes and were scheduled during a three-and-a-half month interval. The duration and periodicity of these observations provided for a prolonged engagement in the work of these teachers. The preparation and submission of the ITIG provided me insight as to the thought process these teachers completed prior to the observed lesson. The interviews occurred shortly after the observations, reinforcing the engagement between the researcher and the teacher. Through our communications and conversations during the time of the study, these teachers were able to share their perspective and concerns as how technology supported their instructional plans.

Dependability. To demonstrate that this qualitative study meets this criterion, great effort was made to notate evidence of the changing aspects of classroom activity. The design of this study included more than one observation of each teacher in order to ascertain if the teacher would make similar decisions in the use of technology to support instruction and students’ needs during these multiple observations. Awareness that the use of technology will change over time to reflect contextual realities and be appropriately matched to instructional demands can create a
realization that exact replication of what we observe and collect as data may not be realistic or feasible.

The dependability of this study (investigating technology use) can be predicated upon the capacity to capture examples of technology use within an anticipated range of options. These options are to be justified by the teacher’s instructional plans and rationales grounded in prior knowledge of students’ needs and content area or curricular demands. Acknowledgement and documentation of these options can assist in demonstrating the study’s dependability. The teachers’ reflection on these kinds of decisions not only revealed their voice, but also contributed to this study’s dependability.

**Transferability.** This criterion of trustworthiness is established through a thick description of what happened in these teachers’ classrooms supported by their thoughts and decisions. The contents of Chapter 4 will offer many vignettes, related quotations and tables of triangulated data (thematicaly presented) to provide other researchers a set of findings. These findings can serve as the basis for other researchers’, teacher educators’ and school administrators’ generalizations as to if these teachers’ uses of technology have resonance and applicability to other classrooms in other school districts.

**Study’s integrity.** My study’s main purpose is to find a truth concerning these participants’ instructional planning practices and behaviors as they choose to use technology. Facilitating the story these teachers can tell, as they agreed to discuss and be observed, and share their perspectives, can create confidence in what we have learned about technology integration practices (within their educational setting) and reveal any new understanding of the complex tasks of instructional planning and selecting strategies and instructional behaviors. Specific comments focused on the nature of guided self-reflection and its impact on the participants who
used the ITIG provided useful evidence of the nature of reflection regarding technology integration and recognition of benefits and shortcomings of technology use in educational settings. Allowing these participants’ story to be told through interviews, observations and comments shared in the artifacts yields a credible description of technology use within the context of these participants’ educational setting.

My experiences as a classroom teacher in a similar setting to the participants’ classrooms provided a basis for my sensitivity to the messages found in the data. My study presents concepts that are grounded in the data, as the participants’ stories are told “with an equal mix of abstraction, detailed description and feeling” (Strauss and Corbin, 2008, p. 41). The goal of these analyses is to promote the voice of these participants and clarify what we can learn from these participants and their experiences.
Chapter 4
Findings

Introduction

Interviewing the participants, observing them in the classroom, and reviewing their documentation of and reflection on their instructional activities provided me a unique opportunity to capture their ideas and voices as to effective instructional technology use within the context of their classrooms. Results of the study are shared in this chapter, which is organized to provide additional information about participants’ technology use (gleaned during the data collection process) and to present data specifically aligned to the research questions presented in Chapters 1 and 2. Before the findings framed by the research questions are presented, observation and survey data that describe these participants’ use of technology at the beginning of the study are shared. I observed all six teachers prior to any introduction to the ITIG, or the instructional planning tool grounded in guided self-reflection to develop a baseline of these six teachers’ technology use.

Description of these teachers’ technology use and decisions during the baseline observations provide a sense of how these six teachers used technology in relatively similar ways and for similar purposes. Since all six teachers completed the same survey instrument concerning technology use levels, information gleaned from the survey instrument will be shared to help us conceptualize how these teachers’ access to and use of varied formats of technology contributed to their instructional planning decisions and enactment of instructional activities.

Themes emerged from the analysis of the triangulated data collected as three teachers used the ITIG to document and evaluate instructional activities that I observed. Three major themes emerged from this analysis: (a) teachers’ decisions and use of technology, (b) teachers’
decisions concerning students’ use of technology, and (c) thoughts and hopes surrounding technology integration supporting teachers’ work. The subthemes and the triangulated data supporting these themes will be shared in light of the three research questions that framed this study. Vignettes, or detailed descriptions of classroom events during observations, are shared to provide you a rich description to include the contextual factors that impact technology use and student learning. Teachers’ Technology Use Levels In Chapter 3, the participants were described in terms of their experience and their technology adoption levels (based on several adoption models from the research literature). Narratives based on observations are now shared to describe how these teachers used technology. In this section of the chapter, tables and figures summarizing the survey and relevant observed data are provided, in addition to comments shared during interviews and within submitted ITIGs. It is noteworthy to recognize that all teachers used both forms of emergent or digital and traditional instructional technology to support students’ instructional needs. The combination of using traditional instructional and emergent technology with refined communication skills, classroom management skills and a desire to select resources and strategies to support content instructional goals contributed to the fluid and student-centered classroom activities I observed in these teachers’ classrooms.

**Description of Baseline Technology Use**

The documented decisions and actions of these teachers reveal the degree to which these teachers combined emergent or digital technology with traditional instructional technology to meet the instructional needs of their students. The following detailed paragraph from field notes is shared to provide you a rich description of how one teacher skillfully used varied forms of technology during instructional activities.
The teacher shared with 26 students a Brain-Pop video clip that explained the design and use of bar graphs and tally marks to represent data, using a district-provided laptop and 3M projector. At the conclusion of the video clip, the teacher and students discussed the ideas from the video clip. The teacher then shared a presentation she had created to extend the concepts shared in the video clip, continuing to use her laptop and the 3M-projector. The slides of the presentation offered additional examples of how bar graphs, tally marks and Venn diagrams are used to represent data. Students were encouraged to suggest how to complete the bar graph, or how to add tally marks or annotate Venn diagrams. Students came readily to the dry erase board to notate their suggestions (the presentation became interactive). Other students were watching and offering additional ideas. The teacher held up three types of paper for students to consider, as they were to create a graphic representation of the data they recently collected. Students then explained how each type of paper could be used. The teacher acknowledged students’ ideas and emphasized the benefits and shortcomings when using each type of paper for this assignment. Students then returned to their tables to work on their assignment.

This description of technology use reveals the extent to which this teacher employed emergent technology (teacher-created presentation slides, instructional video clips) to extend the opportunity for students to develop their skills (to represent data graphically), while using traditional instructional technology (paper, writing implements, dry-erase boards, visual representations or examples of models or desirable outcomes, photocopied handouts). More importantly, the students were encouraged and supported in their discussion of the process for creating graphic representations of collected data.

Another teacher’s use of technology to support a Science lesson similarly reveals the tendency of these teachers to blend traditional instructional technology with emergent
technology. In this example, this teacher tends to use more of the traditional instructional technology than the emergent technology available to her in her classroom.

This teacher’s 21 students are seated in small groups to complete an activity. The activity was an introductory lesson so students would experience the nature of archaeological work. Students had an activity sheet to deduce the name and purpose of an object based on a drawing of only a portion of the object, to replicate the deductive reasoning archaeologists engage in as they uncover broken items in digs. Students had ten minutes to work in small groups. The teacher circulated and provided feedback or redirection (or posed supplemental questions) to these groups of students as they discussed the responses to the items on the activity sheet. The teacher gave students a one-minute warning. The teacher used a document camera and 3M-machine to project an image of the activity sheet onto the dry-erase board. Various students individually shared suggested responses and explained the logic behind the proposed answer. The teacher notated responses and provided feedback, focusing on their explanation of the logic behind the responses. One student approached the dry-erase board to notate a response referring to the projected image, as he struggled to explain the response, using only words. The conversation was paced so almost all students contributed to the discussion. Students controlled the conversation as much as the teacher.

At the conclusion of the discussion, the teacher elicited some “take-aways” from the students. Six students shared ideas. The teacher repeated what was shared and then reinforced two of the ideas. The entire group discussion and “take-aways” summary took 40 minutes of class time. The teacher invited students to put away their work and change their location in the room to facilitate watching a video clip on carbon dating, created by Bill Nye the Science Guy.
The video clip is launched from the district provided laptop through the 3M-projector. Students were seated and attentive to the opening segment of the video clip.

Most noteworthy in these two vignettes is the teachers’ skillful use of classroom management and communication skills. The use of emergent technology supports these other strategies to meet students’ needs. Emergent technology affords teachers the opportunity to share information in ways that engage students (such as the Brain Pop video clip, used frequently by these teachers). These teachers also created presentations that encouraged students to discuss the ideas shared in video clips, thereby reinforcing the content knowledge in ways that can support students’ retention and application of new knowledge and skills. These teachers also recognized that they could find more accurate, illuminating, or up-to-date information on the Internet than is found in textbooks, to explain their tendency to incorporate emergent technology to meet their instructional design goals and their students’ needs as learners.

Analysis of baseline observations of these teachers’ technology use indicates the similarity in how they approached instructional planning and decision making as to the resources used for these lessons. Table 6 shares how these teachers used technology, while Table 7 shares how these teachers asked students to use technology.

### Table 6

*Teachers’ Use of Technology During 7 Baseline Observations*

<table>
<thead>
<tr>
<th>Technology in Use</th>
<th>Variety of Formats&lt;sup&gt;1&lt;/sup&gt;</th>
<th>Frequency of this Type of Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Instructional Technology</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td>Emergent or Digital Technology</td>
<td>8</td>
<td>20</td>
</tr>
</tbody>
</table>

<sup>1</sup>Formats refer to the various forms of technology that are found in classrooms, such as computers, projectors, applications, realia, paper, writing implements, websites, etc.
Table 7

<table>
<thead>
<tr>
<th>Technology in Use</th>
<th>Variety of Formats</th>
<th>Frequency of this Type of Technology Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Instructional Technology</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Emergent or Digital Technology</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

The students in these classrooms were acclimated to this seamless use of technology and shifting between emergent and traditional instructional formats of technology, as if to expect the teacher to navigate between these varied uses of technology and to have opportunities to approach the white board and use technology to explain ideas relevant to the topic of instruction, or to elaborate upon concepts presented in informative web-based video clips. Additionally, some students are developing competence in using technology as they are encouraged to serve as technology assistants and notate responses on the whiteboard or controlling the graphic representation of concepts that are the crux of the lesson.

These teachers did not encourage or provide all students an opportunity to handle the emergent or digital technology during observed class sessions. There was one instance where a student used the in-classroom desktop to launch a search engine to locate information for the writing assignment. Other students had already collected such details, either at home, or during a prior class session. Students were using a range of traditional instructional technology (photocopied handouts, paper, writing implements, reference books), or accessed new ideas and information through emergent technology (viewing a video clip for information or a teacher-created and customized presentation to understand the process of using details to structure a paragraph to relate these collected facts). As you will see, during later observations, there is a change in the proportion of traditional instructional technology versus emergent or digital
technology in use over time. These teachers continue to blend or merge their use of traditional instructional technology with emergent technology and pedagogic skills to meet their students’ needs and present accurate, relevant and illuminating information.

These teachers chose to use technology for instructional planning and for enacting instruction for several reasons. Like so many individuals, they have acclimated to the rapid access to information that technology affords us today. They also recognized how technology facilitates the creation of legible materials to share information in a structured manner for student success. Technology is viewed as a tool of communication. For example, one teacher shared some ideas to explain her comfort and seamless use of technology:

• “I have always felt technology is important both inside the classroom and out.”
• “Because I am successful with technology and function better using technology, I’m more likely to use it. It is faster for me to do some things … using technology rather than do it by hand.”

Another vignette offers us another example of how these teachers blended technology use with effective strategies to organize lessons and communicate with their students.

The 33 students in this classroom were seated in groups of four or five students to work independently, with peer support, on a writing assignment incorporating details from a Social Studies unit on ancient civilizations. The lesson began with students viewing a Brain Pop video clip discussing outlining skills. The Brain Pop video clip concluded with ten multiple-choice questions, to which the students responded. The teacher noted their responses and eventually revealed the accuracy of these responses. Students and the teachers discussed each item.

To reinforce the importance of creating a meaningful structure when composing an essay, the teacher shared a graphic analogy comparing the composition of an essay to the baking of a
pizza. The teacher then shared a presentation with the students, to guide them through the process of structuring their persuasive writing with supportive, factual statements. The students had their papers, a study guide (with explicit directions as a rubric) and sources as they prepared their essay. The presentation slides provided them a sequence of steps through an example of how to compose and structure the essay with supportive details, serving as a model. After each slide, the students were given time to prepare another paragraph of their essay. The teacher circulated and provided students feedback as she monitored their progress.

The teacher invited students to interrupt their individual work and offered suggestions based on her efforts to monitor the students’ progress with their essays. Students directed their attention to the whiteboard, where the teacher explained the option of abbreviating repetitive text in this draft, emphasizing the need to use complete spelling of words for the final draft of the essay. One student was given permission to use the desktop in the classroom to search for images on the Internet. Other students and the teacher continued to focus on their essays. The teacher reminded students to keep track of their sources of information for this essay (referring to guidelines or rubric she had distributed in a prior lesson).

This vignette demonstrates how emergent technology is selected and customized to facilitate the students’ grasp of how to structure an essay with supporting details. This teacher’s organizational skills, creativity and eagerness to monitor and address students’ needs were facilitated through the use of technology within the classroom. She was able to project a text and discuss its structure with the students, making a potentially challenging skill more accessible. The teacher recognized that traditional instructional technology or resources are still vital as not all students have equal access to computers to locate information on the web (a concern shared in a subsequent interview). Despite these challenges, this teacher availed herself, creatively, of the
resources and technologies to design an instructional activity to meet the demands of instructional goals and expectations.

A fourth vignette reveals how some teachers are eager to offer students opportunities to use emergent technology during instruction. During this mathematics lesson, 45 students and two teachers are focused on the whiteboard, where one teacher has written a numeral. Students are invited to write in their math notebooks three equations to represent this numeral and the word form of the number. Four students were invited (in turn) to the whiteboard to share their responses. As the teachers circulated to monitor students’ work, one teacher reminded the students of various concepts that have been part of prior lessons. A third adult arrived in the room and helped to monitor students’ work and encouraged students to focus on the lesson or she redirected them if they are confused.

One teacher approached her laptop and activated digital images of coins that were projected on the whiteboard. Using an electronic marker, the teacher demonstrated how the images of the coins can be moved so students can select the appropriate combination of coins to represent the numeral under discussion. At this point of the lesson, two students were invited to rearrange the graphic images of the coins to represent this quantity of money. The students demonstrated great facility in using the interactive capacity of the whiteboard at this point in the lesson.

Again, this lesson to develop number sense and knowledge of coins is enhanced through the use of emergent technology. Students were engaged and able to follow along with the flow of the lesson. Teachers circulated to check on students’ work and ideas. Sharing images that are projected so many can see and students can explain the process of counting coins can be viewed as one effective way to give students these experiences. This discussion can build upon or can
reinforce other experiences in handling coins (actual or plastic replicas) and other manipulatives to develop number sense.

Analysis of baseline observation data through *NVivo 8* yielded a model that captured the various purposes these teachers chose to use technology (both traditional instructional and emergent or digital technology). Figure 1 shares this model, which indicates how technology is primarily used to communicate, share information and explain lesson concepts.

![Figure 1. Purposes of Technology Use Recorded During Baseline Observations](image)

**Meaning of color codes for Baseline Observations – Purposes of Technology Use**

- Paler fill, broken line border = low incidence
- Gold or green fill, solid line border = mid-range incidence
- Blue fill, darker line border = high incidence
- Purple fill, darker, thicker line border = very high incidence
Findings from baseline observations. These four vignettes, NVivo 8 model, quotations and survey data pinpointed the degree to which these teachers used technology in similar ways and for the same purpose: enhancing communication of information or the modeling of skills to meet students’ instructional needs. The survey data indicated that they all shared comparable levels of competence in using devices, especially if they owned a device. They also shared the belief that technology can facilitate their work as teachers as well as enhance their students’ capacity to learn, develop cognitively and apply skills to solve problems.

Most importantly, the use of technology was intended to enhance the instructional activity and reinforced the teachers’ selection of traditional instructional technology, pedagogy, communication and classroom management skills. The benefit of emergent technology, can not be viewed in isolation, since it rendered details and skills vivid and accessible, as it created an engaging learning environment that presented more accurate, relevant and illuminating information to students.

These teachers continued to use traditional instructional technology due to these resources’ continuing value and the harsh reality that funding for all classrooms and all students to use emergent technology (on a personal and daily basis) is not realistic in this context or for all schools. As one teacher noted, there are some students who benefit greatly from hands-on experiences, achieved through the use of realia, manipulatives, or lab equipment, especially in science lessons. The introduction of the ITIG as a tool to document and evaluate (through reflection) instructional planning practices and decisions provided us an opportunity to learn more about this decision making process through the participation of three teachers in the subsequent segment of the study.
Thematic Analysis of ITIG-documented Instruction

During the course of my study, evidence of the rationale guiding the ITIG-users in their integration of technology through the completion and submission of the ITIG multiple times was uncovered. Analysis of the data led to the identification of three major themes and several sub-themes to be presented with supporting examples in this section of the chapter. The three major themes and related sub-themes, as they relate to each research question are:

Research question #1: In what way did the utilization of the instructional planning tool (ITIG) impact teachers’ instructional planning practices and decisions concerning technology use?

• Technology Use and Decisions through a Teacher-Centered Lens
  o Technology supports teaching
  o Technology facilitates differentiation
  o Choice of technology matches instructional goals
  o Definition of effective technology use

Research question #2: In what ways did teachers’ instructional behaviors differ when the ITIG is utilized prior to delivering technology-supported instruction?

• Technology Selection through a Student-Centered Lens
  o Technology supporting student learning
  o Students’ use of technology
  o Value of students using technology
  o Purpose of using technology with students

Research question #3: What additional issues, surrounding technology use, impacted these teachers’ instructional planning practices and instructional behaviors?
• Teachers’ Thoughts and Hopes for Technology Integration
  o Future thoughts
  o Ongoing concerns viewed as potential barriers
  o The Impact of guided self-reflection

These sections of the chapter present several vignettes, triangulated data and models created in NVivo 8 to provide you an understanding of how these themes and sub-themes emerged through repeated analyses. These sections will open with a narrative revealing how an ITIG-using teacher enacted her instructional plan. Additional data related to the theme or sub-theme will follow.

Technology Use and Decisions through a Teacher’s Lens

Analysis of the triangulated data, surrounding the use of the ITIG as an instructional planning tool, yielded evidence of the degree to which these teachers recognized how technology can support their work as teachers in more than one way. Technology facilitated the communication of information as they projected information that had been word processed or combined with graphics. Technology also helped them create resources that they could alter to meet the needs of groups of students (differentiation). These teachers also realized that students’ capacity to attain instructional goals was enhanced through technology access. Several times they mentioned how technology brings accurate and up-to-date information to the students.

Technology supports teaching. This first section shares a vignette demonstrating how the decision to use technology enhanced the lesson. In this instructional activity, the teacher sets the stage for students to use the desktop computers in the school’s computer lab for a Language Arts portfolio item and grade. Please note how more than one form of technology is used in tandem to guide students to independently compose a structured essay, according to teacher-
defined guidelines. The students are also producing their essay in a format for publication, as required in the Writing standards.

