USING TECHNOLOGICAL, PEDAGOGICAL, AND CONTENT KNOWLEDGE (TPACK) TO SUPPORT UNIVERSAL DESIGN FOR LEARNING (UDL): A CASE STUDY

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ABSTRACT

Research indicates that technology can play a vital role in supporting universal design for learning (UDL); however, little research currently exists to detail specific practices of educators in the field. This qualitative case study was designed to explore and describe the efforts to prepare and deliver instruction with a combined knowledge of technology-content-and-pedagogy (TPACK) to support UDL in an inclusive setting, at a Title 1 school. The justification for this study stemmed from the researcher’s passion to help practitioners in the field understand the strategies and materials utilized by an exemplary educator. It was this researcher’s intuition that an awareness of a unique practice may help broaden the research base for both UDL and TPACK, and possibly impact both policy and practice.

The purposefully selected participant was an experienced general education teacher at a Title 1 school in central Oahu, a part of the Hawai‘i Department of Education (HDOE). Data were collected across the duration of an entire, official HDOE instructional quarter, and included a series of observations followed by in-depth interviews, and the analyses of materials and instructional resources that were designed and utilized to support instruction. The data were coded and analyzed to address the specific research questions of this study. The analysis and interpretation of the findings were organized with respect to the frameworks of this particular study: TPACK and UDL.

This research revealed that a teacher’s TPACK provides important support in preparing for and delivering UDL-based instruction and expands the range of strategies and materials available for the teacher to use. Recommendations included the ongoing integration of 21st century technologies and TPACK in the delivery of professional development for educators.
related to UDL. Additionally there is a call for administrative policies that support the ongoing
development of TPACK for practitioners in the field, as well as broadening opportunities for
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CHAPTER 1. INTRODUCTION

In the public sector of today’s classrooms, influxes of student diversity and vast ranges of technology continuously affect the roles and responsibility of the 21st century educator. One may ask, how are teachers to keep up and to manage such ever-changing environments, and increasing caseloads? What role do technological resources play in the effort to address and support all learners with respect to both federal and state legislated policies and procedures, particularly those related to Universal Design for Learning (UDL)? The Higher Education Opportunity Act of 2008 explicitly states that the term,

Universal design for learning means a scientifically valid framework for guiding educational practice that: (A) provides flexibility in the ways information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and (B) reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient. (UDL and UD Provisions in the Higher Education Opportunity Act (P.L. 110-315), 2010, SEC. 103)

From this landmark legislation we may further inquire: what impact does this explicit definition mean for existing educators and their professional practice, with respect to both the time and skill set required for designing, implementing, supporting and evaluating such instruction? In providing instruction to all students, both with and without disabilities, often within the same inclusive setting, educators are often faced with myriad challenges and responsibilities. However, little attention has been focused upon the specific instructional strategies and professional efforts, both inside and outside the inclusion-based classroom, used by teachers to support UDL. Even less has been focused on what role technology, specifically a teacher’s technical, pedagogical, and content knowledge (TPACK), plays in these UDL efforts.

This study sought to identify how an inclusion-based classroom teacher functions with ever-evolving educational practices, technologies, student populations, and educational subjects. Specifically, it aimed to identify and describe the practices related to TPACK and UDL of an exceptional educator in the field, an individual who works to address the various demands of the modern classroom and facilitate meaningful learning experiences for all of her students. As a case study, this investigation attempted to dig deeper than traditional, survey-based research
(Seawright & Gerring, 2008) and provide richer insights about issues and practices that revolve around inclusion-based settings in the twenty-first century. The results lend insights into how teachers, within their own domain and context, may use TPACK to address principles of UDL in their efforts to support all learners.

**Statement of the Problem**

In the 21st Century, much mainstream, educational research has emphasized and underscored the various roles of technology (Collins & Halverson, 2009; Friedman, 2006; Shirky, 2008), the lack of its full utilization and potential (Cuban, 2001), and its promise to support all learners (Rose & Meyer, 2002). Recent research (Bryant, Rao, & Ok, 2014) has underscored the range of potential that various technologies offer in assisting learners in reading (Twyman & Tindal, 2006), in mathematics (Bryant et al., 2014); and in writing (Silio & Barbetta, 2010). Despite the breadth of much of this research, what has been unclear and absent is the depth of information in understanding how technology is specifically utilized to support current UDL practices, its impact upon instruction, and understanding those educators who are managing both technology and their classrooms, for students with and without disabilities.

Universal Design for Learning (UDL) is viewed as a “framework for making curricula more inclusive” (CAST, n.d.). Historically, much UDL-based research has focused on assessment (Ketterlin-Geller, 2005; Russell, Hoffmann, & Higgins, 2009). There has been a call for additional research to examine the use of UDL in relationship to professional development, technological advancements, and ongoing evaluation (Edyburn, 2010). Such research can serve as a foundation for further validating UDL and its promise of benefiting all learners, not just those individuals with exceptionalities. It is important to note that the theoretical promise of UDL does not directly align with current instructional design, instructional practices and evaluation practices (Coyne, Simmons, Kame'enui, & Stoolmiller, 2004; Edyburn, 2010).

The A3 (Advocacy, Accommodation, and Accessibility) Model (Edyburn, 2010; Schwanke, Smith, & Edyburn, 2001) was originally developed as an instructional tool that described different ways to enhance accessibility for individuals with disabilities. The A3 Model demonstrates the dynamic and interconnected evolution of phases of adoption from awareness to advocacy (anticipating needs), then to accommodation as actions taken for individuals in response to their needs, and on to accessibility where access is distributed in an equitable fashion
to all, reflective of Universal Design. Indeed, this evolution across these phases takes a considerable amount of time, effort, and focus to connect the theoretical components of UDL to its universal adoption and actual praxis (Edyburn, 2010).

Figure 1.1 illustrates the dynamic nature of advocacy, accommodations, and accessibility in three developmental phases of the A3 Model. The differential impact of the three components in terms of time, effort, and focus is illustrated by the waves across phases:

![Image of A3 Model and Transition of Approach]

**Figure 1.1.** Edyburn's A-3 Model.


Present educational practices seem are focused on advocacy and accommodations of individuals with disabilities; however, Edyburn (2009, 2010) argued that accessibility will be obtained when UDL is proactively utilized, maximizing the availability and advancement of educational access for all learners, with greater emphases upon instructional design and the professional development of educators (Harris & Hofer, 2011). Critical factors supporting transformations include understanding and embracing the diversity of learners and their needs (Burke, Hagan, & Grossen, 1998), and infusing these understandings when designing, implementing and evaluating instruction (Coyne, Kame'enui, & Simmons, 2001). Valuing
diversity can take the form of inclusion models, differentiation of instruction and curricular adaptations and modifications (McLeskey & Waldron, 2002).

Edyburn (2010) explained that “diversity blueprints” (p. 36) helped foster a greater understanding of diversity and thereby directed UDL as an ongoing process of instructional and product design that recognized the individual needs of all learners. A series of such plans can help proactively support and structure the instructional design processes with accessibility and usability. Edyburn clearly stressed that UDL is much more than “good teaching” (p. 38). Principles of differentiation are indeed components of UDL, implemented when educators strategize supports and efforts in the classroom. At present, more research between the theoretical models and actual practice is necessary to refine and identify how UDL as a set of pedagogical strategies and content design can be modeled, integrated, and developed further. Edyburn saw that in order to achieve higher levels of performance from students, UDL must be viewed as a skillset necessary for all stakeholders that intertwines a series of “meaningful” (p. 38) design factors to engage students and support their learning. Edyburn pointed to interdisciplinary research across fields of technology, instructional design, learning sciences and brain research to develop products, services and strategies that incorporate, measure, and assess UDL.

**UDL and Technology**

In addition to professional development, technology can also play a significant, if not essential, role in supporting UDL practices (Edyburn, 2010). Blackhurst (2005) noted, such technology within educational settings can be categorized as technology for teaching, which is also known as instructional technology, assistive technology, productivity technology, and information technologies. Yet, Edyburn (2010) clearly defined distinct lines between assistive technology and UDL. With digital technology specifically, educators have the flexibility to foster UDL practices that expand well beyond “low-tech” approaches. Villa, Thousand, Nevin, and Liston (2005) described such “low-tech” solutions as altering the sizes of fonts, color of text, and software that may be commonplace, such as Inspiration or Kidspiration to help create graphic organizers. Such technological features are now commonplace in the tools such as Google Apps for Education with the ability to bridge the socio-technological gaps that are all too prevalent for many students – students with disabilities, students who are English language learners, students from low socio-economic backgrounds, and students from different cultural backgrounds. Other
“low-tech” solutions may also include the use of physical manipulatives, such as counting blocks and tactile objects, as well as visual cues, stickers and graphical prompts.

Assistive technologies are usually provided as a reactive approach after a student receives a personal referral and evaluation. As a dramatic contrast, UDL is viewed as “a critical paradigm shift” (Edyburn, 2010, p. 39), a proactive, not a reflexive, approach that provides tools, strategies and ongoing supports to every learner in the least restrictive environment. Yet, despite these tenants of UDL and the promise and power of technological supports, technology within schools is not always available (Jung, 2008) or when it is present, technology may be underutilized (Cuban, 2001). Questions of equity (Welch, 2000) and student perceptions of school-related supports (Marquez-Zenkov, 2007) are often common themes with respect to the availability of technology within schools today, and related research. From a collective standpoint, student equity will be established when each individual student fully receives the supports and accommodations that he/she needs to succeed in his or her respective, inclusive learning environments.