The teacher and her 25 students were in a classroom, to review the directions for a writing activity the students were to complete using the desktops in the school’s computer lab. Students have completed and edited their first draft and the goal of the activity in the computer lab was for each student to use editing guidelines and to produce a word-processed copy of their writing assignment. The teacher has created a presentation to review the expectations and use of the editing guidelines. Paper copies of the editing guidelines were distributed to the students. Using the district-provided laptop and the 3M projector, the presentation and guidelines are reviewed with students to emphasize specific portions of the activity and expectations. The teacher scanned and circulated the classroom to monitor student understanding of the procedures and expectations. The teacher responded to two clarifying questions and then invited students to gather up their materials and to get in line to leave the classroom and walk to the computer lab.

Students cooperated, walked down the hallway to another wing of the school, and took their places at various desktops in the computer lab. All but four students retrieved their document or file from storage space students are given on the school district’s servers. The other four students were using personal flash-drives to store their work. One student was unable to retrieve her file from the flash-drive, despite attempts on different computers. The other three students readily used their flash-drives. Most students were using Microsoft Word 2007; six were using Microsoft Word 2003. Students were focused and engaged in typing and editing their work. Most students completed the task by the end of the computer lab session. The teacher was circulating and monitoring student work during the time in the computer lab, to provide
feedback, encouragement or redirection. Two students were asked to remain in the lab to shut down the systems/desktops as it was the end of the instructional day at the school.

Beyond this observed use of technology, these three teachers shared their thoughts during interviews and submitted ITIGs, which offer us a sense of their decision-making to plan instructional activities. Below are some comments providing insight as to their instructional planning practices and decisions to use technology:

• “...the more resources I look at – this increases my understanding - the emerging technology and multiple resources facilitate student learning – using multiple resources is key ... I shudder to think of students’ attitudes to content and retention level in the past when there were limited resources introduced into classrooms.”

• “Technology can be used to reinforce what has been explained.”

• “Since students are familiar with technology, they learn without recognizing that they are learning.”

• “There is great potential to integrate technology so it helps instruction, understanding, engagement, helps students who may have minimal success and then become a more engaged learner.”

• “There is increased student engagement due to the quality of the graphics we find on the Internet, embed in presentations, and project through the 3M-machine.”

It is also worthwhile to note the technology use levels of these three teachers as they used the ITIG, as summarized in Table 8, and how these use levels compare to their baseline technology use level as shared in Tables 6 and 7. Please note two distinct changes; the shift in teachers choosing to use more formats of emergent or digital technology and in Table 9, students having more opportunities to use emergent or digital technologies over time.
Table 8
*Teacher Use of Technology During 9 ITIG-Planned Observations*

<table>
<thead>
<tr>
<th>Technology in Use</th>
<th>Variety of Formats</th>
<th>Frequency of this Type of Technology Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Instructional Technology</td>
<td>8</td>
<td>35</td>
</tr>
<tr>
<td>Emergent or Digital Technology</td>
<td>18</td>
<td>40</td>
</tr>
</tbody>
</table>

Table 9
*Student Use of Technology During 9 ITIG-Planned Observations*

<table>
<thead>
<tr>
<th>Technology in Use</th>
<th>Variety of Formats</th>
<th>Frequency of this Type of Technology Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traditional Instructional Technology</td>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>Emergent or Digital Technology</td>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

The three ITIG-users shared several ideas that reveal their motivation to integrate technology via documentation of their instructional planning practices. They communicated a desire to use accurate, legible, customizable resources for instructional activities that align with content standards. This desire motivated them to choose technology as an element, or a facilitator, of the instructional activity. Through technology integration, these teachers presented effective approaches for students to learn, adopt, and acquire skills for the present and the future.

Beyond an analysis of the frequency of technology use based on the format of technology in use and the person using that format of technology, other analyses and interview comments provided evidence of how technology supports learning. Figure 2 pulls together the data revealing the basis for these teachers’ decisions to use technology as it supports their teaching and capacity to meet students’ needs.
<table>
<thead>
<tr>
<th><strong>Theme</strong></th>
<th>Details from the study - ITIG documentation</th>
<th><em>Quote from interview data</em></th>
<th>Related detail observation data</th>
</tr>
</thead>
</table>
| How technology supports teaching | Allowed me to observe student interactions as well as understanding. I was able to assess student learning in a non-traditional way. Provided opportunity for me to consistently and more easily monitor student status and progress | *It’s an everyday part of my teaching*  
*So flexible – ongoing use – extensively adopted use of technology*  
*Monitoring students’ progress with activities*  
*As a review prior to an assessment – online quizzes* | Teachers circulated to check on student progress and need for redirection and for assessment purposes – I did not observe any note-taking by teacher to record their observations of student performance |
| Lesson allowed for independent practice and allowed me to guide students needing extra practice/re-teaching | | | |
| Technology provided interaction for students to practice what they had learned | | | |
| Technology provided the map I needed to show students since there were locations not in book or atlas | *I use ICT as a practice tool to reinforce my teaching* | Students were engaged in practice or the activity – the degree or definition of interaction requires clarification. | |
| Allowed me to be thinking ahead and preparing for what was to come in the simulation | *It is part of a daily routine – I can focus on what comes next in the activity... the need to keep the lesson advancing smoothly* | Teachers demonstrated how technology can help manage instructional flow – sharing directions or controlling the portion of the lesson/activity | |
| Enhanced the goals of the lesson by providing the same information in different manners | *Prefer to use it as much as possible – totally adopted into repertoire of skills* | Teachers used technology to provide info graphically, with text & familiar resources; video clips often used to introduce concepts or skills | |

*Figure 2. Triangulated Data Explaining How Technology Supports Learning*
Here are interview comments that explain these teachers’ selection, use and customization of technology when planning instructional activities:

• “It is an avenue for teaching. It is vital as there are so many resources for use in teaching.”
• “The Social Studies curriculum depends on teachers locating resources on the Internet.”
• “The PowerPoint notes and pictures gave the students another means by which to know the organelles. I think the embedded images gave the students a very clear picture of what each organelle looks like.”
• “This lab could not have been done without the traditional instructional technology. The students needed the materials and lab instruction sheet to be successful.”
• “I definitely like using Google Earth and the 3M makes it nice for students to see the world. The activity was interactive and reinforced the concept… forces more one on one connections…” and the “Use of 3M … helps to model for students” … “to zoom in and see the relationship of these locations”
• “Individual use of computers … [provides] instant feedback at the level of each student” … [and] “allow[s] each student to work independently”
• “[The] document camera allows students to see their work to discuss strategies for solving math problems and ideas to be reinforced”
• “The use of the ITIG helped me realize that I invest time and thought in selection and collection of resources, more than the script of the lesson.”
• “I typically planned my lesson and then chose the examples [as listed in the taxonomy within the ITIG] that fit the lesson.”
These teachers’ demonstrated and documented instructional planning practices centered on searching for, selecting and creating emerging and traditional instructional formats of technology to enable students to make meaningful connections and apply knowledge and develop skills. Classroom management, alignment with instructional goals and communication skills are equally valuable to attain successful outcomes for students. One ITIG user commented, “I also have tricks of the trade so I recognize that I can teach with it or without it [technology] but prefer to use it as much as possible”.

Through the vignette, quotations and triangulated data, we can note several rationales for using technology to support teaching. These rationales were mentioned in other research that has described the multiple and varying ways in which teachers use technology (Ertmer & Ottenbreit-Leftwich, 2010; Mouza, 2006; Pierson, 2001). These rationales also serve as examples of the ways in which teachers consider options for instructional resources and designing instructional activities (Heinich, 1985), especially as the resources and technology become increasingly sophisticated. The desire to create meaningful, accurate and accessible instructional resources undergirds these teachers’ decisions when designing and planning instructional activities. They perceived that technology facilitates the creation of activities that reach students and meet group and individual needs.

**Technology facilitates differentiation.** Differentiation is an approach to plan instruction so the diverse needs of students are addressed, based on prior knowledge of how individual students learn and experience academic success. Teachers demonstrated how they customized instruction, especially if they planned an activity that would be shared with more than one group of students. The pacing and manner in which they presented new information and guided practice was altered based on the group of students. As one teacher explained in the
“As I led the lab on the previous day, I made changes to the way I presented the instructions and gave the students hints for success.” Two other relevant comments to differentiation are: “Individual use of computers … instant feedback at the level of each student. [This] allows each student to work independently. Once completed, they can resume other assignments in the classroom environment.” and “Perhaps an overview or introduction of Microsoft Word” as a way to modify the activity when students were using laptops to create a timeline. In this case, the teacher still felt the lesson was successful as a majority of these students proofread, edited and printed their timeline prior to the end of this instructional period. She felt that each student was enabled to work at their own pace as they individualized their work. They also were able to select one of three tools to use to create the timeline, Microsoft Word or PowerPoint, or an online timeline generator. This teacher encourages her students to explore and extend their skillset at controlling these applications, much in the way that the technological determinists anticipate citizens will do through increasing use of technology.

Figure 3 pulls together the data revealing the manner in which technology facilitated differentiation. Another teacher selected an online math game so her students would practice math skills individually at the desktop computers in the lab. This online math game was created by the adopted textbook publisher, which served as the basis for its usefulness and accuracy. Since the students visited the computer lab once a month, the process for logging into the computers to access the publisher’s online activities was not as familiar for many students and led to a challenge in time management. Once the students were logged into the online game, they were engaged and completed this activity in the manner the teacher had requested.

Students, who skillfully logged into the online games without adult assistance, were able to complete a second mathematical game of their choice. In this way, students were able to work
at their pace and continue to practice relevant math skills intended for their grade and instructional needs, without the teacher needing to use up lots of time to redirect and create similar activities. As this teacher commented to me, [use of the online math game] “allowed for independent practice and allowed me to guide students needing extra practice/re-teaching,” as evidence of how using this emergent technology facilitated the differentiation of the math lesson for her students.

<table>
<thead>
<tr>
<th><strong>Theme</strong></th>
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<th><strong>Quote from interview data</strong></th>
<th><strong>Related detail observation data</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>How technology can be used to facilitate differentiation</td>
<td>Use of 3M … helps to model for students</td>
<td>To zoom in and see the relationship these locations you need to model the expectations of where the students are to go as they use technology</td>
<td>Teachers used 3M to model or demonstrate skills or explain concepts. This facilitated providing detailed modeling of concepts or skills to address students’ specific questions based on teachers’ monitoring of student progress. There were times when teachers interrupted independent work sessions to redirect or clarify directions due to what they noted as students worked.</td>
</tr>
<tr>
<td>Individual use of computers … instant feedback at the level of each student</td>
<td></td>
<td>Allow each student to work independently – do the work &amp; then once completed they can resume other assignments in the classroom environment</td>
<td>Lab experience and laptop experiences allowed for individualized use.</td>
</tr>
</tbody>
</table>

These teachers also discovered the value of other teachers’ and publishers’ work that aligns with their instructional planning needs. As another teacher commented in an interview, “It is also easy to use the Internet as a tool for finding lesson plans and activity ideas in addition to lesson supports (video clips, etc.),” to reveal how other available resources shared via the Internet can be made relevant for other teachers’ work with students.
During an interview, another teacher shared this observation and reflection on the impact of technology use on student engagement.

“The two subject areas I am teaching this year lend themselves to many hands-on experiences with technology [traditional instructional technology moreso than emergent technology]. The students as a result have been enthusiastic about their learning and I see amazing results in their response to the activities. When I compare the focus of my students on days I use technology to days when I don’t, almost all of the students are engaged in the learning for the entire class period.”

Observing this teacher made me aware of her sensitivity to the individual needs of her students. This teacher provided scaffolds to her students as they were needed, so they would be able to participate fully during class activities and discussions. In this class, students spoke as often as the teacher to raise questions or explain their responses. If students were not skillful at copying details from the projected image, these students had paper versions of the presentation. They were still expected to take notes. If students did not feel competent in drawing diagrams or sketches of living things, the teacher encouraged them to focus on noting the details and emphasized how artistic skill was not contributing to the assessment of their work. This teacher made room for the varying skill level of her students and encouraged them to try and excel in their work as individual students, and not be compared to what others could accomplish.

Since this teacher is still learning or exploring the benefits of emergent technology, she may tend to depend on traditional instructional technology more than the other teachers in this study. This reality aligns with the research describing varying levels of technology adoption among teachers. This teacher also shared how she determines one format of technology (application or device) for exploration over the summer, to extend her skills as she does see the
power of these emergent instructional tools. This aligns with a conclusion that Bebell, *et al.* (2004) shared as to teachers’ technology use expanding and emerging over time, indicative of ongoing exploration of emerging formats and uses of technology.

Additionally, the teachers in this study demonstrated very good use of technology, as defined by Hammond, *et al.*, (2009) to increase their capacity to differentiate instruction. Not only did they vary and blend their use of technology formats (both traditional instructional and emergent) to create activities to address students’ differing ways of learning and encourage students to use technology, they used technology more than once a week, the selected technology was used to support subject teaching, and their participation in this study facilitated the documentation of how they reflected on their use of technology.

**Choice of technology matches instructional goals.** The following two related vignettes describe two instructional activities where Google Earth is used so students develop map reading skills and access information about ancient civilizations. Google Earth also provided these students accurate maps that could be manipulated to help them understand the spatial relationship of several geographical and historic sites they are discussing in class.

The teacher and her 26 students are focusing their attention on a projection of Egypt using Google Earth’s web site from the teacher’s laptop. Each student has a photocopy of a map of the northeastern corner of Africa, where only the coastlines are provided. Students also have textbooks, individually created notebooks and atlases, as well as a range of writing implements on their desks. The purpose of this session is to use Google Earth to update the maps in the textbooks and atlases, as well as provide students a chance to navigate the online map. Students approach the teacher’s laptop in pairs to learn how to use Google Earth. At some point, the teacher has to relaunch the web site, as one pair of students navigated in some way that they lost
track of where they are supposed to be and have navigated to another area of the globe. The teacher simply interrupted them and relaunched the web site. This process is repeated for approximately 30 minutes.

At this point, the teacher used an auditory prompt (Hershey – kisses) to indicate a change in activity. The next ten minutes are used to discuss the labeling of the photocopied maps. Students are sharing their suggestions as they approach the image of the map projected through a document camera onto a whiteboard. In some cases, students shared comments regarding the landform or the ancient city, often a detail gained from the textbook or an observation concluded through analysis of the geographic characteristics of this region of the world. At the conclusion of this activity, students were asked to affix their map into their individualized notebooks (often used as a study tool) and included a listing of this map in the notebook’s table of contents.

A few weeks later, this same class was again using Google Earth and this same map, in their notebooks. This time, they were using Google Earth to locate details about these historic cities and sites of Ancient Egypt. The teacher spent five minutes modeling how the informational text and image appears in a new window when the user clicks on a specific icon on the Google Earth map. These icons’ significance was discussed. Again, students were able to use the teacher’s laptop in pairs for a specific time interval so all pairs of students can have a turn. Students also had reference books in front of them and their notebooks to collect relevant information. Some students were intently watching what others were doing, possibly to gain information or to understand the process. Periodically there were conversations about these historic sites, often initiated by the teacher. Concluding comments to bring closure to the lesson were shared just before the time the students were scheduled to leave to go to another room for instruction.
Figure 4 brings together details that clarify how these teachers recognized technology’s power to design and facilitate activities that match instructional goals. These two related vignettes and the triangulated details provide us a sense of how technology was used to meet instructional goals, whether it gives students an opportunity to practice skills or facilitates their creation of a mandated product that represents their increased capacity to understand information and represent it in a meaningful way. Much like the ACOT studies that Sandholtz and Reilly (2004) analyzed, teachers are more successful in their use of technology when they focus on curricular-based instructional goals as they design instruction and select relevant technology formats for use with and by students. Zhao, et al. (2002) noted that teachers who integrated technology with greater success did so to address curricular demands as they noticed an “intimate connection between technology and the curriculum” (Zhao, et al., 2002, p. 492). The described use of technology as depicted in these related vignettes provides us a sense of how technology is used to address curricular demands to benefit students. These teachers’ uses of technology also reflect the underlying definition of technology as a way of thinking (Finn, 1960). These teachers not only thought about the design of the instructional activities, but they expected their students to think about their use of technology, as not all applications or digital tools are as intuitive as digital designers tend to anticipate. The experience of a pair of students in their use of Google Earth demonstrated the need to think how to control the mouse to navigate around the digital representation of the globe efficiently and effectively.
<table>
<thead>
<tr>
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<th>Related detail observation data</th>
</tr>
</thead>
<tbody>
<tr>
<td>This lab could not have been done without the transparent technology. The students needed the materials and lab instruction sheets to be successful</td>
<td>Use of transparent tech to facilitate student exploration students are in charge of their own learning – makes teaching so much fun</td>
<td>All students worked in groups to use materials to create tactile models of cells &amp; were on task 95% of time in the lab.</td>
</tr>
<tr>
<td>The resources given to the kids were well-suited to the lesson</td>
<td>Accuracy &amp; user-friendly materials &amp; resources are important – guiding appropriate use of resources – use of ITIG helped me realize that I invest time &amp; thought in Selection &amp; collection of resources more than the script of the lesson</td>
<td>Students used all resources appropriately as they completed the assignment – asking clarifying questions &amp; requesting feedback from teacher.</td>
</tr>
<tr>
<td>The activity was interactive and reinforced the concept taught</td>
<td>Forces more one on one connections – allows teacher to see what they (students) are doing and where they are- to see the process the students are doing or completing teacher can see more clearly and faster the areas needing improvement</td>
<td>80% of observed classroom activities the students were completing a task, either individually or in small groups. These participants did not lecture for long intervals and expected students to interject questions or comments during some lecture intervals. There may be some concern as to the degree or type of interactivity. This term needs definition.</td>
</tr>
</tbody>
</table>

Figure 4. Triangulated Data of Technology Aligned with Instructional Goals
<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
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</tr>
</thead>
<tbody>
<tr>
<td>The document camera allowed all of the students to be a part of the process of buying the land. [participate in the simulation]</td>
<td>To put it all on the document camera allows for more to be participating in the activity – to get the role playing more engaged as something exciting</td>
<td>Students approached the document camera to participate in class activity. Other students viewed the projected image.</td>
</tr>
<tr>
<td>The video provided a visual representation of westward expansion.</td>
<td>Increase engagement &amp; use visual or graphic quality to increase quality of info exchange</td>
<td>3 minutes of online video were shared – a re-enactment and explanation of how pioneers migrated westward – how the land was wilderness - - teacher indicated she felt it was accurate and easy to understand.</td>
</tr>
<tr>
<td>Having copies of the checklist and list of things to do was helpful as well</td>
<td>Being intentional to give goals to the students so they know what they have to accomplish in the allotted time</td>
<td>Students referred to the checklist prior to asking the teacher to review their work or to submit their work.</td>
</tr>
<tr>
<td>It gave the students option[s] and provided a venue for them to publish the final draft of their timeline.</td>
<td>Creative part – they were able to choose the tool to use – it allowed them time to publish their final draft of their timeline it does allow the students to use their strengths &amp; tap into their different learning styles</td>
<td>Students had 3 options of applications or tools to create their timeline (web – word – ppt). all students in the class used a laptop appropriately to create a timeline as required – ten details of a famous individual’s life. Students referred to prior worksheet to use info to include. Some students used tools with skill, while half of students needed to invest time and effort to apply keyboarding skills and rudimentary use of applications’ features.</td>
</tr>
</tbody>
</table>

**Figure 5. Additional Triangulated Data of Technology Aligned with Instructional Goals**

**Definition of effective technology use.** Completion of the ITIG encouraged these teachers to consider several aspects of technology integration and instructional planning. At the outset, they were asked to define effective technology integration. Figure 6 pulls together their ITIG-provided definitions with other comments shared during interviews and observations.