Consequently, understanding the role of technology and UDL to support all students, not just those with disabilities, will be critical to enhance the performance of all students. Instructional designers can play important roles in defining and designing specific products and supports for UDL (Edyburn, 2010). Additionally, research can help identify the impact of such design implementations and further understanding of the impact of integrating UDL and the varying factors that can be altered and modified to support student achievement.

UDL has been difficult to deploy on a large scale, but relatively easy to convey its potential (Edyburn, 2010). From the standpoint of instructional design, one may see additional opportunities to develop, diffuse, and sustain UDL. In many instances, there is much ambiguity about the roles and responsibilities of those who deploy UDL. These key players include both educators and developers of UDL products and services. Curriculum designers can play a significant factor in the ways in which students interact and engage with educational content, their instructors and peers (Ausband, 2006).

Despite the fact that official and specific UDL-centered professional development has yet to be developed and deployed on national and state-level platforms, many educators are making significant strides towards UDL practices within inclusive settings, often using technology (Villa et al., 2005). This professional practice is occurring as educators are professionally developing
their own personalized and individual knowledge of technology, pedagogy, and content for subjects they teach; collectively, this knowledge is referred to as technological pedagogical and content knowledge (TPACK) (Mishra & Koehler, 2006).

**Purpose**

At present, UDL and TPACK have been widely researched independently, with a focus on the instructional practices of professional educators in the field. However, little, if any, research exists to bridge the tenants of UDL and TPACK as complementary and interconnected frameworks that support learning for all students within inclusive classrooms.

The purpose of this qualitative case study was to investigate and describe how a teacher in the public sector used knowledge of technology, pedagogy, and subject-specific content knowledge (TPACK) to design instruction and classroom supports for students with and without disabilities. This study sought to identify how a teacher used TPACK to facilitate her instructional efforts within the context of a classroom designed for inclusion and how her TPACK supported the principles of UDL.

**Research Questions**

This study posed the following research questions:

Research question #1: How does a Title 1 public school teacher utilize TPACK in preparing UDL-based instruction?

Research question #2: How does a public school teacher utilize TPACK to support UDL during the delivery of instruction in an inclusive environment?

**Significance of the Study**

This study provided direct, in-depth insights into the practices, products, and perspectives of a unique teacher in a specific Hawaii Department of Education (HDOE) classroom, in an instance where inclusion is indeed a focus at the school. At the school level, this research may provide specific details about the roles and efforts of a general education teacher as she seeks to meet the needs of diverse learners in her class. This particular teacher has participated in professional development around technology. By understanding how she melds her TPACK with efforts to implement UDL in her classroom, a clearer articulation of how TPACK can support
UDL in other classroom settings was made possible. This deeper understanding of a single teacher’s practice had implications for professional development for other teachers and for models of support for consideration by school leaders.

From perspectives at the complex, state and federal levels, the insights and conclusions from this study might foster additional questions and dialogue around supporting and assessing inclusion and UDL practices through enhancing teachers’ TPACK. The design, development and evaluation of professional development may come into question, as will the possibility of needing further research and investigations, beyond the scope of this particular study. Prior to this study, little research was focused upon the detailed practices linking TPACK, which traditionally has focused upon pre-service and not in-service teachers, and UDL-based investigations.

From a theoretical standpoint, this study may serve as a possible bridge, linking TPACK-centered research with that of existing and needed UDL-centered research. Accordingly, the research may answer part of the call for additional research from both the Center for Applied Special Technologies (CAST) and TPACK.org.

**Conceptual Framework**

From a historical perspective in evaluating “effective teaching,” research has emphasized the importance of content knowledge (Shulman, 1986), or the knowledge of a particular subject or specific discipline. As time lapsed, emphasis shifted and focused upon pedagogical knowledge and related practices (Ball & McDiarmid, 1990; Shulman, 1987). Shulman (1986) proposed that content knowledge and pedagogical knowledge were not mutually exclusive or isolated, but rather each domain was highly interdependent upon the other, and introduced the notion of pedagogical content knowledge (PCK). At this intersection of pedagogy and content, PCK emphasized the importance of understanding a subject matter to the level of being able to transform the content, in order to deliver it instructionally and accessibly to all learners (Mishra & Koehler, 2006), quite similar to the guidelines and principles of UDL.

Twenty years after Shulman’s affirmations about PCK, Mishra and Koehler (2006) noted the continuous shift in classroom technologies, such as overhead projectors, typewriters, and textbooks, towards technology that was much less transparent and much more visible, sophisticated, omnipresent, computer-based and digital in its nature, design, and use.
Accompanied with these physical and technological changes were the promises of technology and its impact on actual changes in instruction.

The TPACK Model illustrates the complex interplay between technology, pedagogy, and content knowledge for teaching in the 21st century, and is visually represented by Figure 1.2.

![Figure 1.2. The TPACK Model.](image)

*Note: Reproduced by permission of the publisher, tpack.org*

As a framework for assessing and identifying the complex nature of knowledge for teachers to integrate technology, the TPACK model is comprised of three primary forms of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technology Knowledge (TK); and combined, sub-sets: Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), and Pedagogical Content Knowledge (PCK).

Margerum-Leys and Marx (2004) noted, “if teachers are to use technology to further their efforts to be effective facilitators of student learning, it is essential that their knowledge of educational technology encompass not just content-knowledge – the technological capacities of hardware and software – but pedagogical and content knowledge as well” (p. 422). Collectively,
the intersection of these elements and categories of knowledge that converge is known as Technological Pedagogical Content Knowledge (TPACK). TPACK demonstrates a dynamic relationship in the context of different classrooms, educators, students and technological supports.

**Summary of Methodology**

This research was conducted using a case study approach, examining the practices and perspectives of a single teacher. For the collection of data within this project, I gathered resources from multiple sources, including the following: field notes and observations, teacher provided plans and materials for activities and lessons related to instruction, and in-person interviews with the teacher who was the participant in this study. These data were linked to my research focus on understanding how TPACK influenced the UDL practices of a teacher in an inclusion classroom. Through the data, I was able to assess the specific actions and understand the perspectives of this particular teacher as she used her technological, pedagogical, and content knowledge to support her students in a specific inclusion-based setting.

Yin (2009) cited the use of an individual as a “more concrete” (p. 33) unit of analysis. The data obtained for this study provided greater insights to understanding this individual as a concrete and particular case. I linked the data collected in this study to the TPACK established criteria of Archambault and Crippen (2009) and Schmidt, Baran, Thompson, Mishra, Koehler, & Shin. (2009) and to the principles of UDL (CAST, 2011). From these criteria, I was able to interpret the findings in a way that connects the observed instructional practices and collected materials of this particular educator with her TPACK and UDL principles, thus answering my research questions.

By using multiple and complementary sources of evidence, I established a “chain of evidence” (Yin, 2009, p. 122) that underscored the aim of this study. Beginning with the observations of the participant in this study, I had hoped to understand the scope and breadth of the participant’s TPACK and UDL practices within a specific context. Field notes played a critical role during the collection phase in detailing the specific actions taken by the participant, as the instructor, inside her classroom.
Data Collection

As part of my case study, I collected three forms of data. These included classroom observations, review of materials and artifacts, and semi-structured interviews with the participant. These are described in more detail further on.

For my observations, I committed to a series of ongoing, scheduled and mutually agreed upon dates, once a week, across the span of an official quarter for the HDOE. These observations were both structured and unstructured (Jones & Somekh, 2005), and employed the use of digital photography to accompany the field notes. In addition to observing teaching practices, I identified several characteristics of the participant, including gender, age, educational background, professional certifications obtained, area of specialization, current professional development endeavors, and total years of experience in teaching. My observations assisted me in understanding the participant’s actions and efforts with respect to her overall professional background. I also described the physical and technological environments in the classroom and how they were arranged to support instruction with UDL.

With respect to UDL, I experienced firsthand how content was represented: witnessing how visual information was displayed and auditory information presented and alternatives or options for language, symbols, and comprehension. I investigated how this particular educator provided or activated background knowledge; how she highlighted critical features, big ideas and relationships; guided information processing; and, supported memory and transfer using her TPACK.

I observed how this particular educator provided options for action and expression, varied ways to respond and to interact with materials; and integrated assistive technologies that she herself developed. Additionally, I took note of how this educator provided options for expressive skills and fluency, composition and problem solving, and for students’ executive functions. And lastly, I observed how this educator provided a variety of choices for recruiting her students’ interest, sustaining their effort and persistence, and enhancing self-regulation.

Within this co-framework of UDL and TPACK, the goals of my observations were to note both generally and specifically how this particular teacher utilized her technology knowledge, content knowledge, pedagogical knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical content knowledge, and her
technology pedagogy knowledge to support both developing and delivering instruction aligned with the UDL principles.

Through my observations, interviews and reviews of materials I was able to:

- Describe the classroom program setting / physical environment
- Describe the social environment
- Gain an historical perspectives
- Describe planned program implementation activities and structured interactions
- Observe informal interactions and unplanned activities
- Note the classroom language used
- Observe nonverbal communication
- Note unobtrusive indicators
- Comment on notable nonobservances (or what does not happen)
- Observe myself in this particular setting, and,
- Document individualized and common outcomes in this setting.

In an effort to complement my observations in my role as the researcher, I also collected documentation and related materials that corresponded to the periods of observed instruction. These materials included, but were not limited to, the following electronic files and materials: SMART Notebook files, SMART Teacher Tools files, PowerPoint files, blog posts, graphic organizers, websites, podcasts, audio and video resources, productivity files, pictures of physical instructional tools, handouts, books, and additional materials relating to instruction.

To triangulate and cross-reference my observations and the collection of artifacts/materials, I employed semi-structured, standardized open-ended interviews. I utilized the UDL checklist (CAST, 2011) in conjuncture with the TPACK survey (Archambault & Crippen, 2009) to guide my interviews. During these interviews, I sought perspectives from the participant’s own words, not just her actions or products that she developed and utilized, to describe her actions and rationale in using technology to facilitate her professional practice within an inclusive setting.

To facilitate these interviews and the responses, good rapport was essential to ensure confidentiality and trust. Prior to the study, my rapport and my professional relationship with the participant were respectful, created through a series of professional development courses. These courses were offered throughout the HDOE and the participant was taking them for official
professional development credits. I was the instructor for these courses, which centered on the use and application of instructional technologies, such as interactive whiteboards, student response systems, and collaborative learning software. The participants within these courses, including the subject of this particular study, built e-portfolios comprised of a series of interactive learning objects, instructional tools, and student-centered lessons.

The Participant

In the courses described above, the participant of this study demonstrated passion and enthusiasm for the design and use of educational technologies. We exchanged conversation in face-to-face settings and in online course meetings to discuss strategies and issues that pertained to teaching with technology early within the second decade of the 21st century. From such interactions, we established an honest and professional relationship to exchange or to listen to new ideas for instruction supported with technology. For the sake of this study, interviews were built upon the same trust and transparency that had been established through previous professional-centered activities, in an effort to further understand how the participant used TPACK-centered instructional strategies to support her inclusive classroom. However, my role and relationship with the participant within this study had shifted from that of a coach and collaborator within the context of our previous professional development courses, to that of an investigator and observer in her instructional setting. Herein, I conducted observations, interviews, and collected materials, field notes, and personal reflections upon the research process. These interviews were recorded, transcribed and coded, in conjunction with the data from observations and material/artifacts collection. During and after the times of data collection, I thanked the participant and maintained openness, in a continued effort to ensure ongoing trust and a professional relationship.

In this journey of data collection and analyses, I saw many connections between the perspectives of the participant, observations of her professional practice, and the analyses of her materials that interwove TPACK and UDL strategies. Within the context of UDL, I believe that the participant provided a variety of options for perception, language and symbols, and comprehension in her classroom related lessons and activities. Simultaneously she provided multiple means of action and expression, and multiple means of engagement. Many of these
options were provided through a variety of digital formats, which were corroborated between the interviews and the materials/artifacts collected through this process.

Concurrently, much of the data verified that the participant had a strong technology knowledge at the time of this study. She knew how to solve the majority of her technical problems; learned technology rather easily; kept up with many new and current technologies; frequently experimented with the technology; knew about a lot of different technologies; and possessed the technical skills to use technology in her classroom.

With respect to the participant’s content knowledge, the data sources also verified that she possessed sufficient knowledge about her specific discipline of instruction, that particular discipline’s perspective, and simultaneously possessed various ways and strategies for developing her understanding of the material taught. The patterns of her pedagogical knowledge, pedagogical content knowledge, technology content knowledge, technological pedagogical knowledge, and technology pedagogy and content knowledge followed similar trends.

The study lent insights as to how the participant in this study collaborated with other school faculty, other school staff, and stakeholders in student success, including parents. Insights highlighted the impact of professional development upon the TPACK of the participant. Collectively, these data sources helped answer the research questions of how an educator utilized technology to support inclusion-based practices in the classroom.

I observed that this particular educator invested a great deal of her personal time, effort, and even financial investments, in an effort to maintain and further her professional practice with technology. Simultaneously, I found that this particular individual used a variety of creative solutions to circumvent the obstacles in her continuous development. From this investigation, I was able to get an inside view of the participant’s personal learning network and resources, which had a significant impact on how this individual refined her TPACK and UDL-based practice. The participant was an active contributor to the ever-growing, teacher-owned and teacher-operated online marketplace, teacherspayteachers.com. Within virtual communities and online resources, this particular educator was highly regarded by peers from across the world and received noteworthy praise for the materials that she had developed.
Limitations

In the nature of a case study, the scope and breadth of this study was limited only to one individual as a single instance, with limited generalizability (Stake, 1995). Beyond the phenomena described and detailed in this study, personal meaning, applicable to other populations may be inferred to transfer by those reading the study. Additionally, this study was limited to the time that was spent in the field collecting data to tell this particular story at hand. This study was limited by my own sensitivity and experience as a researcher, and thus, the aforementioned and related issues of reliability, validity, and, again, generalizability. Additionally, due to the extreme uniqueness of this particular educator and her experiences, it is difficult to transfer and generalize the findings from this study and apply them to other practitioners in the field.

However, despite views that denounced the wide-scale application of insights garnered from case studies, Flyvbjerg (2006) contended that generalizations, in fact, can evolve from single case studies, and thus, contribute to scientific development through practical knowledge. He went on to argue that, contrary to historical beliefs, case studies can serve important methodological roles in testing, not simply generating, hypotheses and the development of theories, even in the context of cases centered around human learning.

Definition of Key Terms

Throughout this study, the following terms were utilized:

**Applications.** Computer applications or “apps” are synonymous with computer software utilized on various technological devices such as a desktop or laptop computers, tablet devices such as an iPad, or smartphone/handheld devices such as an iPhone or iPod. Within this study, the term application or app referred to the use of the software for a specific purpose and the software itself.

**Artifacts.** Artifacts are objects, tools, or products developed by a person to serve a functional purpose for either learning or instruction, or to solve any related problems inside, or relevant to, the classroom. An artifact may be physical and tangible, or digital and virtual, in its design. For this research project, an artifact referred to any products that served as instructional materials either used by instructional staff, such as, teachers or educational assistants or students in the classroom. Such products included a variety of intellectual property created for
instructional purposes. These artifacts included, but certainly were not limited to, interactive files, assignments, activities, presentations, and additional resources.

**Assistive Technology (AT).** AT is synonymous with adaptive technology, and is meant to include any device or combination of technologies to provide assistance for individuals with disabilities. The goal of AT is to foster and sustain greater independence by enabling individuals to carry out particular tasks. In this study, AT may either be high tech (the most advanced and sophisticated technology available), low tech (technology that is produced or developed by an individual or small group of individuals), or a combination of the two.

**Educational Technology.** Educational technology is “the study and ethical practice of facilitating learning and improving performance by creating, using, and managing appropriate technological processes and resources” (Association for Educational Communications and Technology [AECT], 2013, p. B-3). Instructional technology is the “theory and practice of design, development, utilization, management, and evaluation of processes and resources for learning” (Seels & Richey, 1994, p. 1). In the context of this study, educational technology referred to the former definition, including the process of utilizing, building, delivering, and evaluating technological tools and methodologies in the classroom.

**Hardware.** Hardware, for the purposes of this study, included any physical component or device that connects to a computer system or related technologies in the classroom. Examples of hardware included a SMART Board, Waycom tablet, scanner, digital camera, printer, or USB headset.

**Portfolio.** A portfolio is a collection of artifacts used to demonstrate the evidence of mastery of a particular set of skills and resources. These artifacts included, but were not limited to electronic files such as Microsoft Office, Adobe PDF, SMART Notebook and Teacher files, websites, additional multimedia (images, sound, and video), student work samples, and other computer and web-related content. Personal reflection or blog entries were considered part of the portfolio as well.

**Professional Development (PD).** Professional development, for the sake of this research, included any activities and tasks that related to the continuous refinement of one’s career goals, general or technological skill set.

**Software.** Software, for the sake of this research, was defined as a collection of computer data and instructions utilized to perform a specific task. It included a single program or a
collection of programs utilized for specific purposes, such as word processing, collaborative and interactive learning, spreadsheet building, and so on. For this study, the terms software and applications were used interchangeably.

**Standards.** Standards for instructional content and performance guided what students, teachers, and administrators were expected to know, do, and produce. With the national and state level shift towards Common Core State Standards and National Educational Technology Standards (NETS), such guidelines shaped the development and delivery of related professional development, curriculum, and assessments. For the purposes of this study, the term standards referred to NETS, Common Core State Standards, and Hawaii Content and Performance Standards as they are individually and collectively applied towards professional development, instruction and learning in the classroom.

**Technology Integration.** This study utilizes the term technology integration to describe the adoption, application, and refinement of technology by teachers and students in the classroom setting, to facilitate and support instruction and learning.

**Universal Design for Learning (UDL).** Universal Design for learning is “a set of principles for curriculum development that give all individuals equal opportunities to learn”, (CAST, n.d., About UDL). Within the context of this study, the principles of UDL will be applied to describe efforts to support and sustain an inclusive classroom for multiple subjects.