These definitions emphasized the role of technology to support instructional goals and facilitate the creation of accurate, meaningful and engaging instructional materials. The need to nurture
students’ increasing capacity to think critically, problem solve and express their ideas coherently is also supported by these teachers’ decisions to integrate technology as they design instructional activities for various content areas.

<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
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</tr>
</thead>
<tbody>
<tr>
<td>The student “will use the various forms of emergent and transparent technology to” fulfill the instructional goal Using the most effective technology available to teach with best practices for my students</td>
<td>Students used media that they have familiarity with – they learn without recognizing that they are learning something Facilitating students’ capacity to draw conclusions due to enhanced quality of visual information -</td>
<td>Students used both emergent and transparent technologies in these classrooms. Teachers selected technology they perceived as most effective, relevant and accurate.</td>
</tr>
<tr>
<td>Incorporating technology in a manner that increases productivity, knowledge, and understanding</td>
<td>To reinforce what has been explained</td>
<td>Teachers gained productivity and provided current versions of content information.</td>
</tr>
<tr>
<td>Technology also helps to spark student interest</td>
<td><em>It makes it more interactive and exciting – increase engagement &amp; use visual or graphic quality to increase quality of information exchange</em> Increased students’ excitement – instant interaction &amp; responsiveness of computer</td>
<td>Students were 85% of time (observed) engaged or on task. <em>(a visual estimate)</em></td>
</tr>
</tbody>
</table>

Figure 6. Triangulated Data Defining Effective Technology Use

As part of the observation protocol, one checklist was included to notate the presence of specific instructional behaviors. I felt it was important to situate the use of technology within the use of pedagogic and classroom management behaviors, since prior research has provided evidence that effective technology use is connected to effective pedagogy and instructional behaviors (see Harris, Mishra, & Koehler, 2009; Mishra & Koehler, 2008; Pierson, 2001). Table 10 presents the frequency of observed instructional behaviors in order to gain a sense of the interrelationship of effective technology use and effective instructional pedagogy or behaviors demonstrated by these three teachers. This range of varied instructional behaviors reinforces...
these teachers’ intentions to create instructional activities to meet their students’ needs through the use of a range of meaningful instructional behaviors. Not only do these teachers reveal a perceived benefit in the use of varied formats of technology but this documented use of a wide range of instructional behaviors reinforces the recommendation in the research that effective technology use is linked to effective pedagogy and instructional behaviors (see Harris, Mishra, & Koehler, 2009; Mishra & Koehler, 2008; Pierson, 2001).

Table 10
*Frequency of Observed Teacher-Centered Instructional Behaviors*

<table>
<thead>
<tr>
<th>Instructional Activity</th>
<th>Description of Instructional Activity</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>Teacher is lecturing to the group of students</td>
<td>1</td>
</tr>
<tr>
<td>Lecture with Discussion</td>
<td>Teacher-led lecture, with periodic student discussion or comments</td>
<td>4</td>
</tr>
<tr>
<td>Problem Modeling by Teacher</td>
<td>Teacher is demonstrating how to execute a task</td>
<td>4</td>
</tr>
<tr>
<td>Teacher Demonstration</td>
<td>Teacher is demonstrating a procedure to the students for future, independent application</td>
<td>2</td>
</tr>
<tr>
<td>Questioning by Teacher</td>
<td>Teacher poses questions to students</td>
<td>8</td>
</tr>
<tr>
<td>Anchored or Sponge Activity – Before a Lesson</td>
<td>Teacher presents activity to prepare students for new learning</td>
<td>0</td>
</tr>
<tr>
<td>Teacher Interacting with one Student</td>
<td>Teacher individually helps or assists one student</td>
<td>7</td>
</tr>
<tr>
<td>Teacher Interacting with Small Group</td>
<td>Teacher guides small group of students to explain, re-teach, provide focused instruction</td>
<td>5</td>
</tr>
<tr>
<td>Technology Use by Teacher</td>
<td>Teacher uses technology to present instructional content</td>
<td>6</td>
</tr>
</tbody>
</table>

These teachers saw a connection between effective technology use and effective use of communicative, pedagogic and classroom management strategies to benefit students. Much as Means, Cuban and Kerr (2008) commented that successful technology integration depends on effective implementation of all the elements of instructional activities, these teachers
demonstrated and understood this necessary connection. Their use of technology was one element of the complex interactions and activities they orchestrate for student learning. Effective use of instructional technology was inextricably linked to effectively “us[ing] best practices”, “fulfilling instructional goals” or “increas[ing] productivity, knowledge and understanding”. Technology does not simply make a teacher’s job easier, but these teachers often used technology to “facilitate students’ capacity to draw conclusions” since technology is familiar and increases students’ excitement about the lesson, topic or skill.

**Technology Selection through a Student-Centered Lens**

One message these teachers communicated more than once was their interest to select strategies and resources to meet their students’ needs. This perspective and decision were also reinforced during observations. The needs of students guided instructional decisions and often defined the structure of instructional activities, as classroom events were not what they did as teachers, but what the students were to do so they would learn, develop skills, and understand concepts. Specifically, the quotations below communicate this perspective.

- “It enhances their computer skills to prepare for immediate and distant future… it also allows students to use their interests and strengths…”
- [Technology] “ increased students’ excitement and increased their awareness of the small size of cells.”
- [Technology] “helps students who may have minimal success and them become a more engaged learner.”
- “I realized how much technology I do use, especially traditional instructional technology, and how it benefits my students in a very practical way.”
• “They [students] need to be active learners and interact and ask questions to pry deeper to get more from the lesson – this makes the experience valuable.”

• “actively engage all of their thoughts and attention into the task”

• “I encourage them to use the computer at home to access the web to locate the answers to their questions.”

• “I feel that they are actively engaged and that they enjoy using the technology as it is their world.” … “I feel that they are learning.”

Analyses of the triangulated data yielded the four sub-themes of (a) technology supporting student learning, (b) students’ use of technology, (c) value of students using technology and (d) purpose of using technology with students will help us understand these teachers’ commitment to plan and enact instruction where students use technology and the decision to use technology (both traditional instruction and emergent or digital) intentionally supports student learning. Within the discussion of these four sub-themes, vignettes, data analyses and triangulated data are included to provide a rich description of how these teachers viewed technology use through a student-centered lens.

Technology supporting student learning. During the course of multiple observations of ITIG-planned instructional activities, data were collected to pinpoint these three teachers’ instructional behaviors using technology. The goal of this study is not simply to count or document the frequency of device and application use, as this measurement only serves as a superficial means to recognize and document technology use in classrooms. As shared in Chapter 1, Hammond et al., (2009) defined very good technology use as varied and regular use of technology that supports content area instructional goals. Of emphasis here is to note that student use of technology changed over time, reflecting either a desire for students to participate
fully during instructional activities, or these teachers’ assumption or belief that identified, selected formats of technology would meet the instructional needs of students. These three ITIG-using teachers reported daily use of laptop computers, document cameras and the 3M projectors that were in their rooms (in the Technology Beliefs and Competencies Survey). This was confirmed during all of the observations, as they used these devices and applications throughout the observed lessons to share information and facilitate class discussions.

Within the ITIG and the observation protocol, I provided space for the teachers and for me to indicate specified categorical uses of technology based on two taxonomies of technology use (see Maddux, Johnson, & Willis, 1997; Small, 2005). Table 11 summarizes the type and frequency of these uses of digital or emergent instructional technology. It is interesting to note the high frequency of technology used to share information and to provide students opportunities to use technology. Please recognize the challenge for an observer to find evidence of teachers using technology to prepare or plan instruction through classroom observations of instructional activities. Observed uses of teacher-created, photocopied handouts or presentations and selected online resources (video clips, web sites) provided confirmation that these teachers used technology to plan for instruction, as categorized under Teachers’ Focus on Productivity.

Table 11
Type and Frequency of Taxonomic Instructional Technology Uses

<table>
<thead>
<tr>
<th>Instructional Technology Uses</th>
<th>Frequency Noted in ITIG</th>
<th>Frequency Observed Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I Uses of Technology</td>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>Type II Uses of Technology</td>
<td>17</td>
<td>15</td>
</tr>
<tr>
<td>Tier 1: Teachers’ Focus on Productivity</td>
<td>29</td>
<td>6</td>
</tr>
<tr>
<td>Tier 2: Instructional Presentation</td>
<td>30</td>
<td>27</td>
</tr>
<tr>
<td>Tier 3: Student-Centered Uses of Technology</td>
<td>21</td>
<td>23</td>
</tr>
</tbody>
</table>

Based on Maddux, Johnson, & Willis (1997) and Small (2005).
The following vignette of students using laptops to create a timeline of events gleaned through a prior research activity gives us a good sense of the commitment of these teachers to design instructional activities where students are using technology in meaningful ways. To maximize student productivity, the teacher has created a structure to the activity that encourages all students to have what they need in order to focus on the task. Students also have options for how to create the timeline, to increase their engagement or motivation to complete the timeline within the allotted time. It is also possible that by this time of the school year, these students have recognized the value of the structure and procedures their teacher has established, and have adopted it as beneficial. This teacher shared her beliefs of the need to take note of students’ strengths, interests and needs in order to formulate activities. The students’ level of engagement and commitment to task reflected their adoption of procedures and structure, as well as the teacher’s intentional instructional design reflecting students’ traits and behaviors.

The teacher used her laptop and the projector to explain to her 19 students the creation of a timeline to represent the ten events they have selected (during prior lessons) about an individual. The students were provided options as to which application to use to create this timeline: Microsoft Word, Microsoft PowerPoint, or an online timeline generator. The teacher invested time to model the use of the online generator (its URL was clearly written on the whiteboard for future reference) and respond to students’ questions. Requirements of the assignment were also reviewed. The teacher explained to which printer students were to send their work, with the expectation that she will review their work prior to printing the timeline.

Students were then invited to take one of 20+ laptops from a recharging cart that is placed in the classroom. Students took turns to pick up laptops and return to their desks. They started their individual work. The teacher circulated the room to check on student progress and respond
to focused questions related to the assignment. Students demonstrated skill in using the laptops (logging onto the system and opening the application), as everyone was working within the initial minutes of the work session.

One student was using the desktop at the rear of the classroom to collect more details to finish the timeline planning sheet. This student was using the Google search engine to locate information. Efficient use of Google search was not evident, as the student re-entered search terminology to restart the search, instead of refining the search terminology. Eight students were using the online timeline generator. Eight other students were using Microsoft Word and one student used PowerPoint. Of all the potential applications or tools in use by these students, several students were using the applications with success and creative flair, using word art or font changes to individualize their timeline. Before the end of this observation, 95% of the students had asked the teacher to review their work and had printed their timeline.

This vignette revealed the extent to which technology is used to explain to students what is expected and how to do it. Most importantly, students used the computers and relevant applications to create evidence that they have located relevant information and are developing a range of skills. The decision to use technology, and which technology to use, is defined by the needs of students to become computer literate, to develop competencies as outlined by ISTE defined technology standards, and to demonstrate a variety of content area standards (in this case, Social Studies and Language Arts). The teacher’s decision to use the projector and laptop to model and explain her expectations and the method to complete the assignment successfully reflects her desire to manage classroom activity to maximize student productivity.

The following chart of triangulated data reveals the extent to which these teachers focused on students as learners when enacting their instructional plans.
This chart of thematically aligned data pinpoints the extent to which instructional activities expected students to do things with technology in order to learn concepts or skills. Re-enacting or role playing during a simulation of the pioneers moving westward to individually practicing mathematical skills through a computer game or using a word processor to complete an assignment anticipates individual student action in order to learn. Technology was selected and strategically used to engage students as participatory learners. As Salomon (1998, 1993) clarified how technology facilitates socially situated construction of knowledge and cognitive development, these teachers designed opportunities for students to interact and support one another as they learned. These teachers anticipated that students would think and determine how best to navigate the applications and the web to demonstrate their skills and document their learning. Perhaps these teachers have not yet invested enough time to guide students to become critical users of technology and online sources of information; a potential focus for future instruction.

**Students’ use of technology.** During classroom observations of the ITIG-planned activities I noted specific types of instructional behaviors, using research-based categories and definitions (Cassady, *et al*., 2004). In sharing these data (student-centered instruction) in the following table, Table 12, these teachers used a range of behaviors, which encouraged and supported student empowerment as learners. A range of activities and instructional behaviors are implemented which reflect these teachers’ stated acknowledgement that students are to be engaged as learners and that there are a range of student needs and traits that are to be addressed when planning instruction.
<table>
<thead>
<tr>
<th>Instructional Activity as Observed during ITIG planned activity</th>
<th>Description of Instructional Activity</th>
<th>Frequency of Observed Instructional Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student-Centered Class Discussion</td>
<td>Students are primarily discussing an intentional topic</td>
<td>2</td>
</tr>
<tr>
<td>Small Group Discussion</td>
<td>Groups of students are discussing intentional topics</td>
<td>5</td>
</tr>
<tr>
<td>Student Presentation</td>
<td>Student(s) presenting information to peers – may be planned or on-demand</td>
<td>2 (on demand)</td>
</tr>
<tr>
<td>Students Responding</td>
<td>Students answer questions - may include choral response</td>
<td>6</td>
</tr>
<tr>
<td>Manipulatives</td>
<td>Students are using concrete materials or realia to understand abstract concepts</td>
<td>2</td>
</tr>
<tr>
<td>Learning Center</td>
<td>Students are using planned activities individually or in small groups – could be computer application</td>
<td>6</td>
</tr>
<tr>
<td>Anchored or Sponge Activity – During a Lesson</td>
<td>Students complete an activity to learn new information or a new skill</td>
<td>2</td>
</tr>
<tr>
<td>Anchored or Sponge Activity – After a Lesson</td>
<td>Activity follows the presentation of new information or skill for further practice or application</td>
<td>3</td>
</tr>
<tr>
<td>Seat Work – Individualized</td>
<td>Students independently work on academic materials</td>
<td>4</td>
</tr>
<tr>
<td>Seat Work – Group</td>
<td>Students form groups to work on academic material</td>
<td>3</td>
</tr>
<tr>
<td>Cooperative Learning</td>
<td>Students are organized to complete a task through collaboration or cooperation</td>
<td>5</td>
</tr>
<tr>
<td>Role Playing</td>
<td>Students re-enact a scenario to problem solve</td>
<td>2</td>
</tr>
</tbody>
</table>

In addition to these observed instructional behaviors, these teachers shared how technology provided them opportunities to monitor student learning, individualize instruction, and manage classroom activities. Below are some quotations that offer us a greater sense of how vital the use of technology was for these teachers in creating instructional moments for student success:
• “Technology allowed me to observe student interactions as well as understanding. I was able to assess student learning in a non-traditional way.”

• “Technology provided an opportunity for me to consistently and more easily monitor student status and progress.”

• “Teacher can see more clearly and faster the areas needing improvement.”

• [Use of an online math activity linked to the adopted textbook] “allowed for independent practice and allowed me to guide students needing extra practice/re-teaching.”

• [Technology] “allowed me to be thinking ahead and preparing for what was to come in the simulation.” “I can focus on what comes next in the activity, the need to keep the lesson advancing smoothly.” (These comments are describing the use of presentation slides to guide the instructional activity.)

• “To zoom in and see the relationship of these locations, you need to model the expectations of where the students are to go as they use the technology.” (Use of Google Earth)

The following vignette of a science lesson provides further evidence of how the use of traditional instructional technology is key to providing students a better understanding of the complex and microscopic nature of cell structure. This teacher creatively used art supplies so students, working in pairs, would create a model of either a plant cell or an animal cell. I sense that if this teacher had access to a computer-based activity where students would manipulate shapes to construct a visual, dynamic or virtual model, she would choose to use it. Since this type of emergent technology does not exist for this teacher, she uses art supplies (traditional instructional technology) so students can discuss and manipulate these cell parts or organelles, thereby facilitating their grasp of these concepts and adoption of this terminology.
In the science classroom, the teacher was projecting through the document camera a photocopy of the directions and guideline for how to create a tactile model of either a plant cell or an animal cell, while facilitating a discussion of the terminology. Students were describing the usefulness of specific art supplies they are to use in the science lab to create these models. The students have been organized into partnered work and each pair has a copy of these guidelines. The teacher was checking to see if students have a correct grasp of the process and the purpose of the various materials they are about to use. Discussion ensured among students, guided by the teacher, as to the distinction between cytosol and cytoplasm, and how a gelatin solution (prepared by an educational assistant) can represent this structure within cells.

Students were then asked to take out some paper and to use the next ten to fifteen minutes to create a plan for how they will construct their model. The teacher was circulating to provide feedback or encouragement as to the designs that are under development. She was also monitoring the time. One pair of students referred to other print materials and graphics to check on the accuracy of their plan. As the plans evolved and were formulated, the teacher distributed the art materials, which were organized within ziplock bags. This allowed some students to check if their plan would work and for adequate supplies prior to going to the science lab.

After a reminder to bring the planning process to conclusion, the groups started to collect their materials. Students were encouraged to bring their science notebooks as a resource for details related to their models. They were directed to prepare to move to the science lab, due to the larger tables or surfaces to use as they created their models. The students formed a partnered line, left the classroom and walked to the science lab.

Students have entered this lab and settled down at tables by the time that I arrived. It seems as if the students know what is expected as they started to organize their workspace to
create these models. Once everyone settled down, the teacher elicited from students the key safety guidelines in using the lab. After this review (with students talking much more than the teacher), students were encouraged to refer to their plan as they began to construct their tactile models of plant or animal cells. The teacher circulated to respond to questions or provided feedback, praise or redirection.