**Organization of Dissertation**

This remainder of this dissertation is presented in the following four chapters: Review of Literature, Methodology, Findings from the Data, and Discussion and Interpretation. Chapter 2, Literature Review, surveys the following three main categories from existing literature: Universal Design for Learning, Technological Pedagogical Content Knowledge, and professional development. First, an overview of UDL-centered research is presented as the theoretical framework for understanding how instructional efforts may support inclusive settings and learning opportunities for all students in the 21st Century. To then bridge and co-support this framework, an analysis of TPACK-centered literature is presented in an effort to underscore the roles and skillsets of the educator in facilitating UDL for inclusion-based classrooms. To complement these areas and the dual framework of this study, literature about professional development and details about opportunities for educators in Hawaii is presented and reviewed.
Additionally, Chapter 2 will present an overview of single-teacher focused studies, in an effort to substantiate the need for additional research and to justify the methodological strategy for this particular study.

Chapter 3, Methodology, presents the research methodology of this study. This research will focus on a specific Hawaii Department of Education (HDOE) classroom that supports students with and without disabilities, within an inclusive setting. The participant of this study will be a general education teacher who works with a special education teacher and educational assistant (EA) to support an inclusive, first-grade classroom for the HDOE. To collect data, in an effort to address the research questions in this study, interviews, the collection of instructional artifacts, and general observations during instructional time was utilized. This chapter is divided into the following main segments: participant, description of the instructional setting, data collection and instrumentation, and data analysis.

Chapter 4, Findings from the Data, presents the findings and results of the study. From here, Chapter 5, Discussion and Interpretation, gives an overview of the study and provides conclusions and recommendations for educators who are both entering and practicing the field, as well as suggestions for administrators, policy makers, and future research, specifically implications and suggestions for future research that focuses upon UDL and TPACK within inclusive K-12 classrooms.
CHAPTER 2. REVIEW OF LITERATURE

Shifts towards inclusive settings are occurring at national and state levels; however, many districts and schools are not completely familiar with and have yet to fully or formally embrace Universal Designs for Learning (UDL). This chapter provides an overview of UDL, including its history, connections with brain research, and uses in education. Further, descriptions of the intersection of assistive technology (AT) and UDL are provided, with a survey of related research on AT and learning disabilities (LD). Finally, the chapter provides a historical overview of TPACK, an overview of TPACK-related literature, and a summary and synthesis of both UDL and TPACK for the purposes of this study.

Universal Design for Learning (UDL)

Much of UDL is based upon brain research (CAST, 2011) and it is through such research, that we have come to know that each individual brain is incredibly unique, and that learning is highly distributed across the brain and highly different from learner to learner. This research has helped develop the understanding that there are three distinct brain networks that are collectively active in and responsible for supporting the learning process. These networks are described by (Rose, & Meyer, 2002) as follows:

- “Recognition networks” are specialized to sense and assign meaning to patterns we see and enable us to identify and understand information, ideas, and concepts. This is the “what” of learning.
- “Strategic networks” regulate primarily the executive functions and are specialized to generate and oversee mental and motor patterns. They enable us to plan, execute, and monitor actions and skills. This is the “how” of learning.
- “Affective networks” are specialized to evaluate patterns and assign them to emotional significance; enable us to engage with tasks and learning the world around us. This is the “why” of learning.

Respectively, CAST (2012) goes on to outlay how UDL is based upon three principles to support recognition learning, through providing multiple means of:

I. Representation – that is, offer flexible ways to present what we teach and learn.
II. To support strategic learning, provide multiple means of action and expression – that is, flexible options for how we learn and express what we know.

III. To support affective learning, provide multiple means of engagement – that is, flexible options for generating and sustaining motivation, the why of learning.

History of UDL

To understand the context of UDL, it is important to identify how specific historical pathways led towards the origin and concept of inclusion. In 1990, the passage of the landmark federal legislation, the Individuals with Disabilities Act (IDEA), served as a significant moment in education for students with disabilities, special education services, stakeholders and service providers for their success. Specific provisions that emerged as a result of IDEA included eligibility for services, the individualized education program (IEP), related services, free and appropriate public education (FAPE), procedural safeguards, and the least restrictive environment (LRE). From here, substantial amendments to IDEA were made in 1997, providing more descriptive definitions of disabilities, policies for parental disputes, as well as grants for infants and toddlers with disabilities, parent training, and statements about professional development and technology. And later in 2004, IDEA was reauthorized to advance the power of the IEP even further, expanding upon the concepts of the LRE to advocate for the “maximum extent appropriate, children with disabilities, including children in public or private institutions or care facilities, are educated with children who are nondisabled; and special classes, separate schooling or other removal of children with disabilities from regular educational environment occurs only if the nature or severity of the disability is such that education in regular classes with the use of supplementary aids and services cannot be achieved satisfactorily” (Individuals with Disabilities Education Improvement Act [IDEA] of 2004). As mentioned in the Introduction of this study, it wasn’t until the Higher Education Act of 2008 where the definition of UDL was later formally introduced as a framework for making curricula more inclusive; providing a “blueprint for creating instructional goals, methods, materials, and assessments that work for everyone – not a single, one-size-fits-all solution but rather flexible approaches that can be customized and adjusted for individual needs” (CAST, n.d., “About UDL”, para. 2).

The definition of Universal Design for Learning was provided by the Higher Education Opportunity Act of 2008 explicitly states:
The term Universal Design for Learning means a scientifically valid framework for guiding educational practice that:
(A) Provides flexibility in the ways that information is presented, in the ways students respond or demonstrate knowledge and skills, and in the ways students are engaged; and
(B) Reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students, including students with disabilities and students who are limited English proficient. *(UDL and UD Provisions in the Higher Education Opportunity Act (P.L. 110-315), 2010, SEC. 103)*

From this landmark federal legislation to present, Edyburn (2010) suggested the following ten propositions for new directions for the second decade of UDL:

“Proposition #1: “Universal design in education is fundamentally different from universal design in the built environment …[ where] the essence of UDL lies within the field of instructional design rather than architecture” (p. 36).

“Proposition #2: “UDL is fundamentally about proactively valuing diversity” (p. 36); without a diverse blueprint, it is unlikely that UDL designers will be able to design products that meet the accessibility and usability needs of all individuals, because they do not understand the special needs of some individuals.

“Proposition #3: “UDL is ultimately about design … it may be necessary to rethink UDL as a product development intervention. Perhaps the teacher's role is more appropriately associated with implementing principles of differentiated instruction (which may include some products that have been universally designed) (p. 37).

“Proposition #4: Universal design for learning is not just good teaching…. UDL represents a 21st-century intervention that seeks to use emerging insights gained from research in diverse fields such as brain imaging, learning sciences, instructional design, and technology. Good teaching has never been able to address the full range of diversity found in a classroom” (p. 38).

“Proposition #5: Universal design for learning does not occur naturally…. UDL must be recognized as a learned skill, one that is refined over time, to produce high levels of performance (p. 38).
“Proposition #6: Technology is essential for implementing UDL…To suggest that the potential of UDL can be achieved without technology is simply another way to maintain the status quo (p. 38).

“Proposition #7: UDL is not assistive technology….Twenty-first-century instruction will likely need to alter instructional practices in order to place students in the role of Goldilocks – they try multiple options to determine which option is ‘just right’ for ensuring their performance is acceptable to meet standard. Principles of fairness indicated that equity is achieved when every student receives what he or she needs (p. 38).

“Proposition #8: It is necessary to measure the primary and secondary impact of UDL…. Instructional designers need to explicitly describe the intended user of the product… Appropriate research methodologies must measure the impact of the intervention on the primary audience, as well as, the rest of the students in an inclusive classroom (p. 39).

“Proposition #9: Claims of UDL must be evaluated on the basis of enhanced student performance... The critical focus of UDL is its emphasis on the variables that can be manipulated to produce high-performance…. Ultimately, we need to understand how to measure the contributions of UDL to sustained engagement and development of expertise (p. 39).

“Proposition #10: UDL is much more complex than we originally thought….We need to clarify the core stakeholders (developers or teachers) who will be trained to create UDL products,…. implement UDL, … measure the outcomes of UDL … [and] renew our commitment to equitably serving all students in the event that our UDL efforts fall short (p. 40).

Brain Research and UDL

In Teaching Every Student, Rose and Meyer (2002) established connections for how brain research complements much of the foundations of UDL. New knowledge indicates that not only are the three main networks of the brain (recognition, strategic, and affective) different in purposeful and physical characteristics, but that these networks are interconnected and operating together, working in distributed processes that are both “bottom-up” and “top-down” within their processing hierarchies (Rose & Meyer, 2002). Understanding these three networks is essential for identifying and meeting the needs of learners as individuals, proactively understanding and addressing students’ strengths and challenges, and for creating supports, tools and structures that
address their distinct learning needs. As mentioned earlier, UDL focuses on the recognition network.

With respect to creating meaning during educational experiences, much research emphasized the fact that learners must practice active listening to remember what they hear (Gabrieli, Poldrack, & Desmond, 1998; Posner & Pavese, 1998; Smith, Jonides, Marshuetz, & Koeppe, 1998) and that listeners must focus deliberately and efficiently (Grossman, 1999). However, many individuals have difficulty with hearing, processing semantic colloquialisms, and interpreting visual signals. Injury resulting in problems with language interpretation and vocal recognition can hinder individuals’ capacity to differentiate between different vocal and emotional tones, and thus meaning behind much of what is said (Tucker, Watson, & Heilman, 1977). Additionally, individuals with emotional and behavioral disturbances may also find difficulty with active listening (Quinn, Kavale, Mathur, Rutherford, & Forness, 1999).

Interpreting text and images characterizes reading as a complex and complicated undertaking, which requires coordination across all networks of the brain. As a consequence, Rose and Meyer (2002) strongly suggested that teachers need to be provided with better quality media, not necessarily an increase in the quantity. Digital media is seen as the preferred format as it offers versatility and malleability; it can also be tagged, marked, coded, and thus, shared across multiple networks. This flexible nature of digital media enables content such as speech and text and to be transformed, tweaked, and customized to a variety of formats to accommodate individual learning needs and preferences (Rose & Meyer, 2002).

Rose and Meyer (2002) suggested supporting students' diverse recognition networks by providing multiple examples, highlighting critical features, providing multiple media formats, and supporting background context. As for diverse strategic networks, stakeholders are encouraged to provide flexible models of skilled performance, opportunities to practice with supports, deliver ongoing, relevant feedback, and offer flexible opportunities for demonstrating skill. Furthermore, to address the range of affective networks within the student populations, instructional actions and design should offer choices of content and tools, offer adjustable levels of challenge, choices of rewards and opportunities for learning contexts (Rose & Meyer, 2002). These underpinnings of UDL have emerged from neuroscience.
Multiple Intelligences and UDL

Silver, Strong, and Perini (2000) introduced multiple intelligences and learning styles, and intertwined the two as crucial foundations for understanding how to support instruction within classrooms. Silver et al. expressed this opinion as an opportunity to connect learning styles and multiple intelligences as methods for interweaving meaningful learning across classrooms for students of all ages and as methodological approaches for assessment.

Similarly, Teele (2000) emphasized the importance of integrating multiple intelligences with a focus on how students learn. She challenged traditional lecture-oriented instruction, and recommended changes in our thinking about education by looking at learning as a continuum, similar to the spectrum of colors in a rainbow. This view advocated for ongoing multiple approaches towards representation, action and expression, and engagement.

Researchers (Armstrong, 1998; Silver et al., 2000; Teele, 2000) have recognized how multiple options of representation, expression, and engagement have had positive impacts upon student accomplishments. Armstrong (1998) noted that each child uniquely qualifies as a ‘genius’ and detailed how eventually roles established at home, school, and also through media assist in fading out these attributes and qualities. He suggested teachers invoke several avenues for sparking the excitement of learning, in an effort to combat this effect. Armstrong called for the sharing of “genial” experiences that strive to highlight and support a complete, comprehensive range of student passions, unique ideas, and qualities as individuals.

At the forefront of research for special education and technology is the Center for Applied Special Technologies (CAST), “a nonprofit research and development organization that works to expand learning opportunities for all individuals, especially those with disabilities, through Universal Design for Learning” (CAST, n.d., “About CAST”). Through its research, CAST denoted four significant shifts in ideas centered on teaching and learning: 1. Students with disabilities follow along a continuum of learner differences, just as other students do; 2. Teachers should make adjustments for all students, not just those with disabilities; 3. Curricular materials should be varied and diverse as the learning styles and needs in the classroom, rather than textbook–centered (currently possible with digital and on–line resources); and 4. Rather than the students trying to make adjustments themselves, the curriculum should be flexible and accommodate a range of student differences.
The principles of universal design underscore this perspective, encouraging adaptability and flexibility with the application of digital tools. UDL principles provide a framework for instructional use, emphasizing instructional approaches to utilize multiple means of representation. These principles also structure instructional approaches to utilize multiple means of expression and control, to provide and promote greater student choice and autonomy. Furthermore, principles of UDL call for multiple means for engagement, targeted to the affective system, which highlight different ways of holding students' attention and strategies for motivating them to learn (Meyer & O'Neill, 2000).

At the core of UDL, is support for differentiated instruction (Tomlinson, 2004), where educational efforts are catered specifically for individual student success, with a variety of instructional supports, teaching strategies, and opportunities for students to express themselves, assess and collectively monitor their success on a seamless, continuous basis. This philosophical shift in a time with many technological advances and changes in the nature of educational content, support UDL approaches within traditional teaching. The roles of educators now are less knowledge-providers, but rather facilitators, coaches or guides (O'Donnell, 1998). Learning is more process oriented (Graves, 1983), emphasizing cooperative learning (Johnson & Johnson, 1989) and promoting demonstration of learning and a wide variety of media (Sizer, 1999).

We may infer that curricula, consisting of a variety of goals, assessments, materials, and methods, need to build-in a manner that acknowledges the learning needs of all individuals (Rose & Meyer, 2002). Goals should be explicitly presented, in a manner in which they present the correct level of challenge for learners, without creating unnecessary impediments to learning. Assessments that are both formative and summative, too, need a certain amount of flexibility that help produce meaningful evidence on how all learners are attaining their learning goals, and, how changes to instruction and approaches to material design can further student learning (Rose, Hall, & Murray, 2008). Materials and methodological approaches should vary and facilitate an ongoing equilibrium of rigor, guidance, and access that ensure students attain success, in manners that address and best support each student, individually (Meo, 2008).

**Support for Students with Specific Disabilities**

With respect to students with specific disabilities, there are many considerations and resources that may be utilized, with both high tech and low-tech capabilities and costs that may provide and support appropriate accommodations and modifications within the inclusive
environment. For students with poor vision, Kelly (2000) suggested using large print for video displays and printers, speech synthesis/screen readers, fax, electronic messaging, verbal descriptors shown on video and television, and accessible websites appropriate for screen readers. For students who are blind, certain technology options are considered essential (Lupo, 1997). These tools include speech synthesis, hard-copy braille, refreshable braille (paperless), fax, electronic messaging, and verbal description for video and television, and accessible websites appropriate for screen readers. Kelly (2000) also recommended the use of captioned television and videos, fax, language development and computer-assisted instruction for reading and writing skills, and C-Print (a hearing operator who transcribes a spoken lecture on a PC, which uses a combination of words for a word processor and abbreviations on any type of productivity processor, enabling the note-taker to transcribe words as rapidly as they are spoken) for students who are deaf or hard of hearing.

Additionally, for people with physical disabilities, Langone (2000) suggested environmental modifications for placement of the keyboard, monitor or both; keyboard adaptations; software to stimulate mouse movement; alternative keyboards; and, software that allows the user to control computer functions. It is also possible that new gesture based and tablet based computing may also offer similar assistive technological advantages (Campbell, Milbourne, Dugan, & Wilcox, 2006).

Individuals with moderate to severe mental retardation in the inclusive setting may benefit from many features of technology (Okolo, 2000; Wehmeyer, 1999). Examples of helpful technological features may include computer-assisted instruction that breaks skills down into smaller steps, with unlimited opportunities for repetition and practice with feedback. Simulations may also be beneficial when presenting situations in which students can practice social skills, life skills, and vocational skills prior to transferring the skills to real-life situations and in which the risks or a logistics might reduce practice opportunities. Additionally, augmentative communication devices with communication boards pictures and words, so that students can communicate desires, requests, social interactions, and so on.

Because students with autism frequently feel more comfortable with computer technology and personal communication situations, many technological tools may be of great benefit to families and teachers (Bott, 1998), such as computer-assisted instruction, and possibly, simulations for social skills and skills training. Additionally, students who have severe behavior
problems or emotional disturbance may benefit from the use of technology in several ways (Hieneman, Dunlap, & Kincaid, 2005). The computer can help students and teachers discover hidden interests or talents that can be used to re-direct unacceptable or difficult behaviors. Computer time can additionally serve as an activity reinforcement to help students engage in more productive behavior during class. As with students who have learning disabilities, the computer can serve as an organizing tool to help students keep track of their work. The private and anonymous features of communicating on the Internet may provide students with an avenue for communication and reflection (Male, 2003).

**Supporting Reading and Writing with UDL**

Palincsar & Brown (1984) noted that research on skills needed for successful reading comprehension has shown that students need the metacognitive skills of predicting what a passage or reading selection will be about before starting to read, classifying unfamiliar words through pronunciation prompts, explaining definitions, or using root word strategies to build meaning, self-questioning for meaning (Who? What? When? Where? How? Why?) at both surface and deep level, and, paraphrasing and retelling the key points. Modern educational technologies can support these skills and processes that relate to successful reading and sustained retention.

When children are first beginning to read, they may encounter three significant obstacles to growing and developing as successful readers (Snow, Burns, & Griffin, 1998). Their primary challenge starts with the comprehension and usage of the alphabet, the concept that the various combinations of letters correspond to verbal expression. Text proves to be especially difficult to utilize, if, at the outset, individuals struggle with recognizing words accurately or with automaticity. A second barrier to effective reading is the inability to transform strategies for understanding in an auditory and spoken format into that of reading, and from there, to build and evaluate new techniques for decoding and effective reading. Collectively, these first two barriers may be compounded by a third factor: the personal drive and intrinsic reward found through the process of reading (Snow et al., 1998).

Skills for decoding and fluency quite often are the foundations for building comprehension skills (Male, 2003). Additionally, the prior knowledge and experiences that individual learners possess and bring to the classroom, also impacts comprehension, and are often overlooked in both instruction and assessment (Male, 2003). Strategic tactics for reading
may be underutilized or seldom emphasized within instructional settings. Some researchers (Fletcher, Lyon, Fuchs, & Barnes, 2007; Guthrie & Wigfield, 2000) underscored and validated the need for integrating such strategies for reading.