As you can see, even the selection of traditional instructional technology for this culminating activity, prior to a formal test, supported student learning and took advantage of constructing a tactile model to increase student engagement and grasp of concepts and vocabulary. Analysis of the collected data (observations, interviews, submitted ITIG documents) yielded this chart of triangulated data (Figures 7-1 and 7-2). These teachers repeatedly indicated the importance of students’ focused participation in the instructional activities they planned and that technology would support their students’ exploration of content and development of skills. Technology was viewed as an avenue, a way to bring student and content together to orchestrate teachable moments.
<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
<th>Related detail observation data</th>
</tr>
</thead>
<tbody>
<tr>
<td>They are writing … using written information to make connections…, touching foam models…, witnessing diagrams and electron microscope images…, seeing….</td>
<td>Accuracy &amp; user-friendly materials &amp; resources are important – transparent tech is great &amp; the emergent tech is so wonderful &amp; allows me to create flexible &amp; legible documents for instruction</td>
<td>Teacher provided model to copy into notebooks and other materials to create a tactile model – digitally produced pictorial model used images from the web as model for student made notebooks</td>
</tr>
<tr>
<td>Use the technology to learn how…</td>
<td>It is an avenue for teaching – there are so many resources for use in teaching Integrate tech so it helps instruction, understanding, engagement, helps students who may have minimal success experience more success and then become a more engaged learner</td>
<td>Discussion of how model functions and how the details relate to other details discussed in class – students pose questions as teacher leads discussion</td>
</tr>
<tr>
<td>Using 3M to take a virtual trip to Egypt</td>
<td>The 3M has features to allow interactive lessons… &amp; provide more info than the textbook offers</td>
<td>Teacher demonstrated power of Google tool to share info about ancient Egypt</td>
</tr>
<tr>
<td>Using computers to access the everyday math web site</td>
<td>I use ICT as a practice tool to reinforce my teaching</td>
<td>Students were in lab to access this web site for additional practice of algorithm</td>
</tr>
<tr>
<td>Use interactive Google earth to find locations</td>
<td>This allows them to demonstrate that they can locate a site &amp; the info button &amp; new window about the site offers them the background they are to learn.</td>
<td>Students had opportunity to use web and teachers’ laptop to develop map reading skills</td>
</tr>
<tr>
<td>Document camera and 3M will be displaying directions, images, information</td>
<td>The coolest thing with SS is to visit sites… to take tours of places that are relevant to the curriculum that make ideas real that were not feasible in the past - document camera allows students to see their work to discuss strategies for solving math problems &amp; ideas to be reinforced by placing a model …for discussion</td>
<td>These devices were used for these purposes to guide students in completion of an assignment</td>
</tr>
</tbody>
</table>

Figure 7-1. Triangulated Data of Student Use of Technology (Intended)
<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
<th>Related detail observation data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom supplies help to create the environment for this simulation experience</td>
<td>Manipulating objects is key to success with inquiry-based teaching</td>
<td>Supplies were made available for student capacity to participate in activity Note how technology in the classroom is intended to facilitate student learning (Researcher comment)</td>
</tr>
<tr>
<td>Using the laptops to finish typing their drafts some students problem solve to figure out how to use a tool or application</td>
<td>It produces a neater, smarter looking product than a handwritten product – sometimes students collaborate to help each other – seek tips on how to do something using the computer –</td>
<td>Students used laptops to complete this assignment during class time – 90+% of students demonstrated engagement and sought to be creative in their work</td>
</tr>
<tr>
<td>Internet site provides template for timelines – PowerPoint for instruction and direction</td>
<td>Allowing or expecting it to be typed exposes them to Microsoft office to give them experience to use tech tools as needed in society</td>
<td>8 of 18 students used the timeline generator from the web. 8 of 18 used word processor. 2 used presentation slides to create timeline.</td>
</tr>
<tr>
<td>Document camera and 3M will be displaying directions, images, information</td>
<td>The coolest thing with SS is to visit sites … to take tours of places that are relevant to the curriculum that make ideas real that were not feasible in the past – document camera allows students to see their work, to discuss strategies for solving math problems &amp; ideas to be reinforced by placing a model … for discussion</td>
<td>These devices were used for these purposes to guide students in completion of an assignment.</td>
</tr>
</tbody>
</table>

Figure 7-2. Triangulated Data of Student Use of Technology (Intended)

These comments more importantly emphasize that technology is used to facilitate students’ success as learners, whether giving students opportunities to be active learners (socially constructing knowledge), or to more effectively represent and communicate information among students and teachers. Much like the 21st century power of digital technology to customize our instructional resources, these teachers recognized that this customization will benefit students in multiple ways. Much as the Annual Report from Becta (2007), in the United Kingdom, described the capacity of digital technology to blur the distinction between learning, working and
entertainment. These teachers mentioned how the students may not recognize that they are indeed learning, as their technology-defined world seems so much like play or entertainment.

**Value of students using technology.** To justify student use of technology, teachers should be able to ascribe value to their choice of technology. These values or rationales for using technology often need to be discussed or elicited. Such ideas were elicited through the reflective questions embedded in the ITIG, if they are not already a focus of instructional planning during collaborative or collegial interaction (both formal and informal). Through the intentional incorporation of questions discussing the value of technology integration within the ITIG, this aspect of instructional decisions can become a regular focus of formal collaborative instructional planning.

Through the reflective section of the ITIG and interviews, these teachers shared their rationale or value for students’ use of technology. The triangulated data that pinpointed these teachers’ ascribed value for students’ use of technology is shared in Figure 8.
These teachers valued and provided opportunities for students to use technology as they recognized the need for students to become competent users of technology. They also recognized the accuracy and enhanced visual qualities of digital images. The design of online instructional games or activities provided instant feedback and heightened engagement. Of greatest note, these teachers perceived that providing technology for student use increased student responsibility for their learning. Expanding students’ levels of engagement and their...
opportunity to make decisions as to the format and appearance of their work (in addition to content) would provide students incentive and a basis to demonstrate what they learned and can do independently. The outcome would depend on their effort, persistence and desire to follow the guidelines and accept teacher feedback, redirection and support in completing such assignments. Through the guidelines for these assignments, teachers felt the structure and process would offer adequate support or scaffolding to assure student success with these assignments.

A scenario where students used technology to learn and develop skills was already described in the vignette where students used laptops to create a timeline. This was equally true in the following vignette, where the students use computers in the lab to practice a mathematical algorithm for comparing and multiplying fractions. This teacher recognized how this use of the textbook publisher’s online activities allowed students to work at their own pace (discussed earlier) as well as demonstrated the value of these online instructional activities.

The teacher was using the whiteboard to model for the students an online mathematics activity they will be completing during that day’s math class. These students already had some guided practice in the use of this algorithm and were viewed as ready for individualized practice. The teacher modeled how to access the online activity, using her laptop, as the image of the interface was projected onto the whiteboard as well. Additional details (the url for this activity) were notated on the whiteboard.

Students were able to use calculators and were expected to notate on paper the practice problems they were completing while using the online activity. Fifteen minutes of class time were invested in eliciting from students an explanation of the algorithm and to model which details of the math activity (and solution) were to be notated on paper. Students took turns
explaining the steps of the algorithm. The teacher monitored what was explained, offering feedback to reinforce the nature of this learning activity as individualized practice that would be graded based on the submitted, notated paper.

Students were then directed to take paper and pencils with them as the class lined up to go to the computer lab. Some students were taking their planner, to refer to their login codes. Once students were seated in the lab, at desktops, the teacher encouraged them to log into the system and the online mathematics instructional tool. For those students who remembered their login codes and procedure, they started working on the assignment rapidly. Other students (approximately 60%) waited their turn to get some assistance in logging into the online activity with the teacher’s guidance or with another adult’s guidance. After a 22-minute interval, almost all students had completed the assignment as requested, with a hand-written explanation of the solution to ten online problems for submission. There were five students who completed this activity with time remaining to explore another online activity on this publisher’s web site. The teacher commented afterwards how challenging it was to move through the activity smoothly as so many of the students struggled to recall the login codes and procedure. Two students indicated that the students come to the computer lab only once a month, emphasizing how individualized access to computers remained a challenge for these teachers to offer students.

Once these students had successfully logged into the fractions activity, they were focused on the activity and transcribing their problems and solutions to paper. Four students used headphones to listen to the computer activity. Five students worked so diligently, that they navigated to another math activity within the online instructional tool. All students continued to work at these tasks. Occasionally, they shared their work with their adjacent peer, to check on answers or to discuss what they were doing. The teacher elicited from students a comment to
indicate if they had completed the required ten items, and then gave them a 5-minute warning that they would be leaving the computer lab soon, and the need to complete this activity. Students focused on their work for the remaining interval, gathered up their papers, pencils (and for some, their planners), and then proceeded back to the classroom. Two students remained behind to shut down the desktops in the computer lab as it was just before the end of the instructional day at this school.

During this session in the lab, the teacher was able to circulate and provided feedback, re-teaching or further guidance to each student based on their individual needs. In this way, technology was used to support differentiation and student learning (as discussed in a prior section) and demonstrated its value for students’ direct use. It is worth noting the teacher’s requirement that students notate and submit a paper version of their computer-based independent practice of the algorithm. Perhaps extracting the data on student performance from the online instructional activity is not easy or too time consuming. Requesting students to document their work using paper and pencil may be a temporary solution for teachers seeking to use online instructional activities for assessment and as one part of many elements of collecting data on student performance. As the teachers in this study commented, technology provided them alternative methods for assessing student learning and performance. This use of the online instructional activity is one example of using technology for assessment of students to confirm or reject observable performance or to provide students an environment that is more conducive to capturing students’ full potential.

Please note how in the description of this instructional activity the focus was on what the students were doing with the technology in the computer lab as evidence of the value and the purpose that students have opportunities to use technology. This teacher felt that offering
students the opportunity to use the adopted textbook’s online activities to independently practice
calgorithms would have greater impact, and greater engagement than the typical paper and pencil
practice from the pages of a textbook. From my observation, these students were engaged, and
for those students who finished the assigned online activity before the end of the computer lab
session, they were willingly seeking out another mathematical online activity (often focused on
gometry). Since this online version of algorithm practice is available, it can be used.

More importantly, this online activity anticipated that students would have to think
through the steps of the algorithm, as well as how to control the flow of the instructional activity.
These students then have an opportunity to use technology to develop problem solving as well as
learn a sequence of steps. Obviously, with limited or infrequent access to laptops or desktops in
the computer lab, this is not a daily occurrence for this teacher and these students (a shared
concern to be discussed later in this chapter). Other teachers in this study provided additional
opportunities for students to develop thinking and problem solving skills. Students were often
encouraged to strategize how applications can be used to create evidence of students learning
new information and skills. As you will read in the next section, since there is a value for
students to use technology, there was also significant evidence collected through this study of
these teachers’ purposes for using technology with students.

**Purpose of using technology with students.** Through the documentation of lessons and
decisions in the ITIG, it became readily apparent that these teachers saw that technology
enhanced and contributed to the quality of their instructional plans and capacity to communicate
during instruction. These teachers’ use of the 3M projector, document camera and laptop truly
facilitated the exchange of information, text or graphic. Two of the three teachers had used
Microsoft PowerPoint to create presentations that included relevant and high-quality graphics to
structure the presentation of information and guide students through the steps of the instructional activity. The next two vignettes, describing the use of presentation software, for a science lesson (the benefit of graphics to represent microscopic creatures) or for a participatory activity (simulation of pioneers’ movement westward) will highlight these two rather effective purposes for using technology with students.

Vignette #1: The students in this science class were seated in groups (of 3 or 4) and were focusing on the projected presentation on organelles. The teacher elicited from the students the names of specific organelles depicted in the slides of the presentation. After a 2 to 3 minute guided discussion of the details on each slide, the students were given 5 to 10 minutes to copy the details into their notebooks for study and future class sessions. The teacher commented that she had found these images on the Internet and that they were possible due to electron microscopes (to help students grasp how small these organelles actually are). At times the students posed relevant questions or referred to prior work to help them recreate these annotated drawings or diagrams in their notebooks. The teacher circulated the room, stopped to monitor students’ progress, respond to their questions or offer suggestions. She managed the time by encouraging students to focus on the labeling, as the attractiveness of their representation of each organelle would not impact the grade they were to receive for this assignment.

After this observation, this teacher communicated to me her efforts to design a presentation that would be an accurate and an up-to-date explanation of these microscopic elements of cells. It was critical that the students had access to accurate and legible sources of the information listed in standards. She was so thrilled that she was able to locate an accurate series of digital images from the Internet to design this presentation. The fact that she was able to share it made her feel that her students were benefitting from the power of digital technology.
For students who struggle to copy and read from the whiteboard, she had provided paper versions of the presentation as a reference. They were still encouraged to copy the information into their individual notebooks.

Vignette #2: Another teacher designed a presentation to guide students through the process of re-enacting the American pioneers’ westward expansion during the 1800’s. Even though the slides contained a lot of text, she shared these slides in sequence, revealing segments of each slide gradually. After the teacher has reviewed the directions and guidelines for this class activity, the teacher returned to her laptop to share the slides (or portions of the slide) to reveal specific aspects and details of westward expansion. The teacher was reading almost all of the details, as the slides contained so much text that it would be a challenge to read the text from a distance. In this instance of using a teacher-customized presentation, the slides contained information to trigger students’ decisions as to which action they would take as pioneers (to stay or to move westward). After this observation, the teacher indicated that students had been assigned some reading in the textbook about westward expansion, the concept of manifest destiny and the historic and geographic details from the trajectory of movement from the eastern shore through the Pacific shore and along the border with Mexico.

As these two descriptions of classrooms where presentations were customized for students reveal, teachers realize that students can benefit greatly from customized presentations designed to explicitly communicate details and directions. These customized presentations helped one teacher manage classroom activity and the other teacher share up-to-date, accurate and detailed images to benefit students.

As shared in the earlier section of this chapter, dedicated to the baseline observations of technology use, technology was intentionally used for a range of purposes. Using NVivo 8, I
similarly coded my observation data for lessons where these teachers used the ITIG to document their instructional planning and decisions. Using the model creation tool of NVivo 8, I created a parallel model (during ITIG use) of the purposes these teachers used technology, as shared below.

Using the color coding key and comparing the intensity of these incidences of the categories of purposes of technology use, the data revealed that teachers increasingly used technology to manage classroom activity and direct students’ use of technology when they were using the ITIG to document instructional planning. This could be simply happenstance that their participation in the study provided them an opportunity to choose to use technology more frequently, as one teacher admitted to me, “I have always felt technology is important both inside the classroom and out. If anything, it was a time to prove technology is important and show my understanding and use. It also reminded me of how I love technology.” Even if this is the result of happenstance, this study’ documentation of the degree to which these teachers decided to use technology to support students’ learning experiences offers researchers an example of how technology can be used effectively and under which circumstances (as suggested by Kopcha, 2008; Vrasidas and Glass, 2007; Zhao et al., 2002). The NVivo 8 model also reveals that some purposes to use technology increased in frequency (please note more green-coded purposes of technology use) during the course of this study. Looking at these identified purposes of using technology with students to compare baseline episodes with ITIG-documentated instructional planning, we can recognize a change in the incidence level of various purposes. For example, the greatest degree of change is in directing students to use technology (from low incidence to very high incidence) reflecting the number of times the students were scheduled to use either the desktop computers in the lab or use the laptops in the classroom.
Figure 9. Observed Lessons Planned with ITIG – Purposes of Technology Use

Meaning of color codes for Observed Lessons Planned with ITIG – Purposes of Technology Use

- Paler fill, broken line border = low incidence
- Gold or green fill, solid line border = mid-range incidence
- Blue fill, darker line border = high incidence
- Purple fill, darker, thicker line border = very high incidence
Another two examples of change are in using technology to seek information (from low incidence to mid-range incidence) and using technology to manage class activity (from mid-range incidence to very high incidence). While the baseline data revealed these teachers’ awareness and decision to use technology for a variety of purposes, the focused use of technology documented through the ITIG provided additional evidence that there are many purposes to use technology to support student learning (sixteen purposes were identified). This descriptive data also provided a richer set of examples of how technology is used to meet students’ needs in several content area lessons or activities to include in the research literature and support teacher education initiatives.

Triangulated data also provided additional evidence of the purposes these teachers identified for using technology with students. The capacity of technology to present information and ideas in varied formats and about places that are beyond the range of a local and affordable field trip has contributed to these teachers’ desire to integrate technology in the manner that they demonstrated during the course of this study. The rapid, interactive nature of emergent technology also makes it a useful instructional tool. Since we have entered an age where skills in effectively using and managing technology (devices and applications) and there is no turning back, these teachers understood the imperative for their students to develop computer competence and confidence. The chart below of triangulated data (Figures 10.1 and 10.2) shares these key rationales for using technology with students as well as other ideas revealed through documentation, interviews and observations.
<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
<th>Related detail observation data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enhance student learning and to make teaching and learning creative</td>
<td>I could not imagine teaching without technology especially if we consider transparent and emergent tech. I feel that they are learning.</td>
<td>Teachers selected the use of specific apps or video or web sites to engage students and be creative in reaching students.</td>
</tr>
<tr>
<td>Give students multiple ways of interacting with material</td>
<td>They also got exposure to using different resources</td>
<td>I did observe more than one lesson to discuss the same concept or skill using more than one form of tech or more than one strategy.</td>
</tr>
<tr>
<td>Help “students to see the world and where every location is at in relationship to other places we have learned about. Technology offers so much as far as seeing the locations.”</td>
<td>Geographical relationships that the cities are close to the Nile – to et a sense that Mesopotamia was spread out while Egypt is long &amp; narrow – also to make a connection that the geography impacted the governmental structure and lifestyle.</td>
<td>Students were able to view the image of the entire globe through the google earth interface and then use the mouse to navigate or move to a region of the globe of specific interest – in this case the Mideast and Egypt – allowing them to gain a sense of relative location.</td>
</tr>
<tr>
<td>Technology provides instant feedback to kids and it is very interactive so they are learning while they are having fun.</td>
<td>It is that instant interaction and the responsiveness of the computer ... they learn without recognizing that they are learning something new.</td>
<td>Student engagement level was indeed elevated and students appeared to be pleased with their work on the computer or with other activities these teachers organized for them. There remains a question as to the degree of interactivity and how this can be measured or noted.</td>
</tr>
<tr>
<td>Create opportunities for students to utilize their own strengths and talents.</td>
<td>It also allows for students to use their interests &amp; strengths to convey what they know.</td>
<td>These teachers asked students to complete projects where artistic skills and teamwork or peer support are valued and nurtured. Allowing students to help one another also sends a message that using strengths and talents for others is desirable.</td>
</tr>
</tbody>
</table>

Figure 10-1. Triangulated Data of Teachers’ Rationale or Purpose for Using Technology
<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
<th>Related detail observation data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using the most up to date maps</td>
<td>To get the newest map possible the most recent you can find</td>
<td>The Google map interface did offer an accurate and up to date map of the region – perhaps more realistic than the atlases these teachers were provided.</td>
</tr>
<tr>
<td>District policy and encouragement to use online resources for SS instruction reflects the reality that more accurate and up to date resources can be shared through the web, laptop and 3M projector. This was the rationale for these expenditures. (Researcher comment)</td>
<td>I guess that there is more completeness when I use tech as I use the most current sources and the best practices for my students</td>
<td></td>
</tr>
<tr>
<td>To meet different learning styles and needs – helping all students achieve and succeed.</td>
<td>It does allow students to use their strengths &amp; tap into their different learning styles Giving them time to do what is to be done &amp; have expectations that they will do the task step by step (scaffolding of resources) early in the school year – journal prompt – how do you best learn science to gain sense of learning style</td>
<td>Teachers noted specific instructional needs of students in subtle ways, through the provision of supports (hard copies of presentations when students were expected to copy projected info). There was an active resistance to noting the attractiveness of drawing or copying diagrams so that students are not intimidated about using their drawing skills to create their science or social studies notebooks.</td>
</tr>
<tr>
<td>Expose students to the technology they will … in the future</td>
<td>It is a benefit to have them investigate as they retain this info and skill set for the future They enjoy using the tech as it is their world</td>
<td>Teachers demonstrated a willingness to use the digital technology as frequently as is possible and expect students to use technology as often.</td>
</tr>
<tr>
<td>Help prepare students to function in the 21st century</td>
<td>Ability to push the responsibility of learning onto students</td>
<td>These comments were repeated or shared at another point in the ITIG</td>
</tr>
<tr>
<td>Put responsibility for learning on the student</td>
<td>I feel that they are actively engaged and that they enjoy using the tech as it is their world Increase student engagement or excitement Increase level of engagement and active participation</td>
<td>These comments were repeated or shared at another point in the ITIG</td>
</tr>
<tr>
<td>Promote student engagement &amp; active involvement</td>
<td>I feel confident as to what will happen as it helps the lesson move more smoothly I feel challenged to empower them to feel confident. I am able to give my students the most up to date info I can find</td>
<td>Teachers demonstrated that use of technology allowed them to teach in ways that could be viewed as more effective and stimulating for students.</td>
</tr>
</tbody>
</table>

Figure 10-2. Triangulated Data of Teachers’ Rationale or Purpose for Using Technology
These documented purposes for using technology with students reflect the mindset that instruction is to be designed to meet the needs of students, where students are at the center. Furthermore, these teachers also selected a wide array of formats or types of technology to meet their students’ needs, as represented by Table 13. Examining the purposes these formats of technology were introduced into these classrooms reinforces the conclusion that technology was selected to meet students’ needs and incorporate multiple modes of learning or engaging students in their exploration of information and development of skills. These teachers also scheduled time for their students to use the computer lab or the class set of laptops within their school. Even though these teachers commented of the challenges to schedule access to the computer lab, the laptops on a cart, and even the science lab, they still rose above these challenges as they recognized the importance of providing these experiences and resources to their students.

These teachers also describe their perceived benefit of interactivity and enhanced engagement that using technology affords. This aspect of interactivity and engagement remains difficult to measure, recognize and evaluate. Additional professional development focused on student motivation will cause teachers to rethink their perception that technology’s capacity to engage students suffices to nurture students’ success as learners.
Table 13  
*Variety of Technology Formats in Use During this Study of ITIG Planned Instruction*

<table>
<thead>
<tr>
<th>Format of Technology</th>
<th>Purpose</th>
<th>Frequency of Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Storage space on a server or flashdrive</td>
<td>Students are able to complete an assignment in more than one class session and edit this work</td>
<td>1</td>
</tr>
<tr>
<td>Battery-powered electronic pointer or remote control</td>
<td>Teacher is able to direct students to a specific aspect of projected information</td>
<td>2</td>
</tr>
<tr>
<td>Laptops for use in a classroom</td>
<td>Individual student use of laptops to complete assignments</td>
<td>1</td>
</tr>
<tr>
<td>Headphones</td>
<td>Students are able to use auditory to focus on computer-based instruction</td>
<td>1</td>
</tr>
<tr>
<td>Computer lab with desktop computers</td>
<td>Individual student use of desktops to complete assignments</td>
<td>2</td>
</tr>
<tr>
<td>Document camera</td>
<td>Project student work for critique or worksheet to record student responses</td>
<td>4</td>
</tr>
<tr>
<td>Microsoft Office applications (Word &amp; PowerPoint)</td>
<td>Facilitate students’ competency Create legible sources of information for guided, interactive lectures</td>
<td>5</td>
</tr>
<tr>
<td>Teacher’s laptop</td>
<td>Projecting or sharing information during a lesson Facilitating students’ skill development to navigate Google Earth</td>
<td>10</td>
</tr>
<tr>
<td>Web sites</td>
<td>Provide engaging information in accessible format that is accurate</td>
<td>9</td>
</tr>
<tr>
<td>Traditional instructional technology</td>
<td>A range of resources that are often used by teachers and students</td>
<td>12</td>
</tr>
<tr>
<td>Digital or emergent technology</td>
<td>Newer formats that often depend on electrical energy to function</td>
<td>17</td>
</tr>
</tbody>
</table>

Collected data yielded a sense of how these teachers’ use of technology met their needs as instructional designers and facilitators of learning. Their decisions to choose specific formats of traditional instructional and emergent or digital technology were influenced by students’ needs. Through the reflective questions embedded in the ITIG and as part of the interviews, these teachers had much to share about the challenges they continue to face as instructional designers who have access to emergent forms of technology.
Teachers’ Thoughts and Hopes for Technology Integration

Reflecting on how technology supports their work as teachers and what it can do for students provided us with a range of expectations and concerns that often are presented as barriers in the research literature. These teachers also were given an opportunity to suggest enhancements or improvements for these instructional activities and shared ways that they felt technology would improve instruction. Their comments and my observations provide us with a sense of the potential for guided self-reflection to empower teachers to more consistently and effectively integrate technology as one of several resources and strategies to create meaningful instructional activities for their students.

Overall, teachers who used the ITIG described how the process of reflection guided them to reconsider and select additional forms of technology for instructional activities. They also provided examples of how the use of technology facilitates their work as teachers and benefits their students. In particular, two teachers, who represent new members of the profession, and who use emergent technology in their daily lives and enjoy using it in their classrooms, demonstrated the process of technology transparency (Bruce & Hogan, 1998) as the emerging and innovative uses of technology have become embedded features of their world and classrooms. This section of the chapter focuses in on these teachers’ future hopes for how technology can continue to support student learning. It also shares their ongoing concerns due to perceived barriers that were identified in the survey instrument they completed during the course of this study. Discussion of these desirable uses of technology and perceived challenges will help establish some direction for establishing supportive infrastructures in schools and designing teacher education initiatives and professional development sessions, to be discussed in Chapter 5.
Future thoughts. Thorough analysis of the triangulated data pinpointed desirable uses of technology that would enhance instructional activities. During interviews, these teachers also mentioned how their goals for upcoming professional development sessions would offer them additional tools to design activities to impact student learning as they take advantage of emergent technology. Please note the comments included in Figure 11.
<table>
<thead>
<tr>
<th>Details from the study - ITIG documentation</th>
<th>Quote from interview data</th>
<th>Researcher comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using digital pictures to help me show future students what they will be doing in the lab</td>
<td>Thinking to participate in training of interactive whiteboard and how to make PPT interactive. Same for the digital camera – using these devices &amp; tools to support SS instructional preparation.</td>
<td>Recognition that an image of the end product could offer another level of support for students to succeed in creating a tactile model of cells.</td>
</tr>
<tr>
<td>Develop a Google Earth lesson to preview or review the region</td>
<td>As I am planning a unit of study … I am incorporating two activities that require the use of technology.</td>
<td>Grasp of the power of newer digital tools to explain info or assess learning.</td>
</tr>
<tr>
<td>Find a sight to show how ancient Egypt looked</td>
<td>Take a virtual tour of places in the world – like the caves of Lascaux.</td>
<td>Valuing the virtual field trip experience as time is dedicated in class to visit relevant sites. Teacher encourages students to invest time at home to visit similar sites.</td>
</tr>
<tr>
<td>Find a game that the class could possibly play together using just the 3M machine</td>
<td>At times they get to vote on which math web site will be used – selecting one from a group of sites that are pre-selected. Limited amount of web sites that work for the content in 8th grade.</td>
<td>Seeking to harness the power of online activities to increase participation &amp; need for management of activity.</td>
</tr>
<tr>
<td>Students could each use a computer to access Google Earth… other sites available about …</td>
<td>If they each had a laptop or access to the labs (this was already booked so it was not possible) this would allow me to use another potential resource.</td>
<td>Reflects struggle to provide all students frequent access to laptop or desktop due to limited infrastructure or funds within district.</td>
</tr>
<tr>
<td>Taking pictures of the process for us to refer back to when reviewing</td>
<td>In one activity (being planned or created via tech) students will view landscape pictures … view pictures of archaeological …</td>
<td>Recognition of the power of images to help students recall an experience like a simulation or a field trip.</td>
</tr>
<tr>
<td>Students to have an interactive site where they could answer questions about …(topic)</td>
<td>If there would be an easy button to launch a web site and it would work. They can spend more time on an area of interest.</td>
<td>Conceptualizing the power of interactivity that is designed for specific instructional purposes – expressed interest to locate this for use.</td>
</tr>
</tbody>
</table>

Figure 11. Triangulated Data: Future Thoughts about Using Technology to Improve Activities
These teachers desired elements of technology to further customize for and bring to students’ attention ways of exploring information and experiencing processes that enhance and enrich the classroom setting. These teachers understood the power of virtual field trips, interactive activities and rich, accurate digital graphics and expressed a desire to start to capitalize on these emergent and customizable forms of technology. They recognize the need to allocate time to explore and become competent in using these emerging forms of technology to benefit their students.

**Ongoing concerns viewed as potential barriers.** These teachers were asked to share their concerns surrounding technology use, especially when they are planning and enacting instruction. During interviews and within the submitted ITIG they shared these concerns:

- “Before the lesson, is it working properly, does everything go as planned?”
- “It is questionable if there will continue to be funds to purchase consumable supplies.”
- “Students are not receiving an equal amount of exposure and involvement.”
- “There would be adequate computers so all students could use one.”
- “Getting [science] lab time could have been an issue, but it was resolved.”
- “Using the [computer] lab is always interesting. There were some computers that didn’t work and some students forgot their passwords, so it was time-consuming getting everyone started.”
- “Students’ lack of knowledge on how to perform certain tasks in Word; students unfamiliar with Office 03.”

Survey data also revealed the challenge these teachers perceived in prioritizing students’ development of technology skills and their expansion and application of content knowledge.
Table 14 shares the barriers listed within the survey these teachers completed during this study, and the ratings these teachers ascribed to these barriers.

Analysis of these ratings revealed concerns about access to the technology so all students can have comparable experiences to develop skills as a member of 21st century society. Time tends to be an ongoing concern in many studies of technology integration in educational settings. These teachers noted that the lack of time interferes with their capacity to collaborate and design technology-integrated projects to benefit their students. One potential explanation for these teachers’ eager use of technology and participation in this study is their access to mentoring, software and their realization that they possess some knowledge of technology while indicating the desire to learn more.
Table 14
*Ratings of Specific Barriers to Technology Use*

<table>
<thead>
<tr>
<th>Identified Barriers as Listed in the Survey Instrument</th>
<th>Ratings (# Indicating How Many Teachers Selected that Rating)</th>
</tr>
</thead>
</table>
| Lack of or limited access to computers in schools.     | Major Barrier (4)  
Minor Barrier (1)  
Not a Barrier (1) |
| Not enough software available in schools.              | Major Barrier (0)  
Minor Barrier (3)  
Not a Barrier (3) |
| Lack of knowledge about technology.                     | Major Barrier (1)  
Minor Barrier (4)  
Not a Barrier (1) |
| Lack of knowledge about ways to integrate technology into the curriculum. | Major Barrier (1)  
Minor Barrier (4)  
Not a Barrier (1) |
| The administrator doesn’t require technology use.       | Major Barrier (0)  
Minor Barrier (4)  
Not a Barrier (2) |
| There is too much material to cover.                    | Major Barrier (0)  
Minor Barrier (4)  
Not a Barrier (2) |
| Lack of mentoring to help me increase my knowledge about technology. | Major Barrier (0)  
Minor Barrier (1)  
Not a Barrier (5) |
| Technology-integrated curriculum projects require too much preparation time. | Major Barrier (3)  
Minor Barrier (2)  
Not a Barrier (1) |
| There isn’t enough time in class to implement technology-based lessons. | Major Barrier (0)  
Minor Barrier (4)  
Not a Barrier (2) |
| There is limited support and encouragement through collaboration to integrate technology. | Major Barrier (4)  
Minor Barrier (1)  
Not a Barrier (1) |

These teachers recognized the district’s desire for students to develop 21st century skills (aligning with their beliefs) as well as the district’s expectation that content area knowledge and skills are expanded and developed during the course of the academic year. Observations confirmed that these teachers used technology to support content knowledge transmission and students’ skill development (technological skill and content area skills). There were times (3 out
of 9 observations) that the entire class gained access to the computer lab or to the class set of laptops. One teacher noted how technology “helps me focus on the information to be shared and how I intend to discuss the details.” During two different instructional activities, individual students were able to use emergent technology to develop skills in the classroom (i.e., use of Google Earth, adding comments or details to a projection of a teacher-produced presentation). These observable details demonstrate that despite specific barriers, these teachers made concerted efforts to provide their students access to the technology that would help them develop desirable 21st century skills competencies.

During every observation, traditional instructional technology was employed by teacher and for student use to develop skills and to represent abstract concepts (i.e., atlases, tactile models, notebooks, paper, writing implements). Use of traditional instructional technology continues despite the presence of more emergent technology and devices for sharing information than some schools may have. This ongoing use of traditional instructional technology remains unquestioned for numerous reasons discussed in prior sections of this chapter. Funding of emergent resources, awareness of emergent resources (and how to use them) that may replace and improve upon these traditional instructional technologies, comfort and competence in using emergent technologies are some of several viable reasons for traditional instructional technologies’ presence in classrooms. In some cases, traditional instructional technologies may remain a more desirable resource for instruction than emergent and customizable resources. With all of these efforts to integrate and customize technology to meet students’ instructional needs, these teachers indicated that challenges remain in providing all students access to work independently on computers for a range of assignments and balancing all of the competing instructional demands within the constraints of the typical school day.
We also have to recognize that there are distinct differences in these teachers as individual technology integrators, as to be expected among any group of educators. Contextual and personal characteristics influence the degree to which an individual teacher will embrace or reject emergent technology for use in classrooms. Context, time, access, confidence and competence in the use of technology impact teachers’ decisions, as mentioned and concluded in many other studies of teachers’ use of technology (Bauer & Kenton, 2005; Hew & Brush, 2007; Zhao & Frank, 2003). This was also true in this study of these three teachers. The time that they felt they can invest in exploring technology to find appropriate resources or to create or customize resources for use with students also tended to impact their decisions and their level of technology adoption. These teachers communicated a need for more time to explore and practice navigating around web sites that provided relevant information for lessons or activities. As individuals they have taken advantage of the infrastructure their school district has provided. They expressed a desire to continue to explore and experiment with emerging forms of technology as well as to seek traditional instructional forms of technology that are affordable, as they became increasingly aware of budgetary limitations facing their school and district.

**The impact of guided self-reflection.** Another key characteristic of very good technology use, (Hammond, et al., 2009) concerns teachers who use technology very well have been known to take time to reflect upon their use of technology. Interview comments provide evidence of these teachers’ level of reflection about the use of technology.

- “[The ITIG] helped me become more technologically minded.”
- “[The ITIG] encouraged me to think about the value of technology.”
- “[The ITIG] helped me process the purpose of technology” [and look for] “a more effective way to use technology than I was planning.”
One ITIG user commented, “It may be an assumption that teachers reflect on their work” to express her perceptions. Through interviews and observations of her work with students in the classroom and her efforts to design instruction (that is responsive to students’ needs and aligned with district expectations and instructional standards), it became apparent that reflecting on instructional planning and its outcomes had become a key aspect of this teacher’s repertoire of skills.

Closing Thoughts

The teachers in this study planned instructional activities with consideration of mandated content standards and their students’ needs as learners. Through use of traditional instructional and emergent technology, these six teachers presented a more effective way for students to learn, adopt, and acquire skills for the present and for the future. Use of the ITIG increased these teachers’ awareness of their decisions as instructional designers and extended their perspective of which resources to use and how to effectively use them. Observations served as opportunities for teachers to demonstrate this connection between effective technology use and deploying effective instructional strategies (identified by one teacher as ‘best practices’). Beyond facilitating the creation of legible and customized resources, technology is used to increase the students’ capacity to grasp, understand and apply the content and skills stated within instructional goals.

Observations provided evidence of high levels of student engagement, not simply because these participants used technology, but there was a rationale for using technology to support a range of instructional goals and strategies. These teachers established a structure or process where the technology supported pedagogy, balanced discussion or dialogue between students and teacher, or questions and answers, of relevant concepts. Classroom management
techniques served as a foundation for the interconnected use of instructional technology, effective pedagogic strategies and selected resources as key elements of beneficial instructional settings. Technology was used to share the most accurate maps and scientific images, as well as provide visuals to enhance the quality of instruction. Students were often doing and not simply listening, since they used technology (traditional instructional and/or emergent) and applied information to problems or scenarios.

These teachers shared ideas for technology to be used in response to students’ needs as technology has become increasingly flexible, customizable and a natural part of our personal lives. Chapter 5 will focus on the impact of this study on the educational technology research agenda and the design and goals of teacher education and professional development.
Chapter 5
The Effect of Guided Self-Reflection on Technology Use

The Outcome of This Study

The purpose of this study was to investigate the effect of the ITIG on teachers’ instructional planning and technology use in classrooms. The teachers indicated that using the ITIG and referring to the taxonomies embedded in the ITIG encouraged them to rethink and consider other uses of technology as they planned and enacted instructional activities for their students. The initial piloting of the ITIG provided evidence that guided self-reflection and the process of documenting technology supported instructional planning had some impact on teachers’ instructional behaviors and technology use levels. Teachers who used the ITIG during instructional planning documented and chose to use more emergent technology use than was observed during the baseline observation interval of this study. These teachers also identified specific barriers to consistent and more frequent technology use that have been mentioned in prior research on technology integration in classrooms (Bauer & Kenton, 2005; Ertmer, 1999; Hew & Brush, 2007). After using the ITIG for three instructional planning intervals, these teachers viewed the process and planning tool as guiding them to reflect about their designed instructional plans and activities. As a piloted tool, the ITIG shows promise and requires further investigation of its benefit for a larger and more diverse group of teachers.

Further investigation of using a tool to document teachers’ reflection on technology integration, instructional planning and enactment may offer teachers an enhanced awareness of how technology becomes embedded and gains transparency (where emergent technology is an accepted and integral part of ongoing instructional activities – there is no turning back in the use or thought-process linked to specific technology; see Bruce & Hogan, 1998). These teachers
also shared some hopes or expectations of how highly creative, flexible and empowering
technology would increasingly penetrate the classroom so virtual field trips, scientific probes,
handhelds to record digital data, or other opportunities to travel, create and record data
electronically would provide students the rich experiences that all students can now have, (due to
innovations) once teachers are competent in the use of these specific forms of technology.

A review of all of the collected data (documented technology use in the submitted ITIG,
interviews, observations) revealed that teachers would benefit from a formalized instructional
planning process, such as the use of the ITIG. In this way, teachers would develop a deeper
understanding of their role as an instructional designer, who also demonstrates pedagogic skills
and specific content expertise. At more than one point, it became clearer that these teachers
recognized their need to learn more about technology and develop more strategies for successful
integration of content matter. They also indicated that reflecting about the technology they chose
to use (to determine how well technology supported the instructional activities they designed)
helped them acknowledge the value of technology. Reflection led them to think proactively as in
pinpointing the purpose of technology they identified more effective ways to use technology
with their students.

Analyses of collected data revealed the extent to which teachers blended traditional
instructional technology with digital or emergent technology found in their classrooms or
discovered as they invested time to design instructional activities. These teachers emphasized
that their choice of instructional resources and technology was predicated on their level of
competency and confidence in using it to model specific tasks or to encourage students to use the
technology. These teachers also recognized that effective communication and management of
classroom activities were crucial for students to gain the most from technology-integrated
instruction. Technology served as one element or tool to design effectively transmitted and implemented instructional activities. Selecting resources that contain accurate and legible content was a starting point. These teachers valued accurate and relevant information shared through technology applications, devices or databases as another essential element of their success as instructors or facilitators.

**Discussion**

The outcome of this pilot study relates to several issues raised in the educational technology research literature. Beyond demonstrating the relevance of the study’s findings, this section of Chapter 5 addresses how ongoing use of the ITIG has the potential to help educators in several ways as they develop skill as instructional designers and technology integrators. Through guided self-reflection, teachers can become sensitized to and increasingly recognize the benefits, shortcomings and unanticipated consequences of using technology in classrooms. Increasingly we notice the information explosion requiring critical thought and examination to determine if sources are accurate or biased. Teachers and students benefit from reflective practice, especially if reflection becomes a core process within class discussion and analysis of instructional texts.