Reading and writing-based instruction, especially when it is only paired and presented with static, print-based based media, can be a challenge for educators and students alike. Print is static, a one-dimensional medium that is not designed nor is it flexible to address individual student needs (Bryant et al., 2014). In contrast, pairing stories, songs, and digital text with high quality images and interactive pictures are much more customizable, interchangeable and dynamic. Research shows these formats are especially helpful in addressing and meeting the needs of readers who are challenged by furthering their strategies and skillsets (Dalton & Strangman, 2006). Quickly and easily, texts within a digital format can be altered to address individual learning needs and integrated within a variety of contexts. It is this media that can change and support the reader to meet his/her needs, and not the other way around.

Digital media can be utilized to create “scaffolded digital reading environments” or SDR framework (Dalton & Proctor, 2007, p. 422; Dalton & Proctor, 2008, p. 306). SDR’s empower students to interact with text in ways that are purely inaccessible with traditional, flat print. SDR’s may be utilized to support reciprocal teaching (Palincsar & Brown, 1984) and may be especially useful with introducing and supporting vocabulary instruction (Beck, McKeown, & Kucan, 2002). SDR’s have presented promising results in reading achievement for students with learning disabilities (Dalton, Pisha, Eagleton, Coyne, & Deysher, 2002), students who are identified with intellectual disabilities (Coyne, Pisha, Dalton, Zeph, & Cook Smith, 2012), students who are deaf or hard of hearing (Dalton, Schleper, Kennedy, Lutz, & Strangman, 2005), and even for students who are learning English as a second language (Dalton, Proctor, Uccelli, Mo, & Snow, 2011; Proctor, Dalton, & Grisham, 2007; Proctor, Uccelli, Dalton, & Snow, 2009). SDR’s are designed to engage all students and intertwine structures and support that can match the learning needs of individual students.

Instructional strategies, such as reciprocal teaching (Palincsar & Brown, 1984), when instructors and their learners talk about text while also engaging with the medium, have proven to boost students’ comprehension and sustain their attention and efforts towards reading (Male, 2003). In this practice, student-teacher discourse is built upon four main tactics: predicting, questioning, summarizing, and clarifying. The goals are for the instructor to initiate discussions
and to gradually facilitate and fade from the position of the expert or director, as students gradually assume these roles. Graphic and advanced organizers can support and facilitate these discussions and strategies, and have been proven effective with both print-based text (Palincsar & Brown, 1984) and digital, interactive tools (Morgan, Ferdig, Pearson, Wardrop, & Blomeyer, 2008). The guidelines and three overarching principles of UDL correspond to the teaching and learning of reading.

**UDL Guidelines**

It is important to note that UDL strongly emphasizes technology’s vast potential and its ability to support instructional flexibility, as well as pedagogical routines to support individual needs. Such refinements in professional practice and development by practitioners and other stakeholders are essential components that contribute to the support of students who may have disabilities or who may struggle with other learning-skills. UDL efforts can benefit an entire range of students, not just students with disabilities (Hitchcock & Stahl, 2003).

Digital media, by its nature, is flexible and malleable and can be used to create robust academic content that can be displayed in a variety of layouts, designs, and systems. Formats may include text, images, audio, movies/videos, digital-interactive objects, and even video games share customizable properties that may be altered to address individual needs quickly and easily (Rose & Meyer, 2002; Simpson, 2009). The amazing potential of such content may be extended further, through the use of networking and hyperlinking (Edyburn, 2009). These strategies and tools can certainly be high-tech, but not all UDL-centered solutions have to be. High quality UDL-centered instruction may utilize technology or not (Edyburn, 2010). The use of UDL guidelines may help steer and structure UDL instructional efforts.

UDL emphasizes the mastery learning process, where curricula supports the needs of learners guided by the UDL principles created by the Center for Applied Special Technologies (CAST). CAST’s guidelines for UDL are represented in Figure 2.1. The guidelines can be viewed as a strong resource for educators and curricula designers involved in instructional planning and development of curricula (Meo, 2008). Learning for each individual is different (Rose & Meyer, 2002) – and the UDL guidelines can steer the development stages of curriculum design to ensure that curricula are proactively tailored to meet individual learning needs. Therein, learning is not supposed to be a simple or easy endeavor, but a process that intertwines “desirable difficulties”
(Bjork & Bjork, 2011) or meaningful challenges and experiences that provoke, sustain, and reward learners across multiple learning environments.

UDL guidelines call for multiple means of representation, multiple means of action and expression, and multiple means of engagement (Rose & Meyer, 2002). Instructional practices are expected to deliver a variety of options in the way that educational content is delivered to students. Indeed, within the 21st Century, the lines between educational content and technological knowledge are blurring (Collins & Halverson, 2009), altering traditional perceptions and practices of students, learning, and educators in the field. In traditional settings, individuals have been labeled as “disabled”, yet in fact it may be the curricula that hinder individuals from accessing, interacting, and mastering content (Rose & Gravel, 2010). Such issues in traditional curricula may be unintentional. However, such issues permeate all facets of curriculum design and delivery, including setting goals and determining methods, materials, and assessments. To combat these hindrances, the UDL guidelines have three foundational principles: 1) provide multiple means of representation; 2) provide multiple means of action and expression; and, 3) provide multiple means of engagement (Rose & Gravel, 2010).
The manner in which students interact and show proficiency in their knowledge, tasks, and skills are also of instructional significance (Edyburn, 2010). UDL guidelines lay out provisions to proactively support students with disabilities and students with limited English proficiency, providing them with equitable access to learning at all times. If educational material or information is exclusively delivered via only one particular method, mode or instructional media, a range of students will undoubtedly be discounted from the experience and curriculum. The same can be said for students who are permitted to communicate in only one specific...
manner. In order to build fluency and automaticity, options are critical for students and their instructors to embrace (Rose & Meyer, 2002).

Using UDL principles can facilitate and help students develop their executive functions, which in turn can help them realize the importance and meaning behind much of their learning experiences (Rose & Meyer, 2002). When students have greater autonomy and a range of opportunities, they are more likely to be engaged and thus, more likely to learn. By varying activities and choices for students, especially if they are authentic in nature, students are more likely to sustain their interest and establish a range of connections with educational content, material, and information, both furthering and enriching their prior experiences and understandings (Rose & Meyer, 2002).

It is when activities are too difficult and when choices are limited for students that they become disconnected and disinterested with educational content (Rose & Gravel, 2009). When balance is attained, on both individual and collective levels for student communities, tools, alternatives and options for students can counter disengagement (Rose & Meyer, 2002). Educators involved in ongoing and meticulous planning, can be supported, most certainly, by the UDL guidelines.

Consequently, these UDL guidelines are tenets or goal posts, so to speak, as to suggest curricular design and instructional practices for stakeholders in education to integrate, in order to foster learners who are both independent and successful. The UDL guidelines may be interpreted from a perspective of individuals who design materials, deliver instruction, or in many instances, both. By following the guidelines, educators may aim to develop learners who are resourceful, knowledgeable; strategic, goal-oriented; and, purposeful, motivated learners. Cast (2011) recommends the following:

1. Providing multiple means of representation – the “what” of reading. This knowledge helps educators and emerging readers understand the distinction and meanings of words. This principle demonstrates the brain’s recognition networks.

2. Providing multiple means of action and expression – the “how” of reading. This foundation helps practitioners and stakeholders understand the tactics and skills application to comprehend text and to communicate what is understood. Respectively, this principle links to the brain’s strategic networks.
Providing multiple means of engagement provides the “why” of reading. This principle helps to understand how developing readers connect to reading on emotional and motivational levels, and connects to the brain’s affective networks. (CAST, 2011, p. 5)

There are many strategies and tactics that may be utilized and further refined to support the implementation UDL guidelines. The following UDL guidelines and strategies from CAST (2012) may be employed to assist all learners with reading:

- **UDL Guideline 1** calls for providing multiple means for perceptions, and pairing struggling readers with text-to-speech (TTS) software provides an opportunity for them to focus on understanding content, and less time on decoding oral text.
- **UDL Guideline 2** suggests options for language and symbols; this can be especially helpful for English language learners, who need supports other than just oral guidance.
- **UDL Guideline 3** suggests options in comprehension, and thereby, access to words and their meanings. Graphic organizers and various technologies (both high and low-tech) can be effective in helping students construct context and highlight critical information within text.
- **UDL Guideline 4** underscores the provision of options for physical action, and again, creative solutions may be both high-tech and low-tech in their nature and design.
- **UDL Guideline 5** suggests options for expressive skills and fluency, and thus has implications for the method in which individuals express themselves, not just physically. An example of a unique tool that may support such services is TextHelp, a tool that is available in UDL Editions (see Figure 2.2). This tool serves as a toolbar that “balances challenge and support for each learner” (CAST, n.d., *UDL Editions*)
- **UDL Guideline 6** advises giving students options for their executive functions, which entails skillsets for establishing goals, and observing their progress. Although many students do this with automaticity, such progress can also be represented in number of different ways, and students may help design solutions and partake within the routines relating to measuring progress. To be successful, readers must be
functional and involved in the practice of reading. They must know how to persevere and measure their growth, and modify their goals and related methods.

- **UDL Guideline 7** recommends the need to sustain the interest of readers. Underlying this need is the importance for readers to embrace the fact that reading has a meaningful role in their lives, not merely an arduous task that is asked of them. Interest can be recruited by granting students autonomy, in order to choose what they want to read or how they may be supported, independently.

- **UDL Guideline 8** endorses providing options for maintaining students’ determination and perseverance. This skillset is especially necessary to keep students’ attention and difficulties with reading in check. SDR’s may help combat boredom and other roadblocks that impede students’ personal connections with reading material and content.

- **UDL Guideline 9** underscores the provision of self-regulation, where in sum, all related strategies of all UDL are geared students towards greater independence (CAST, 2011).

![Figure 2.2](http://udleditions.cast.org/)

*Figure 2.2. Reproduced from *UDL Editions* by CAST (n.d.). Retrieved from http://udleditions.cast.org/*

Another thing to consider with respect to technology is the collective definition of literacy. As technologies evolve and progress, the definition of literacy changes concurrently. For students born into a world of greater interactivity and digital technological advancements than the generation before, “literacy” means something different, as will continue do so for the next generation (Male, 2003).
For “digital natives” (Prensky, 2001) technology is both a tool and literacy. Accordingly, SDR’s can incorporate UDL-guided designs to make reading engaging and balanced with challenge, for students as they mature as readers (Dalton et al., 2011). Digital text has the critical features and abilities to change into formats that provide greater access and strategies for students traditionally shut down by traditional print (Meyer & Rose, 2005). Educators will not be supplanted by technology, but technology has the ability to influence the roles and relationships that educators have with students, pedagogy, content, and technology itself (Male, 2003). At its core, technology’s most important focus is to provide access and equity to readers, as they become successful, independent and life-long learners (Morra & Reynolds, 2010).

Quite similar to reading, writing too, connects all academic subjects, and students are consequently expected to utilize writing to connect and present understanding and mastery of content (Gersten & Baker, 2001). The ability to write and to write well is also contextual to specific subjects (Graham & Perin, 2007). Regardless, narrative writing requires the presentation of rules, exemplars, ongoing practice (Langer, 2009), and structure, also known as process writing (Graham & Perin, 2007). The process of writing is divided into four distinct stages: a) clarify, b) pre-compose, c) compose, and d) publish (Badger & White, 2000). Although these stages are discrete and distinct, the process of writing is an organic progression that involves ongoing planning and evaluation, writing itself, and continuous revision (Male, 2003). Throughout each stage, students learn its purpose with individual guidance and practice (Applebee & Langer, 2006), and then collectively through collaborations with the whole class (Male, 2003). Additionally, Arnett (2000) suggested that for reading especially, the combination of student choice, targeted reading levels, ongoing assessment paired with instant feedback, self-monitoring to review progress, and a rewards/recognition system results in reluctant readers becoming motivated readers.

Instruction that is effective certainly begins with the foundation of establishment of succinct, challenging but attainable goals for all learners (Rose & Meyer, 2002). The instruction of writing is certainly no exception. In an effort to steer the effective writing instruction and learning, the following guidelines are recommended:

1. Provide well-defined writing goals, but do not provide specifics on how to meet them.
2. Keep the path to writing challenging, but embedded with flexibility and options in order to accomplish these goals.
3. Keep learners absorbed and encouraged along the journey of learning to write, by giving them autonomy and ownership of tactics, various learning instruments, and creative pathways that connect to the overall learning goals. (Meo, 2008)

A major component of motivating students throughout the writing process involves feedback from both teachers and peers. Such feedback can serve as the foundation for relaying and supporting the understanding of what defines good writing. However, time, classroom sizes, and often the curriculum itself may serve as collective hindrances for building appropriate interactions and discussions about student writing (Male, 2003). One particular strategy for the writing process of incorporating classroom-community strategies to provide individual and group feedback on the writing of peers is through the writer’s workshop method (Gabriel, 2002).

When students are involved directly with the writing process and assessment process, with greater autonomy and awareness of both their own goals and current levels of performance, they too can strive and achieve stronger writing skills (Amato & Watkins, 2011; Murphy & Yancey, 2008; Topping, 2009). Curriculum based measurement (CBM) is established when assessments are straightforwardly connected to specific curricula. Such processes are legitimate and consistent methodological strategies for enabling educators to observe what is working across the systems of their instructional strategies and design, to further assess students’ progress, challenges, and, if needed, additional interventions (Deno, 1985; Shinn, 1989).

Additionally, when peers are a part of the assessment process, they too can provide additional supports to individuals, as both assessors and the assessed (Masten, Morison, & Pellegrini, 1985; Topping, 2009). In such situations, educators focus less upon direct instruction and more upon facilitating student relationships and building and clarifying criteria for effective writing and student performance (Topping, 2009). Teachers may intervene to offer suggestions and provide direct supports if needed, while students are generally given greater autonomy and a range of options for identifying and employing what works best for them as developing writers. Thereby, students are actively involved in this participatory system, as they both guide and evaluate each other’s writings (Topping, 2009). Thus, students are further engaged on multiple levels, academically, socially, culturally and emotionally – throughout the writing process (Topping, 2009). At the culmination of these activities, educators will provide meaningful feedback and collectively organize the input and resources from peers and their newly, improved proficiencies in writing (Murphy & Yancey, 2008).
In addition to assessment from peers, self-assessment can play a similar role as students dive deeper into the reflective process of taking the feedback from their teachers and peers, and reflecting upon their own writing. Such strategies can allow students to make stronger connections with their personal performance and evaluate, and track, their individual growth (Murphy & Yancey, 2008). Collectively, the benefits and customization of these strategies will range from students as individual, as well as from teacher to teacher, across different classrooms.

With writing, there are many skills involved that cannot quickly be transferred across curricula and subjects. If a student masters writing in one particular subject, it does not necessarily mean that these skills and mastery will directly connect to another subject or related strategy (Male, 2003). Students should be provided opportunities for planning, practice, and evaluating writing across a range of subjects. Along this process, they should be guided with encouragement, examples of exemplary writing, and reasonable goals along the way, in an effort to minimize frustration and boredom (Jiménez, Graf, & Rose, 2007). Again, UDL can serve as an effective framework that carefully directs teachers to build instructional tactics that tie in these effective strategies, goals, and methods for accomplishing writing tasks and related benchmarks, with a range of tools, for a range of student learners (Rose & Meyer, 2006).

**Pairing UDL with Technology**

In addition to effective teaching, technology, too, offers a wide range of benefits to students with disabilities and all stakeholders in their success within the inclusive classroom and beyond (Lewis, 2000). Technology can bridge the gaps that have historically existed with much traditional educational media and instruction (Rose & Meyer, 2002), echoing the notion that many challenges that educators face lie within the curricula itself, not within students themselves. However, this perspective represents a strong contrast to the status quo. McKenzie (2000) affirmed that ongoing questions and questioning, more so than the technology itself, would lead to greater insights in student performance and success. Students should remain at the focus and core of instructional efforts and design, yet it is also undeniable that technology offers a wealth of opportunities to empower students, teachers, and family with a range of productivity tools (Rao & Skouge, 2015). Technology can proactively assist a wide gamut of students, by establishing choices for students, as well as modular and authentic instructional settings from the very start (Strangman & Dalton, 2005).
Multimedia, specifically, requires more than understanding the operation and functionality of current technology, but also its application and purpose. Consequently, these tools offer a new perspective in how curricula is designed, delivered, and evaluated, and how student interactions are facilitated and modified to support learning for all (Mageau, 1994). As Papert (1990) concluded, multimedia offers changes in the way that teachers and students access content, and thereby the way in which they interact and build subsequent understanding and personal mastery, in a far-reaching, multi-sensory “micro world.” Gardner (1985) and others (Armstrong, 1998; Silver et al., 2000; Teele, 2000) contended that there are multiple intelligences and that no two students can or do learn exactly the same way. Thus, perhaps multimedia-supported learning can introduce new, supportive relationships and experiences between educators and their students.

Digital tools and how they relate to content, multimedia and hypermedia, can foster opportunities for social growth and various interpersonal interactions (Parr, 1995; Singer, 1998) for students that work together in groups of two or three. Further research (Male, Johnson, Johnson, & Anderson, 1986; Polin, 1992) showed that technology can support cooperative learning within computer-based applications, lessons, activities, and educational experiences. Educators have adopted computer-based platforms as a basis of cooperative learning within inclusive classrooms, in an effort to exploit the synergistic magic they produce (Sandholtz, Ringstaff, & Dwyer, 1997). Sandholtz et al. specifically called for the adoption of technology to address learners as individuals and to foster collaboration between students and educators, with greater emphases on student projects through technology.

**UDL and Assistive Technology**

As UDL has become further researched (Rose, Harbour, Johnston, Daley, & Abarnell, 2006) focus has also shifted to keep with ever-changing technologies and related practices. Technology certainly plays a critical role in universally designed curriculum (Bryant et al., 2014). Based on the Tech Act of 1998 and IDEA 2004, AT is defined as “a combination of AT devices and services that are intended to enhance the skills of people with disabilities in a variety of contexts of interactions.” Rose et al. (2006) and Edyburn have also noted the differences between UDL and AT, however, it is possible that the two can certainly be complimentary and, in certain instances, UDL may supplant particular AT investments and related services (Bryant et al., 2014) for students with various disabilities, including learning disabilities (LD).
This inherent flexibility and customizability of digital technologies allows individuals with disabilities to access instructional content. For example, text may be read aloud or transformed into formats that address the individual preferences and needs of learners (Pisha & Coyne, 2001; Browder, Mims, Spooner, Ahlgrim-Delzell, & Lee, 2008). Such features of technology only used to exist within the domain of AT but are now ubiquitous across a range of laptop, netbook, tablets, phones and mobile devices (Male, 2003). Other technologies, both high-tech and low-tech, such as CDs and DVDs, can also foster and support teaching and deliver instruction in different modes (Male, 2003). Electronic books, which scaffold the reading process with pronunciation, definitions, and prompted comprehension activity; word processor support with spelling and grammar checkers, and with word prediction, such as Co-Writer. Speech synthesis and idea processors such as SMART Ideas, Inspiration, Kidspiration, and TimeLiner and organizational and reference tools, such as electronic encyclopedias and dictionaries, may also be supportive and accommodating the needs of various learners (Male, 2003).