As shared in Chapter 1, technology is a thought process and teachers are obligated to become thoughtful and critical users of devices and applications just as they are held accountable for student outcomes and academic growth. Embedding this thought process about technology use within the instructional planning process has the potential to encourage effective instruction. Using the ITIG can help teachers document and describe exemplar uses of technology-supported instruction and offer researchers and stakeholders a meaningful measurement or snapshot of how technology is being used in classrooms.
Relevance. Time and again, many of our schools provide teachers with emergent technology. If it were not for some teachers’ curiosity and diligence to investigate, explore and create (often reported as a minority of teachers within schools) with technology (both applications and devices), many of these emergent educational tools would continue to exist but would rarely be used by teachers or students (as described by Cuban, Kirkpatrick and Peck, 2001, and other studies included in the literature review). As mentioned in this study and others, investigating the power and benefit of technology for learners requires time to explore, which is often viewed as a luxury. Additionally, teachers may receive negative administrative or parental feedback when an experiment with technology yields an unfavorable outcome. The literature on the adoption of innovation theories has mentioned the need for tolerance to allow mistakes to happen, especially when the mistake yields an enhanced understanding of technology use and viable solution to a problem (Rieber & Welliver, 1989; Sherry, Billig, Tavalin, & Gibson, 2000).

Other literature shared in Chapters 1 and 2 brought to our attention the need to encourage and support teachers’ cyclical evaluation of the outcomes of instructional plans, with a focus on technology use, to yield identification of exemplar uses of technology (Gülbahar, 2007; Kopcha, 2008; Vrasidas & Glass, 2007). The piloted ITIG is intended to facilitate cyclical evaluation of instructional plans so reflective practice becomes an embedded aspect of teachers’ practice; a desired goal of recent research in Australia (see Fitzallen, 2004; Trinidad, Newhouse, & Clarkson, 2005, 2002) that contributed to the design of the ITIG (and documents used to collect data for this pilot study). Additional investigation of teachers’ consistent use of the ITIG for instructional planning over a longer time interval would offer an opportunity to determine the ITIG’s capacity to support the embedding of reflection within teachers’ daily practice. Further research investigating the use of the ITIG can also ascertain if consistent and meaningful
technology integration can nurture technology transparency and instructional practices that are perceived as effective and responsive to students’ needs as learners.

**Technology as thought process.** Providing teachers a vehicle to reflect and document their decisions as instructional designers increases teachers’ recognition that using technology requires thought about its impact and consequences (unanticipated and counterproductive) (see Ellul, 1964; Finn, 1960; Heinich, 1984). With the increasing sophistication and automaticity of emergent and digital technology, and the increasing need to think critically as to the quality of information shared in web 2.0 supported media, teachers and students will continually require supports to consider and reflect upon the benefits of the technology and media used in classrooms and for all sorts of learning situations (traditional, experiential, informal).

**Measuring technology use.** As shared in Chapter 2, massive expenditures of governmental and private sector funds to bring innovative uses of technology and devices to classrooms encouraged measuring technology use levels. The tendency to count or report how many times per week or month a device or application is used separates the use of technology from its purpose and context. This study did ask teachers to complete a survey that included comparable questions about their level of technology use. In addition, the completion and submission of the ITIG, along with observations provided a sense of how well suited the use of technology would be for a specified instructional activity for a defined student population. Determining the value of technology as it is used within its context and defining effective technology use within the constraints and affordances of a context are two goals of the ITIG piloted in this study. The piloting of a tool and related instruments to capture and describe technology use levels within its context could improve our understanding if financial investments in schools’ technological infrastructure are prudently spent.
**Documenting exemplar uses of technology.** The outcome of this pilot study of the ITIG as an instructional planning tool offers the research community a vehicle for collecting examples of effective and less effective uses of technology by teachers, for students, and by students. If teachers used a structured format to describe their instructional plans to include their use of technology, teacher educators would have scenarios for critiquing or ascertaining the activity’s educational value. Due to the ease of access and its increasing presence, more teachers today visit Web 2.0-based repositories of instructional ideas, which may not have the details that the ITIG included (to guide teachers to consider a range of technology uses and notate strategies) to enact the documented learning activity typically provided in these popular, online collections.

Consistent use of an instructional planning tool, like the ITIG, has the potential to address these varied needs within the educational technology research community (as shared in Chapter 2): (a) document effective exemplar technology-supported lessons, (b) encourage reflective practice and in turn impact or transform the quality of instruction, (c) extend teachers’ awareness of alternative and innovative ways to integrate technology, (d) measure technology use within its context for a better assessment as to its educational benefit and financial value, and (e) cyclically evaluate technology use to maximize its impact on student learning.

**Addressing This Study’s Limitations**

There were several limitations to this qualitative study. The limitations are due to decisions related to the duration of the study, the piloting of newly created instruments such as the instructional planning tool, survey instrument, observation and interview protocols, and the type of teachers that participated in this study.

As mentioned in Chapter 4, the teachers in this study used the ITIG for a limited time (during a three to four month interval). Further investigation of the benefit of the ITIG is
needed, especially over a longer time interval, hopefully during an entire academic year. In this way, researchers and practitioners can determine if using guided self-reflection, documenting and evaluating technology integration decisions can impact teachers’ instructional behaviors and students’ learning.

After developing and piloting the ITIG, an ongoing goal would be to determine through repeated use by multiple teachers if indeed the ITIG is a viable and beneficial tool to document and enhance technology integration that benefits students. Additional research to collect evidence and feedback as to its benefit and impact on technology use levels and decisions is required to determine if the group of instruments (created and modified for this study) facilitates the collection of data that continue to meet the criteria of trustworthiness (comparable to reliability and validity), especially confirmability, creditability, dependability and transferability.

In Chapter 3, I described the teachers in this pilot study as individuals who understood the benefit of technology integration. Comments shared during interviews and observations made it obvious that these teachers chose to use technology for teaching and expected students to use technology for learning. These teachers’ beliefs, actions and characteristics yielded evidence that the ITIG has potential benefit to document and evaluate technology integration decisions.

Reality in many schools forces us to acknowledge that there are teachers who remain tentative and reluctant to integrate technology. There are also indicators that students may not use technology as extensively as this study’s teachers or as anticipated by other innovative researchers and the public. The characteristics of the teachers who participated in this study is another limitation of this pilot study. Future studies piloting or investigating the ITIG as an instructional planning tool would seek out the tentative and reluctant technology user, in order to determine if guided self-reflection would alter these teachers’ attitudes on technology integration
and students’ use of technology. Consistent use of an instructional planning tool has the potential to encourage teachers to extend their awareness and comfort with technology and in turn alter their decisions as instructional designers and technology integrators.

**Future Studies**

Due to this pilot study’s limitations, future studies exploring the benefit of the ITIG would initially address these limitations. Findings from these future qualitative studies would offer evidence of the instructional planning tool’s dependability, creditability and transferability for any teacher in any instructional setting. The ITIG was designed for use at any grade level and to guide or document instruction in any content area. There remains a need to determine if the combination of the instructional planning tool, observation and interview protocol and study design are viable as a framework to encourage and support increasing levels of technology integration due to mindful, intentional and meaningful uses of technology in response to curricular goals and students’ instructional needs. With each replicative, qualitative study, the design of these tools and protocols is challenged and refined to help the research community better grasp the issues surrounding technology integration in classrooms.

Another key question remains: how sustainable are the preliminary changes in teachers’ instructional planning decisions and behaviors surrounding technology integration? Longer term and more consistent use of the ITIG and these protocols could help us ascertain the tipping point when teachers perceive technology’s transparency. It is equally important to ascertain under which circumstances technology integration becomes embedded practice.

A further two-pronged issue that was not addressed in this study design related to critical thinking about the outcomes of technology use and the need to encourage students to look critically at the sources they use to locate information for an assignment. I sense that once
researchers and teacher educators encourage and support teachers and students in the critical thought surrounding technological determinism, technology’s value, shortcomings, unanticipated consequences, and the accuracy or bias in digital sources of information, teachers, administrators and parents will feel more in control of the technology we can use innovatively in our classrooms so students gain proficiency in 21st century workforce and citizenry skills.

**Implications for teacher education.** Through the ongoing examination of how guided self-reflection and the use of a standardized instructional planning tool document technology integration decisions, researchers can distill desirable strategies and mindsets for emphasis in teacher education experiences and coursework. With increasing evidence that guided self-reflection promotes more effective and consistent technology use while students are engaged in meaningful learning experiences, then providing pre-service teachers opportunities to understand the role of reflection in teaching becomes necessary. The process of reflection is rather sophisticated and requires guidance and scaffolding to impact the quality of instructional planning and behaviors. The literature on reflection (see Brookfield, 1995; Mezirow, 2000) reveals the complexity and multiple stages of reflection, so it becomes necessary for teachers (as well as other educators) to be coached in the reflective process. Administrators may need to allocate time to continue to nurture and help teachers extend their capacity to reflect upon classroom events and instructional planning outcomes. Faculty who train school administrators also could support the acquisition, adoption and embedded use of reflective practice within school settings.

Many schools of education offer a required course for pre-service teachers to discuss and learn how to integrate technology for a specific content area and for a specific age-range student. Often such courses are mandated by states’ Boards of Regents. The outcome of this study and
future studies of an instructional planning tool can offer teacher educators exemplar lessons or case studies for class discussion or for pre-service teachers’ analyses. Future teachers can use these exemplars as a model for instructional design assignments they may have. Researchers recognized the importance of pre-service teachers learning from models or mentors of technology integration (see Doering, et al., 2003; Ertmer, et al., 1994, Hughes, et al., 2005). They noted that exposure to mentors or models (of technology integration, not just content) during teacher training or internships was a predictive factor of these novice teachers’ capacity to integrate technology more frequently and meaningfully than other teachers. Developing reflective practice during pre-service training and internships has the potential to establish a foundation of reflective practice impacting meaningful technology integration levels and overall instructional quality.

Implications for professional development of in-service teachers. As shared in the prior section of this chapter, the process of critical reflection is a challenging skill to apply on a consistent basis. The cognitive demands of critical reflection (see Preskill and Brookfield, 2009) warrant consideration of providing scaffolded experiences to facilitate teachers’ capacity to critically reflect on teaching practices and classroom activities. Introducing an instructional planning tool that scaffolds and nurtures critical reflection would support teachers in becoming reflective about instructional practices and behaviors. Linking reflection on instructional planning with decisions surrounding technology integration can also influence technology use decisions in classrooms (see Fitzallen, 2004; and Trinidad, et al., 2005). Stakeholders and the public are continually eager to observe increasing and meaningful technology use in classrooms (Dickard and Education Development Center, Inc., 2003; OTA, 1995). Classroom teachers can benefit from supportive structures and processes to conceptualize and plan meaningful
technology-integrated instructional activities. Through enhanced awareness of the link between effective technology integration and instructional design, teachers’ instructional planning can yield sought-after outcomes for students.

Many in-service teachers recognize their ongoing need for professional development regarding technology skills, much like the teachers in this study. Any support that could help teachers identify areas for personal development of pedagogy and technology skills (knowing how to use technology, knowing how to integrate technology and knowing how to guide students to use technology in meaningful ways) has value within the research community and for stakeholder decision-making. The instructional planning tool piloted in this study can offer stakeholders useful insights as to professional development topics that address teachers’ identified needs and interests. The inclusion of two taxonomies (Maddux, Johnson, & Willis, 1997; Small, 2005) offered teachers and administrators a glimpse at potential uses of technology to support students and teachers. The reflective questions can guide teachers to decide how they want to extend their repertoire of skills and competency in using technology (devices and applications). Teachers can also gain an increasing sense of the consequences (see Chandler, 1995; Ellul, 1964; Pannabecker, 1991; Salomon, 1998) and cultural implications (Wajcman, 1991) for designing and using technology with students.

**Concluding thoughts.** The pilot study of the ITIG yielded preliminary evidence of its value for guiding teachers to recognize and document technology as a supportive element of instructional activities. Use of the ITIG as a tool (for instructional planning and implementation) provided practitioners a systematic process to document: (a) their role as a mediator of technology, (b) their rationale for selecting technology that is additive and facilitates decision-making, (c) the process of guided self-reflection determining how technology facilitated
instructional activities and student learning, and (d) a practitioner’s evaluation as to the effectiveness of this specified technology use in classrooms.

The teachers in this study demonstrated the tendency to blend the use of traditional instructional and digital or emergent technology in order to create meaningful instructional activities to address their students’ needs. They began to recognize their role as an instructional designer through their investigation of technologies listed in the taxonomies embedded in the ITIG. The process of critical reflection remains one aspect of teaching that requires scaffolding to become a consistent, embedded practice with fundamental and far-reaching decisions.

Ongoing research and introduction of critical reflective practice into teachers’ repertoire of skills holds promise to nurture consistent and meaningful use of technology and transformative instructional practices in schools. If we acknowledge the exponential rate of change in how technology has impacted our society, we also recognize the importance of providing teachers with a systemic process to think through the ways technology supports teaching and learning, for both teachers and students.
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Appendix A
The Informed Technology Integration Guide

<table>
<thead>
<tr>
<th>Teacher's Name</th>
<th>Grade level</th>
<th>Instructional Subject</th>
</tr>
</thead>
</table>

District’s or School’s Definition of Effective Technology Integration:

Teacher’s Definition of Effective Technology Integration for this lesson:

Unit or Topic:

Time frame:

- # of lessons to cover this topic:
- Dates:
- Length of Instruction (pick one) – Day --- Week -- ______ # of minutes

Instructional Goals:

Instructional Objectives:

This lesson/ activity is aligned to the following

<table>
<thead>
<tr>
<th>Content standards &amp; Benchmarks:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Language Arts:</strong> Standards &amp; Benchmarks</td>
</tr>
<tr>
<td><strong>Mathematics:</strong> Standards &amp; Benchmarks</td>
</tr>
<tr>
<td><strong>Social Studies:</strong> Standards &amp; Benchmarks</td>
</tr>
<tr>
<td><strong>Sciences:</strong> Standards &amp; Benchmarks</td>
</tr>
<tr>
<td><strong>Foreign Language:</strong> Standards &amp; Benchmarks</td>
</tr>
<tr>
<td><strong>Fine Arts:</strong> Standards &amp; Benchmarks</td>
</tr>
<tr>
<td><strong>Physical Education:</strong> Standards &amp; Benchmarks</td>
</tr>
</tbody>
</table>
This lesson/activity is aligned to the following technology standards:

NETS-Teachers: (http://cnets.iste.org/Teachers/t_stands.html)

NETS-Students: (http://cnets.iste.org/students/s_stands.html)

Differentiation details:
Which resources or materials are customized to meet specific students' needs?

Any specific directions:

Accommodations:
Specify which students are using specific assistive devices or alternate materials.

Indicate which students have additional time to complete the activity, and describe alternate conditions these students may be granted to complete this work.

Indicate which specific students receive services from interventionists, therapists or practitioners and indicate the form of services they receive.

List specific resources needed for successful implementation of this lesson sequence.

List specific devices & applications needed for successful completion of this lesson sequence.

Are you implementing Type I or Type II uses of technology? (Maddux, Johnson & Willis, 1997)

Please highlight the uses of technology that apply to this instructional plan.

<table>
<thead>
<tr>
<th>Type I uses</th>
<th>Type II Uses</th>
</tr>
</thead>
<tbody>
<tr>
<td>◦ Software like Accelerated Reader</td>
<td>◦ Word processing to create documents</td>
</tr>
<tr>
<td>◦ Educational games</td>
<td>◦ Spreadsheets</td>
</tr>
<tr>
<td>◦ Study guides</td>
<td>◦ Databases</td>
</tr>
<tr>
<td>◦ Tutorials</td>
<td>◦ Simulations</td>
</tr>
<tr>
<td>◦ Using a word processor to type words</td>
<td>◦ Online research</td>
</tr>
<tr>
<td></td>
<td>◦ Problem-solving software</td>
</tr>
<tr>
<td></td>
<td>◦ Assistive devices</td>
</tr>
<tr>
<td></td>
<td>◦ Digital cameras</td>
</tr>
<tr>
<td></td>
<td>◦ Virtual experiences</td>
</tr>
<tr>
<td></td>
<td>◦ Presentation software</td>
</tr>
<tr>
<td></td>
<td>◦ Graphing calculators</td>
</tr>
<tr>
<td></td>
<td>◦ Video cameras</td>
</tr>
<tr>
<td></td>
<td>◦ Integrated projects</td>
</tr>
</tbody>
</table>
Consider these uses of technology and select which use aligns with this activity/lesson:

Please highlight the uses of technology that apply to this instructional plan.

<table>
<thead>
<tr>
<th>Tier 1: teacher focus on productivity</th>
<th>Tier 2: instructional presentation</th>
<th>Tier 3: Student-Centered</th>
</tr>
</thead>
<tbody>
<tr>
<td>o Locate standards using electronic tools to align lessons</td>
<td>o conduct one-computer classroom lessons</td>
<td>Enable students to:</td>
</tr>
<tr>
<td>o Find Instructional resources on the Internet</td>
<td>o deliver presentations with graphics &amp; sound</td>
<td>o create &amp; use online resources</td>
</tr>
<tr>
<td>o Produce, store, retrieve learning materials electronically</td>
<td>o lead students in brainstorming</td>
<td>o essential questions → inquiry</td>
</tr>
<tr>
<td>o Keep/organize student information, grades more effectively</td>
<td>o represent information visually</td>
<td>o student use of technology</td>
</tr>
<tr>
<td>o Communicate information</td>
<td>o facilitate group discussions</td>
<td>o research, analyze in global context to solve problems</td>
</tr>
<tr>
<td>o to parents &amp; students via the web</td>
<td>o have students write papers using computers or “smart keyboards”</td>
<td>o use of models &amp; simulations</td>
</tr>
<tr>
<td>o or email</td>
<td>o create scaffolding for students</td>
<td>o write, develop, publish projects</td>
</tr>
<tr>
<td>o Communicate quickly with Email</td>
<td>o facilitate students using technology for assessment</td>
<td>o invent products</td>
</tr>
<tr>
<td>o Email</td>
<td>o interactively communicate with parents &amp; students</td>
<td>o create scaffolds for student use</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o involve parents &amp; teachers &amp; analyze data-develop learning plan</td>
</tr>
<tr>
<td></td>
<td></td>
<td>o initiate communication among students, parents, teachers, etc.</td>
</tr>
</tbody>
</table>

Prior knowledge (students are using in this lesson sequence):

Specific vocabulary (terminology and concepts to be used and introduced):

Description of activity & flow of the lesson(s):

How are students using technology?

Are students cognitively or intellectually challenged? Please explain.

Form of Assessment of student learning: (How do you know students gained skills & knowledge?)

Reflection:  
What went well?  
Potential modifications:

How well did your selection of technologies support the instructional plan? Elaborate.

What is the value of having students use technologies?
<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>How did the technology support your teaching?</td>
<td></td>
</tr>
<tr>
<td>How did the technology support students in their learning and exploration of a topic/skill?</td>
<td></td>
</tr>
<tr>
<td>Which other forms of technology could be used to enhance this lesson or activity?</td>
<td></td>
</tr>
<tr>
<td>Were they any obstacles to the success of this instructional activity(s)? Describe them and suggest potential remedies.</td>
<td></td>
</tr>
<tr>
<td>What are the main purposes for using technology with your students?</td>
<td></td>
</tr>
<tr>
<td>What benefits do your students gain in using technology?</td>
<td></td>
</tr>
<tr>
<td>What unexpected challenges occurred during the lesson/activity?</td>
<td></td>
</tr>
<tr>
<td>Follow-Up activities or next steps:</td>
<td></td>
</tr>
</tbody>
</table>
## Appendix B
### Interview Protocol

<table>
<thead>
<tr>
<th>Questions</th>
<th>Response</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What are the main purposes you want to use ICT for with your students?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. What are you focusing on at the moment in the use of ICT?</td>
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<tr>
<td>3. What is the value in having your students use a computer?</td>
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<td></td>
</tr>
<tr>
<td>4. How does ICT fit into your teaching overall?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. How often do your students use ICT?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Independently</td>
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<td></td>
</tr>
<tr>
<td>b. Collaboratively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. What teaching strategies have you used, and do you use consistently, where ICT is involved?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Concerning your students’ use of ICT, how does this use support the demonstration of instructional standards?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. What potential do you see for ICT to support learning and teaching processes with your class?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. What do you see as your main role(s) when using ICT with your students?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. What roles do students have as they use ICT?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questions</td>
<td>Response</td>
<td>Comments</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>----------</td>
<td>----------</td>
</tr>
<tr>
<td>11. In what way(s) are students encouraged to contribute to decisions concerning ICT use in your classroom?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. What skills do you have in using ICT in your classroom?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. What steps do you need to take to further develop your skills in using ICT?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. How do you feel when you use ICT?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. How do you feel when your students use ICT?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. What concerns do you currently have for the way in which ICT is used to support teaching and learning?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Interview Questions from Newhouse, Trinidad, and Clarkson (2002)

#### Appendix C

<table>
<thead>
<tr>
<th>Communiites to Contribution</th>
<th>Overlap</th>
<th>View of ICT</th>
<th>Principle</th>
<th>Purpose</th>
<th>Vision &amp; Contribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>How does ICT influence learning?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(or NR or OK)</td>
</tr>
<tr>
<td>What role does ICT play in the classroom?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(or NR or OK)</td>
</tr>
<tr>
<td>How do you see ICT being integrated into the curriculum?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(or NR or OK)</td>
</tr>
<tr>
<td>What impact does ICT have on student learning?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(or NR or OK)</td>
</tr>
<tr>
<td>How do you see ICT being used in different subject areas?</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(or NR or OK)</td>
</tr>
</tbody>
</table>

**Steps to Progress**

- (c) Select the appropriate implementation phase for each ICT.
- (d) Analyze the impact of ICT on the learning environment.
- (e) Evaluate the efficiency of ICT integration.
- (f) Implement strategies for sustainable ICT use.

**Stage of Dialogue**

Layer Three Instrument: Stages of Dialogue

- (c) Reflect on the learner's perspective of the technology and its influence on learning.
- (d) Synthesize the insights gained from the learner's experience with the technology.
- (e) Explore the implications of the learner's perspective on future technology integration.
- (f) Summarize the key points and conclusions drawn from the dialogue.
<table>
<thead>
<tr>
<th><strong>INTEGRATION &amp; USE</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency of use</strong></td>
<td>Is there any pattern to your ICT usage? How often do your students use ICT? Do they work independently or in groups?</td>
</tr>
<tr>
<td><strong>Implementation strategies</strong></td>
<td>What teaching strategies have you used, and do you use consistently where ICT is involved? How do you decide on the strategy you use?</td>
</tr>
<tr>
<td><strong>Type of activities and pedagogy</strong></td>
<td>What activities have you used computers for in the last term?</td>
</tr>
<tr>
<td><strong>Tasks for applications</strong></td>
<td>To what tasks have you applied computers during the last term? How have you determined those tasks?</td>
</tr>
<tr>
<td><strong>Assessing student learning outcomes</strong></td>
<td>Have you assessed work that students have done with ICT? How has this been included with your overall assessment processes?</td>
</tr>
<tr>
<td><strong>Relevance of ICT to content</strong></td>
<td>In what ways do you connect what the students do with ICT and the way ICT is used in our society?</td>
</tr>
<tr>
<td><strong>Achievement of CF overarching outcomes</strong></td>
<td>In what ways does the use of ICT by your students support the demonstration of the CF overarching outcomes?</td>
</tr>
<tr>
<td>Support Required to Progress</td>
<td></td>
</tr>
<tr>
<td>------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>Concerns</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Affecive Response</strong></td>
<td></td>
</tr>
<tr>
<td><strong>ICT Skills</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Use of ICT</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Source of Direction for</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Roles of Teacher and Students</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Potential Uses of Support Learning and Teaching</strong></td>
<td></td>
</tr>
</tbody>
</table>

Teacher ICT Capabilities & Feelings

Discuss above.

In a few words, address how you currently have:

- What concerns do you currently have?
- Are you confident in using ICT?
- Do you support your students in using computerised? How do you feel when you use a computer and when you support your students in using computerised?

What skills do you have in using ICT and what skills do you need to develop the skills you need?

What ways are you students permitted to contribute to discussions about the use of ICT in your class and what do your views as students mean to you?

When and how do you use ICT with your class? What do you see and how does it impact your teaching and learning?

What potential do you see for ICT to support learning and teaching?
Observation Protocol – Effect of Guided Self-Reflection

Participant ID # _____

Date of Observation ____________________

Focus of instructional activity: ______________________________________

Content area: __________________________________________

Instructional Goals & Objectives: ____________________________________

Type of resources in use: ________________________________________

Names: _______________________________________

Strategies in use: ___________________________________________________

Description of activity: (field notes – added electronically)

Implementation of Type I or Type II uses of technology? (Maddux, Johnson & Willis, 1997)

Highlighted uses of technology that apply to this observed instructional activity.

Type I uses

◊ Software like Accelerated Reader
◊ Educational games
◊ Study guides
◊ Tutorials
◊ Using a word processor to type words

Type II Uses

◊ Word processing to create documents
◊ Spreadsheets
◊ Databases
◊ Simulations
◊ Online research
◊ Problem-solving software
  ◊ Assistive devices
  ◊ Digital cameras
◊ Virtual experiences
  ◊ Presentation software
◊ Graphing calculators
◊ Video cameras
◊ Integrated projects

Observed uses of technology with this activity/lesson:

Highlighted uses of technology as observed in this instructional activity.

Tier 1: teacher focus on productivity

- Locate standards using electronic tools to align lessons
- Find Instructional resources on the Internet
- Produce, store, retrieve learning materials electronically
- Keep/organize student information, grades more effectively
- Communicate information
- to parents & students via the web
- by email
- Communicate quickly with
- Email

Tier 2: instructional presentation

- conduct one-computer classroom lessons
- deliver presentations with graphics & sound
- lead students in brainstorming
- represent information visually
- facilitate group discussions
- have students write papers using computers or “smart keyboards”
- create scaffolding for students
- facilitate students using technology for assessment
- interactively communicate with parents & students

Tier 3: Student-Centered

Enable students to:

- create & use online resources
- essential questions → inquiry
- student use of technology
- research, analyze in global context to solve problems
- use of models & simulations
- write, develop, publish projects
- invent products
- create scaffolds for student use
- involve parents & teachers & analyze data-develop learning plan
- initiate communication among students, parents, teachers, etc.
Comments (reflecting on observation):

Comments during interview (discussion with participant after the observation of the lesson described in these field notes):

Instructional activity coding:

<table>
<thead>
<tr>
<th>Instructional activity</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>L</td>
<td>Teacher is lecturing to the group of students</td>
</tr>
<tr>
<td>Lecture with discussion</td>
<td>LD</td>
<td>Teacher-led lecture, with periodic student discussion or comments</td>
</tr>
<tr>
<td>Class discussion</td>
<td>CD</td>
<td>Students are primarily discussing an intentional topic</td>
</tr>
<tr>
<td>Small group discussion</td>
<td>GD</td>
<td>groups of students are discussing intentional topics</td>
</tr>
<tr>
<td>Problem modeling by teacher</td>
<td>PM</td>
<td>Teacher is demonstrating how to execute a task</td>
</tr>
<tr>
<td>Student presentation</td>
<td>SP</td>
<td>Student(s) presenting information to peers – may be planned or on-demand</td>
</tr>
<tr>
<td>Teacher demonstration</td>
<td>D</td>
<td>Teacher is demonstrating a procedure to the students</td>
</tr>
<tr>
<td>Questioning by teacher</td>
<td>Q</td>
<td>Teacher poses questions to students</td>
</tr>
<tr>
<td>Students responding</td>
<td>SR</td>
<td>Students answer questions posed by teacher – may include choral response</td>
</tr>
<tr>
<td>Manipulatives</td>
<td>M</td>
<td>Students are using concrete materials or realia to understand abstract concepts</td>
</tr>
<tr>
<td>Learning center</td>
<td>LC</td>
<td>Students are using planned activities individually or in small groups – could be computer application</td>
</tr>
<tr>
<td>Anchored or sponge activity – before a lesson</td>
<td>ASB</td>
<td>Teacher presents activity to prepare students for new learning</td>
</tr>
<tr>
<td>Anchored or sponge activity – during a lesson</td>
<td>ASD</td>
<td>Students complete an activity to learn new information or skill</td>
</tr>
<tr>
<td>Anchored or sponge activity – after a lesson</td>
<td>ASA</td>
<td>Activity follows the presentation of new information or skill for further practice or application</td>
</tr>
<tr>
<td>Seat work – individualized</td>
<td>SI</td>
<td>Students independently work on academic materials</td>
</tr>
<tr>
<td>Seat work – group</td>
<td>SG</td>
<td>Students form groups to work on academic materials</td>
</tr>
<tr>
<td>Instructional activity</td>
<td>Code</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>CL</td>
<td>Students are organized to complete a task through collaboration/cooperation</td>
</tr>
<tr>
<td>Role playing</td>
<td>RP</td>
<td>Students re-enact a scenario to problem solve</td>
</tr>
<tr>
<td>Teacher interacting with one student</td>
<td>TIS</td>
<td>Teacher individually helps or assists one student</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Instructional activity</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher interacting with small group</td>
<td>TIG</td>
<td>Teacher guides small group of students to explain, re-teach, provide focused instruction</td>
</tr>
<tr>
<td>Technology use by teacher</td>
<td>TT</td>
<td>Teacher uses technology to present instructional content</td>
</tr>
<tr>
<td>Technology use by students</td>
<td>TS</td>
<td>Students use technology related to learning activity</td>
</tr>
<tr>
<td>Assessment activity</td>
<td>A</td>
<td>Students are completing a formalized assessment activity</td>
</tr>
</tbody>
</table>

1. **Note:** The Coding System for Instructional Activities was first shared in the following article:


J. Cassady gave me permission to use these codes in my research, as per personal communication dated November 16, 2009.
### Appendix E

#### The Differentiated Classroom Observation Scale

<table>
<thead>
<tr>
<th>Instructional Activity Code</th>
<th>Instructional Activity</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>L</td>
<td>Lecture</td>
<td>L</td>
<td>Teacher lecturing to group of students</td>
</tr>
<tr>
<td>LD</td>
<td>Lecture with Discussion</td>
<td>LD</td>
<td>Teacher-led lecture, with periodic student discussion (recitation)</td>
</tr>
<tr>
<td>CD</td>
<td>Class Discussion</td>
<td>CD</td>
<td>Discussion in class, students are primary discussants</td>
</tr>
<tr>
<td>GD</td>
<td>Small Group Discussion</td>
<td>GD</td>
<td>Discussion in class, but in small groups, not whole group</td>
</tr>
<tr>
<td>PM</td>
<td>Problem Modeling by Teacher</td>
<td>PM</td>
<td>Teacher demonstrating how to execute a task (e.g., working a math problem on board)</td>
</tr>
<tr>
<td>SP</td>
<td>Student Presentation</td>
<td>SP</td>
<td>Student(s) presenting information to the class (either planned presentation or on-demand task)</td>
</tr>
<tr>
<td>D</td>
<td>Demonstration by Teacher</td>
<td>D</td>
<td>Teacher demonstrating a procedure to the class (e.g., how to safely use lab equipment)</td>
</tr>
<tr>
<td>Q</td>
<td>Questioning by Teacher</td>
<td>Q</td>
<td>Teacher asking question of student(s) in group setting</td>
</tr>
<tr>
<td>SR</td>
<td>Student Responding</td>
<td>SR</td>
<td>Student(s) answering questions posed by the teacher (choral response included in this category)</td>
</tr>
<tr>
<td>M</td>
<td>Manipulatives</td>
<td>M</td>
<td>Student(s) working with concrete materials to illustrate abstract concepts (e.g., math blocks)</td>
</tr>
<tr>
<td>C</td>
<td>Cubing</td>
<td>C</td>
<td>Student(s) working with cubing curriculum materials (differentiated, see Adams &amp; Pierce [in press] for details)</td>
</tr>
<tr>
<td>LC</td>
<td>Learning Center(s)</td>
<td>LC</td>
<td>Student(s) working at planned learning center(s) individually or in small groups (computer stations can be included if they are planned activities)</td>
</tr>
<tr>
<td>Instructional Activity</td>
<td>Code</td>
<td>Description</td>
<td></td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Anchored activity before lesson</td>
<td>AB</td>
<td>Use of lesson-anchoring materials prior to teacher presentation of content. (see Adams &amp; Pierce [in press] for details).</td>
<td></td>
</tr>
<tr>
<td>Anchored activity during lesson</td>
<td>AD</td>
<td>Use of lesson-anchoring materials during teacher presentation of content.</td>
<td></td>
</tr>
<tr>
<td>Anchored activity after lesson</td>
<td>AA</td>
<td>Use of lesson-anchoring materials after teacher presentation of content.</td>
<td></td>
</tr>
<tr>
<td>Seat work – Individual</td>
<td>SWI</td>
<td>Student(s) working at desk on academic materials (independently).</td>
<td></td>
</tr>
<tr>
<td>Seat work – Group based</td>
<td>SWG</td>
<td>Student(s) working at desk on academic materials (groups).</td>
<td></td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>CL</td>
<td>Students working in a planned cooperative structure to complete a task.</td>
<td></td>
</tr>
<tr>
<td>Role Playing</td>
<td>RP</td>
<td>Student(s) engaged in role playing exercises (e.g., “playing store” to practice counting change).</td>
<td></td>
</tr>
<tr>
<td>Teacher interacting with individual student</td>
<td>TIS</td>
<td>Teacher working with/talking to/helping individual student.</td>
<td></td>
</tr>
<tr>
<td>Teacher interacting with small group</td>
<td>TIG</td>
<td>Teacher working with/talking to/helping small group of students.</td>
<td></td>
</tr>
<tr>
<td>Technology use – Students</td>
<td>TS</td>
<td>Technology being used by students for related learning activities.</td>
<td></td>
</tr>
<tr>
<td>Technology Use – Teacher</td>
<td>TT</td>
<td>Technology being used by the teacher for presenting instructional content.</td>
<td></td>
</tr>
<tr>
<td>Assessment activity</td>
<td>A</td>
<td>Student(s) engaged in a formalized assessment activity (e.g., test; performance).</td>
<td></td>
</tr>
<tr>
<td>Pull-out activity, individual or group</td>
<td>PO</td>
<td>Student(s) removed from the room – no observation of these students possible.</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>O</td>
<td>List “other” activities.</td>
<td></td>
</tr>
</tbody>
</table>
**Student Engagement, Cognitive Activity, & “Learning Director”**

These are global ratings for each 5-minute segment. Thus, each segment will have only one rating for each of these two domains, the rating that is most representative of that time period for that group.

<table>
<thead>
<tr>
<th>Student Engagement</th>
<th>Cognitive Activity</th>
<th>“Learning Director”</th>
</tr>
</thead>
<tbody>
<tr>
<td>L = low engagement = 20% or fewer of students engaged in learning</td>
<td>Remember</td>
<td><em>Who directs the learning or makes the decisions about the learning activities.</em></td>
</tr>
<tr>
<td>M – Moderate engagement = 21 – 79% of students engaged in learning</td>
<td>Understand</td>
<td>Use the following scale for making your segment ratings for the identified groups:</td>
</tr>
<tr>
<td>H – High engagement = 80% or more students engaged in learning</td>
<td>Apply</td>
<td>1 – Teacher directs all learning</td>
</tr>
<tr>
<td></td>
<td>Analyze</td>
<td>2 – Teacher directs most learning</td>
</tr>
<tr>
<td></td>
<td>Evaluate</td>
<td>3 – Teacher and students share learning decisions</td>
</tr>
<tr>
<td></td>
<td>Create</td>
<td>4 – Student directs most learning</td>
</tr>
<tr>
<td></td>
<td>Ratings are made in each segment following the given scale:</td>
<td>5 – Student directs all learning</td>
</tr>
<tr>
<td></td>
<td>1 – Not evident</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 – Evident</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 – Well-represented</td>
<td></td>
</tr>
</tbody>
</table>


J. Cassady gave me permission to use these codes in my research, as per personal communication dated November 16, 2009.
Appendix F
Technology Beliefs and Competencies Survey

Section I – Background Information

Directions: For items 1-5, please circle or supply a response:

1. What grade level are you teaching?
   *If teaching more than one grade level, please select accordingly.*
   a. Kindergarten
   b. First
   c. Second
   d. Third
   e. Fourth
   f. Fifth
   g. Sixth
   h. Seventh
   i. Eighth

2. Please indicate how many years you have been teaching? ________ years

3. What is your gender? a. Male b. Female

4. How often do you use your computer at home?
   a. Less than once a month
   b. About once a month
   c. About once a week
   d. Several times a week
   e. Daily
   f. I do not have a computer at home

5. How often do you use a digital camera?
   a. Less than once a month
   b. About once a month
   c. About once a week
   d. Several times a week
   e. Daily
   f. I do not own a digital camera

6. How often do you use a mp3 player (or ipod)?
   a. Less than once a month
b. About once a month
c. About once a week
d. Several times a week
e. Daily
f. I do not own a mp3 player (or ipod)

7. How often do you use a scanner?
   a. Less than once a month
   b. About once a month
   c. About once a week
   d. Several times a week
   e. Daily
   f. I do not own or have access to a scanner
Section II – Technology Skills

**Directions:** In this section, each item will ask about technology skills and competencies. Please **determine your skill level** and circle the appropriate response, based on this key:

**KEY:**
1= I can’t do this
2= I can do this with some assistance
3= I can do this independently
4= I can teach others how to do this

<table>
<thead>
<tr>
<th>Basic Operation</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8 Create, save, copy &amp; delete files; move or copy files onto hard disks or flashdrives; find files on a hard disk or a flashdrive; create folders and move files between folders</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9 Print an entire document, selected pages, and / or the current page within a document</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>10 Cut, paste and copy information within and between documents</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>11 Troubleshooting: When my computer freezes or an error message comes up, I can usually fix the problem</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>12 Troubleshooting: I know the things to check if my computer doesn't turn on</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>13 Viruses: I can use anti-virus software to check my computer for viruses</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Productivity Software</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>14 Word Processors: Use the functions of a word processor to format text (Font colors and styles), check spelling / grammar</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>15 Word Processors: Use advanced features of a word processor such as headers/ footers, tables, insert pictures</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>16 Spreadsheets: Use the basic functions of a spreadsheet to create column headings and enter data</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>17 Spreadsheets: Use advanced features of a spreadsheet (e.g. using formulas, sorting data, and creating charts/graphs)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>18 Presentation: Create a presentation using predefined templates</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>19 Presentation: Create a presentation with graphics, transitions, animation, and hyperlinks</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>20 Classroom Management: Use electronic grade book</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**KEY:**

1= I can’t do this  
2= I can do this with some assistance  
3= I can do this independently  
4= I can teach others how to do this

<table>
<thead>
<tr>
<th>Communication</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>21</strong> Email: Send, receive, open and read email</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>22</strong> Email: Use advanced features of email (e.g. attachments, folders, address books, distribution lists)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>23</strong> Listservs: Subscribe to and unsubscribe from a listserv</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Electronic References</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>24</strong> Searching: Use a search tool to perform a keyword / subject search in an electronic database (e.g. CD-ROM, library catalog)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>25</strong> Use advanced features to search for information (e.g. subject search, search strings with Boolean operators, combining searches)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>World Wide Web</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>26</strong> Navigate the WWW using a web browser (e.g. Netscape Navigator, Internet Explorer, AOL, Safari, Mozilla Firefox)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>27</strong> Use more advanced features of a web browser (e.g. creating, organizing, and using bookmarks; opening multiple windows or tabs; using reload/refresh and stop buttons)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>28</strong> Use advanced features of a web browser (e.g. install plug-ins, download files and programs, download images)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>29</strong> Use a search engine (e.g. Yahoo, Lycos, Google, Alta Vista, Bing) to search for information on the Web</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>30</strong> Use a web authoring tool (e.g. SeaMonkey, FrontPage, Dreamweaver, GoLive, HTML Editors) to create basic web pages with texts and images</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>31</strong> Format web pages using tables, backgrounds, internal and external links</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td><strong>32</strong> Upload web page files to a server</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**KEY:**

1 = I can’t do this  
2 = I can do this with some assistance  
3 = I can do this independently  
4 = I can teach others how to do this

<table>
<thead>
<tr>
<th></th>
<th>Multimedia</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Drawing / Painting: Create simple shapes such as lines, circles, rectangles, and squares with a drawing program (e.g. KidPix, SmartDraw, GIMP, Pixia, Paint, Inspiration)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>34</td>
<td>Drawing / Painting: Use advanced features of a drawing program (e.g. layering, grouping objects, changing fill and outline colors)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>35</td>
<td>Authoring: Create and modify a simple multimedia product using an authoring tool such as HyperStudio or Adobe Director</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>36</td>
<td>Digital Images: Import a digital image (e.g. clip art, photograph) into a document</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>37</td>
<td>Digital Images: Use various tools (e.g. digital camera, scanner) to capture a digital image</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>38</td>
<td>Use a photo editing tool (e.g. Photoshop, PhotoDeluxe, PhotoScape) to manipulate a digital image</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>39</td>
<td>Desktop Publishing: Use desktop publishing software (Publisher, Adobe PageMaker, CorelDRAW) to create a newsletter, pamphlet, or award certificate</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
### Section III – Technology Beliefs

**Directions:** Below is a list of statements regarding technology. For each statement, please **indicate your level of agreement** with each statement, by **circling** the appropriate number.

**KEY:**

1 = strongly disagree  
2 = disagree  
3 = agree  
4 = strongly agree

<table>
<thead>
<tr>
<th>Statements</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 I support the use of technology in the classroom.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>41 A variety of technologies are important for student learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>42 Incorporating technology into instruction helps students learn.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43 Content knowledge should take priority over technology skills.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>44 Most students have so many other needs that technology use is a low priority.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>45 Student motivation increases when technology is integrated into the curriculum.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>46 Teaching students how to use technology isn’t my job.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47 There isn’t enough time to incorporate technology into the curriculum.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>48 Technology helps teachers do things with their classes that they would not be able to do without it.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>49 Knowledge about technology will improve my teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 Technology might interfere with “human” interactions between teachers and students.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>51 Technology facilitates the use of a wide variety of instructional strategies designed to maximize learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section IV – Perceived Technology Barriers

**Directions:** Below is a list of potential barriers to integrating technology. For each statement, please indicate your perception of each barrier, by circling the appropriate number.

**KEY:** 1 = not a barrier 2 = minor barrier 3 = major barrier

<table>
<thead>
<tr>
<th>Barriers</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>Lack of or limited access to computers in schools.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>Not enough software available in schools.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Lack of knowledge about technology.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55</td>
<td>Lack of knowledge about ways to integrate technology into the curriculum.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56</td>
<td>The administrator doesn’t require technology use.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>There is too much material to cover.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Lack of mentoring to help me increase my knowledge about technology.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Technology-integrated curriculum projects require too much preparation time.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>There isn’t enough time in class to implement technology-based lessons.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>61</td>
<td>There is limited support and encouragement through collaboration to integrate technology.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Thank you for investing time and sharing your thoughts by completing this survey instrument.*

Adapted from an instrument developed by Brush, Simons, & Hew (2009) Development of an Instrument to Measure Pre-Service Teachers’ Technology Skills, Technology Beliefs, and Technology Barriers – to be published in *Computers in the Schools*
## Frequency of Instructional Behaviors Noted During Observations

<table>
<thead>
<tr>
<th>Observed Instructional Activity</th>
<th>Frequency of Observed Behaviors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>1</td>
</tr>
<tr>
<td>Lecture with Discussion</td>
<td>4</td>
</tr>
<tr>
<td>Class Discussion</td>
<td>2</td>
</tr>
<tr>
<td>Small Group Discussion</td>
<td>4</td>
</tr>
<tr>
<td>Problem Modeling by Teacher</td>
<td>3</td>
</tr>
<tr>
<td>Student Presentation</td>
<td>1 (on demand)</td>
</tr>
<tr>
<td>Demonstration by Teacher</td>
<td>4</td>
</tr>
<tr>
<td>Questioning by Teacher</td>
<td>8</td>
</tr>
<tr>
<td>Student Responding</td>
<td>6</td>
</tr>
<tr>
<td>Manipulatives</td>
<td>1</td>
</tr>
<tr>
<td>Learning Center(s)</td>
<td>2</td>
</tr>
<tr>
<td>Anchored activity before lesson</td>
<td>0</td>
</tr>
<tr>
<td>Anchored activity during lesson</td>
<td>4</td>
</tr>
<tr>
<td>Anchored activity after lesson</td>
<td>2</td>
</tr>
<tr>
<td>Seat work – Individual</td>
<td>5</td>
</tr>
<tr>
<td>Seat work – Group based</td>
<td>2</td>
</tr>
<tr>
<td>Cooperative learning</td>
<td>3</td>
</tr>
<tr>
<td>Observed Instructional Activity</td>
<td>Frequency of Observed Behaviors</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Role Playing</td>
<td>1</td>
</tr>
<tr>
<td>Teacher interacting with small group</td>
<td>3</td>
</tr>
<tr>
<td>Technology use – Students</td>
<td>7</td>
</tr>
<tr>
<td>Technology use – Teacher</td>
<td>5</td>
</tr>
<tr>
<td>Assessment activity</td>
<td>0</td>
</tr>
</tbody>
</table>
### Appendix H

**Confirmability Audit – Critical Incident Chart**

**Baseline Group B**

**Analysis of Instructional Behaviors**

<table>
<thead>
<tr>
<th>Description of Incident</th>
<th>Researcher Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Setting:</strong> 21 students are seated in small groups to complete activity. Each student is given a photocopied activity sheet, produced by a foundation to encourage students to critically examine partial images to deduce the identity of the depicted objects. This activity is an introductory lesson to explain the nature of archaeological work and scientific approaches to understand what has been found and how it can be identified and dated.</td>
<td>Traditional instructional technology is used to provide students information and to facilitate communication and recording of ideas.</td>
</tr>
<tr>
<td>After 10 minutes of group brainstorming, teacher provided a one-minute warning.</td>
<td>Classroom management skills are used.</td>
</tr>
<tr>
<td>Through whole group discussion, teacher elicits students to share their responses to any item on the photocopied activity sheet. Teacher uses a document camera and 3M projector so students can view the activity sheet and suggested responses. Teacher – and sometimes a student – uses dry erase markers to notate suggested responses on white board.</td>
<td>Two connected forms of technology are used to provide students information and to facilitate communication and recording of ideas.</td>
</tr>
<tr>
<td>Students volunteer their answer as well as an explanation as to why they have suggested this answer. The conversation is paced so many students are able to participate. Student engagement is relatively high (at least 90%) (visual scan of room). Students control the conversation as much as the teacher. This exchange of ideas lasts 35 minutes.</td>
<td>The use of technology is balanced with the use of effective communication and classroom management strategies so this lesson is perceived (by teacher) as effective.</td>
</tr>
<tr>
<td>Teacher asks students to share some “take-aways”. 6 students share ideas. The teacher repeats or reinforces 2 of these comments. This discussion lasts for 5 minutes.</td>
<td>Techniques for closure of lessons are used.</td>
</tr>
<tr>
<td>Teacher introduces a video clip explaining the practice of carbon dating as students put away their work and rearrange their seats to facilitate viewing the video clip from the white board. Teacher uses a laptop connected to the 3M projector to launch the Bill Nye video clip. Observation ended prior to the end of viewing the video clip.</td>
<td>Technology is used to share information with students as an introductory lesson. Teacher selects video clip due to its accuracy and capacity to engage students.</td>
</tr>
<tr>
<td>Description of Incident</td>
<td>Researcher Comments</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Setting:</strong> Teacher and 25 students are in a classroom to review directions for writing activity to be completed at the desktop computers in the computer lab. Teacher distributes a photocopied guidelines sheet as she reviews the key details and the editing tasks students are to complete prior to submitting this assignment.</td>
<td>Traditional instructional technology is useful so students have individual copies of required guidelines.</td>
</tr>
<tr>
<td>Simultaneously, teacher is using the document camera, laptop and the 3M projector to share this information, using a projected powerpoint slide with the details related to expectations for the writing assignment. Teacher is periodically scanning the room and circulating to monitor student understanding of the procedures.</td>
<td>Several forms of emergent technology are used to provide students information and to facilitate communication. Teacher uses communication and management skills so activity is completed in a timely manner (8-10 min).</td>
</tr>
<tr>
<td>After 2 clarifying questions are asked and answered, the teacher and students leave the classroom to go to the computer lab.</td>
<td>Communication skills are used to support student learning.</td>
</tr>
<tr>
<td>Once in the lab, students sit at desktop computers where they last completed an assignment, sign in and start their work. Most students (all but 4) are using the storage space on the school district server to retrieve and continue their work. Four students depend on flashdrives.</td>
<td>Technology facilitates each student so they can produce a text to meet specific requirements and develop 21st century communication skills (teacher’s stated goal).</td>
</tr>
<tr>
<td>Students are focused on typing their documents in Microsoft word. One of the flashdrive users encounters a challenge as the computer can not retrieve their file from the flashdrive after 3 attempts on 2 different desktops. This student is obliged to restart typing the text.</td>
<td>Students demonstrate skill in storing and retrieving their work.</td>
</tr>
<tr>
<td>Most students are using 2007 version of the software; six are using the 2003 version.</td>
<td>Students develop skill using ubiquitous software.</td>
</tr>
<tr>
<td>Most students, referring to their edited draft, demonstrate typing fluency and a good sense of how to use the icons and features of the application to customize the appearance of the text they are producing.</td>
<td>Students develop keyboarding skills and rapid capacity to navigate through applications to create documents.</td>
</tr>
<tr>
<td>Description of Incident</td>
<td>Researcher Comments</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>The teacher is circulating to provide students feedback, encouragement and redirection, as needed.</td>
<td>Teacher recognizes need to monitor student progress and provide support as needed (classroom and technology management strategies)</td>
</tr>
<tr>
<td>After 35 minutes in the lab, students are asked to bring their work to closure as about 14 students have already printed their text and the end of the session in the computer lab is near. A one-minute warning is announced.</td>
<td>Teacher is monitoring time and completion rate so instructional time is used effectively. (classroom management strategies)</td>
</tr>
<tr>
<td>Students start to save their document and gather their belongings to return to the classroom.</td>
<td>Students recognize the need to follow directions in handling devices.</td>
</tr>
<tr>
<td>Description of Incident</td>
<td>Researcher Comments</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Setting:</strong> 20 students are seated at five tables. Teacher’s desk is at right front</td>
<td>Room is set up for students to function and find the resources they need to complete</td>
</tr>
<tr>
<td>corner of the classroom, with a laptop on its surface. There is a 3M projector and the</td>
<td>assignments. Students are empowered to be learners and develop confidence in self.</td>
</tr>
<tr>
<td>document camera is secured to a desk adjacent to the teacher’s desk and accessible to</td>
<td></td>
</tr>
<tr>
<td>students. This participant encourages students to be technical helper – control the</td>
<td></td>
</tr>
<tr>
<td>volume and turns the systems on &amp; off.</td>
<td></td>
</tr>
<tr>
<td>The activity is to provide students an opportunity to represent the data they have</td>
<td>Students are posing questions and taking turns. A visual scan every ten minutes</td>
</tr>
<tr>
<td>collected in graphic form. The students are given options and are able to discuss the</td>
<td>indicates at least 90% of students are on task.</td>
</tr>
<tr>
<td>steps of the process. The students already collected the data by asking each other</td>
<td></td>
</tr>
<tr>
<td>questions.</td>
<td></td>
</tr>
<tr>
<td>The teacher shares a brain pop video clip from the internet (through the laptop and</td>
<td>The video loads rapidly and is legible and easy to hear the narration. Students are</td>
</tr>
<tr>
<td>the 3M projector) that explains the design and use of bar graphs and tally marks to</td>
<td>attentive.</td>
</tr>
<tr>
<td>represent data.</td>
<td></td>
</tr>
<tr>
<td>Students are reviewing or discussing the ideas from the brain pop clip. Teacher</td>
<td>After viewing the video clip, a teacher-guided discussion gave students an</td>
</tr>
<tr>
<td>elicited responses or ideas.</td>
<td>opportunity to retell what they understood about the topic. The teacher uses the</td>
</tr>
<tr>
<td>Teacher has created a presentation shared from the laptop to explain the concept and</td>
<td>discussion to check on student understanding of details shared in the video clip.</td>
</tr>
<tr>
<td>provide different models or examples of bar graphs and data representations. She has a</td>
<td></td>
</tr>
<tr>
<td>special marker to notate on the whiteboard changes to the presentation slides. The</td>
<td></td>
</tr>
<tr>
<td>presentation slides are modified to reflect the students’ latest suggestion or</td>
<td></td>
</tr>
<tr>
<td>understanding of how to create bar graphs. Students share ideas readily. Venn diagrams</td>
<td></td>
</tr>
<tr>
<td>are also depicted as a way to represent data.</td>
<td></td>
</tr>
<tr>
<td>Students are invited to the dry erase or whiteboard (where it is interactive) to</td>
<td>More than one format of graphic representation of data is shared and discussed by</td>
</tr>
<tr>
<td>indicate numerals or tally marks or bars for the graph that is the focus of the</td>
<td>students. They have had prior exposure to the concepts. This lesson appears to give</td>
</tr>
<tr>
<td>specific portion of the lesson.</td>
<td>students an opportunity to demonstrate some command of the representing data</td>
</tr>
<tr>
<td></td>
<td>graphically.</td>
</tr>
<tr>
<td>Description of Incident</td>
<td>Researcher Comments</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>As students work independently at their tables, using paper</td>
<td>Students are engaged in their</td>
</tr>
<tr>
<td>and pencil to create their unique graph of the data they</td>
<td>independent work. Some students</td>
</tr>
<tr>
<td>collected, they can seek help from someone else at the table or from the teacher. Three</td>
<td>seem to work productively in</td>
</tr>
<tr>
<td>different forms of paper are provided. Each type of paper is discussed as to its benefits</td>
<td>pairs as both are adding details to</td>
</tr>
<tr>
<td>and shortcomings. Students offer these ideas before teacher summarizes and adds</td>
<td>their papers. Students share comments in a</td>
</tr>
<tr>
<td>ideas that were not yet identified. Students are attentive and engaged in this</td>
<td>thoughtful and sensitive manner. The recipient accepts the</td>
</tr>
<tr>
<td>discussion (visual scan of room every ten minutes).</td>
<td>feedback and suggestions.</td>
</tr>
<tr>
<td>Teacher circulates to troubleshoot or redirect or offer praise.</td>
<td>Teacher demonstrates how to</td>
</tr>
<tr>
<td></td>
<td>praise and redirect or correct others without disturbing or</td>
</tr>
<tr>
<td></td>
<td>distracting students.</td>
</tr>
<tr>
<td>Teacher also encourages each child to determine how to</td>
<td>Teacher creates an atmosphere</td>
</tr>
<tr>
<td>represent the data. Teacher emphasizes that there are multiple ways to do this</td>
<td>where risk and personal effort are</td>
</tr>
<tr>
<td>assignment correctly.</td>
<td>valued.</td>
</tr>
<tr>
<td>Teacher sits at one specific table to work with this group of</td>
<td>Teacher offers this group of</td>
</tr>
<tr>
<td>students.</td>
<td>students her support as needed.</td>
</tr>
<tr>
<td>Students who need some feedback tend to walk over to teacher once they have</td>
<td>Teacher offers supports as</td>
</tr>
<tr>
<td>gained her attention and she has nodded to them that they may visit with her.</td>
<td>needed, based on specific needs of students.</td>
</tr>
<tr>
<td>Document camera is now used to share one student’s work</td>
<td>Teacher uses technology to teach</td>
</tr>
<tr>
<td>for comment and critique. Students are grouped together on the carpet in order to focus</td>
<td>students how to critique and</td>
</tr>
<tr>
<td>on the projected example of the assignment.</td>
<td>think about their work and help</td>
</tr>
<tr>
<td>Students offer their ideas. Ideas to complete the assignment as well as potential</td>
<td>each other out.</td>
</tr>
<tr>
<td>enhancements are offered by peers.</td>
<td>Students demonstrate a</td>
</tr>
<tr>
<td>Teacher indicates that the assignment requires thought and planning. Teacher</td>
<td>willingness to help one another.</td>
</tr>
<tr>
<td>encourages students to breathe deeply to reduce stress over the assignment.</td>
<td>Teacher responds to elevated</td>
</tr>
<tr>
<td>Students return to the tables where they were working on the assignment.</td>
<td>stress level without having to</td>
</tr>
<tr>
<td></td>
<td>sacrifice the sophistication of the task at hand. Teacher models</td>
</tr>
<tr>
<td></td>
<td>how to handle stress.</td>
</tr>
<tr>
<td>Teacher announces a 3-minute warning.</td>
<td>Time management.</td>
</tr>
<tr>
<td>Students resume their work.</td>
<td></td>
</tr>
<tr>
<td>One student asks for assistance. Teacher sits nearby to problem solve. Teacher</td>
<td>Teacher offers support as needed and models problem solving</td>
</tr>
<tr>
<td>asks clarifying questions to guide student through process.</td>
<td>strategy.</td>
</tr>
<tr>
<td>Description of Incident</td>
<td>Researcher Comments</td>
</tr>
<tr>
<td>-------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Teacher claps rhythmically to gain students’ attention, and invites students to line up to leave the classroom for a library visit.</td>
<td>Classroom management. Despite the pace of the class activity, students remain engaged and willing to do the work. Teacher has been perceptive of how the rhythm of the class shifts and adjusts for students’ needs. Technology is used to communicate and correct misunderstanding and support student learning.</td>
</tr>
</tbody>
</table>