As previously stated, these technologies, strategies, and services can benefit learners both with and without disabilities. At the core, UDL may utilize these ideas to make content accessible within educational settings (Meo, 2008). Diversity permeates and connects many classrooms, and this notion is particularly true within inclusive classrooms. These practices may include collaborative, co-teaching or consultative models, where both special education and general education teachers perform a variety of tasks and roles (Friend, Cook, Hurley-Chamberlain, & Shamberge, 2010). In many instances and with experience, general education teachers may develop expertise with such diversity in their classrooms through such professional relationships with special education teachers and also the technology itself (Ertmer, 1999; Butler & Selbom, 2002).

Within these diverse classrooms, for students with LD, listening, speaking, reading, writing, mathematics, and reasoning may pose challenges in the classroom (National Joint Committee on Learning Disabilities, 1994). Consequently, many technologies, both hardware and software “apps” can possibly be integrated to support such diversity that is so commonplace (Bryant et al., 2014). Features within such technologies may include text-to-speech and multi-modal options (digital coloring, highlighting, and typing) that can support and showcase student knowledge in alternate methods and amongst different platforms (Bryant et al., 2014).
With the knowledge and confidence of such features and the potential of various technologies, educators can plan and deploy instruction that addresses the learning needs of their students. Consequently, UDL, as a framework and guidelines learning, can be integrated and refined to serve AT-needs and support diverse learners, with options and autonomy. The following section provides a greater overview of how educators develop their knowledge of technology, in conjuncture with knowledge of content and pedagogy, collectively their TPACK, to support and deliver instruction in the classroom.

**Technological Pedagogical Content Knowledge (TPACK)**

Technology alone will not serve as the foundation for integrating UDL and technology-based supports within classrooms. Even more obvious, from a traditional perspective is the fact that educators need much more experience and knowledge than that of just the subjects in which they teach. Within the twenty-first century, knowledge of technology, pedagogy, and content—and quite often varying combinations of all three forms of knowledge (TPACK) will be necessary to support students and instruction within the classroom and beyond (Bryant et al., 2014). The section to follow will introduce theoretical foundations for the TPACK-framework, supporting research, and implications for practice.

**Foundations of TPACK**

As the complex world of teaching is investigated, the roles and needs of a theoretical framework to frame such investigations can certainly play an important role and facilitate further investigations through a shared lens. To fuse traditional research with questions about teachers’ knowledge and their decision-making, Shulman (1986) posited, for example, how do researchers identify the sources of teacher knowledge and how do they acquire new knowledge to support their instructional efforts?

From these questions, Shulman (1986) suggested that researchers classify such knowledge into two distinct areas: subject matter content knowledge and pedagogical-curricular content knowledge. Shulman defined subject matter content knowledge as the quantity and structure of knowledge and expertise per individual teacher, represented through Bloom’s cognitive taxonomy, Gagne’s varieties of learning, and Schwab’s distinction between substantiated and syntactic structures of knowledge. From here, Shulman defined pedagogical content knowledge as the “knowledge of teaching” (p. 14), which goes further than the
understanding of that particular subject and underscores the knowledge of transferring it to minds of others. With respect to pedagogical content knowledge, Shulman meant that these were areas of knowledge in which an educator knows how to transfer ideas through examples, visualization, and various forms of explanations in an effort to describe and transmit meaningful information and knowledge to others. Additionally, when he referenced curricular knowledge, Shulman referenced teaching programs and related topics, as well as the materials needed to support instruction and various curricula, to deliver, evaluate and refine related instruction.

Shulman (1986) noted that complex descriptions rather than anecdotal evidence have traditionally been void in much of teaching-based research, which has historically centered on a systemized and a vast quantified collection of teacher-centered data. Such data sets, he argued, seldom provide the specifics of what teachers should know, practice, comprehend, or believe in their professional expertise, other than that of a formalized licensure from state to state and district to district. To face these issues and problems, Shulman followed the foundations set forth by prominent and ground-breaking researchers such as Dewey (1904), Scheffler (1965), Green (1971), Fenstermacher (1978), Smith (1980), and Schwab (1964), in addition to many more (Berliner, 1986; Leinhardt & Greeno, 1986). Investigations have paved the way to research how specific kinds of content knowledge and pedagogical knowledge influence the professional practice of educators, and vice versa. Historically, Shulman (1986) noted, much research has grossly overlooked the intricacies and complications of the teaching profession, as well as the vast skillset needed for such a practice and complex profession, citing the fact that educators themselves have trouble describing their knowledge and expertise, and how it formed.

Traditional educational research has ignored essential components of teaching such as the specific subject matter that is instructed and supported, the various situations and cultures in which teachers teach and students learn, how teachers themselves learn, and descriptions of these shared environments and the nature of students themselves (Putnam & Boroko, 2000). Rather, standardized testing and related research have falsely supplanted the claims of how teachers are performing, what they know, and, how they are supporting instruction and learning in schools (Fuchs, Mock, Morgan, & Young, 2003).

As part of the foundation for TPACK, Shulman (1986) contended that a knowledge base of research was needed to expand the understanding of effective teaching. Educators offer a greater and direct connection to students as individuals. It is the educator who has the ability to
manipulate and support students’ comprehension, their levels of aptitude, and student perspectives and citizenship through pedagogy and interactions (Shulman, 1986). If compiled, researching such expertise and knowledge of educators would fall under multiple categories, including, but certainly not limited to (Shulman 1986, 1987):

- Content knowledge,
- General pedagogical knowledge,
- Curriculum knowledge,
- Pedagogical content knowledge,
- Knowledge of learners of their characteristics,
- Educational context;
- Knowledge of educational context,
- Knowledge of educational purposes, values; philosophical and historical grounds.

Pedagogical content knowledge is especially an area of focus since the area demonstrates unique and specific collections of knowledge relating to teaching. Collectively, it merges pedagogy and content understandings, and organizes such information into the form of unique categories for pedagogical specialism and content specialism (Shulman 1986, 1987).

Shulman (1986) denoted that there are at a minimum four main channels for the knowledge base of a professional educator:

- Academic prowess in content areas of specialization;
- Instructional resources and surroundings;
- Inquiry on schooling and associated social contexts and variables;
- Experience and expertise from the profession.

Becoming an educator is a process in which educators are participants of a community that is based upon scholarship. Educators understand how content and subjects are organized, foundations of core concepts, and how new ideas, skills, and practices are integrated. This notion was emphasized earlier by Schwab (1964) who underscored how knowledge is both syntactically and fundamentally constructed. Additionally, content knowledge is a strong resource for wide, rich and varied educational experiences and new instructional opportunities.

Materials play a critical role for instruction and range vastly in their scope, application, and sequence in which they are integrated throughout instructional systems. Consequently, materials and resources play a critical role in how educators perform their professional practice,
and serve as a direct link to student learning, options for instruction, and student performance (Harris & Hofer, 2009). This link between the practices of educators and the growth and performance of students was echoed by Bloom (1976), Rosenthal and Jacobson (1968), and later summarized by Gage (1978), Brophy and Good (1986), and Rosenshine and Stevens (1986). There is a danger of presenting practices or applications, where generalizations evolve into mandates made on broad scales. These trends often impede instructional innovations, rather than advance and expand upon them (Koehler & Mishra, 2009). The research community role is not to develop a stagnant body of knowledge, but to offer continuous discoveries, inventions, and refinements of the field and its related sub-systems

**TPACK-Centered Literature**

Despite the promise of so many technologies, much research falls within a trend of becoming far too “technocentric” (Papert, 1990) and falls short of measuring other instructional elements required in today’s classrooms (Cox & Graham, 2009). Consequently, there is often a strong divide and disconnect between what leaders of educational technology envision for successful integration and what actually happens with various technologies across the educational sector (Ertmer, Addison, Lane, Ross, & Woods, 1999).

To focus upon technological pedagogical knowledge, a need for a framework, in conjunction with UDL, is necessary to understand teachers’ specific skill set, professional knowledge, and resources for effectively adopting and utilizing technology (Mishra & Koehler, 2006; Koehler & Mishra, 2008). In conjunction with the principles of UDL, TPACK identifies and stresses the relationships among technology, the content of various curricula, and pedagogical strategies. Collectively TPACK underscores the knowledge base for effective teaching in the inclusive classroom of the twenty-first century (Mishra & Koehler, 2006; Koehler & Mishra, 2008).

Previous and traditional studies in TPACK have focused on pre-service teachers (Mishra & Koehler, 2006; Koehler & Mishra, 2008), to describe and dissect their practice (Cox & Graham, 2009), their strategies and routines for planning (Harris & Hofer, 2009), as well as technology integration (Harris, Mishra, & Koehler, 2009) with the use of web tools (Nelson, Christopher, & Mims, 2009), and possible new directions with TPACK (Polly & Brantley-Dias, 2009). Additional TPACK research emphasizes the importance of establishing an awareness of instructional practices and types of learning activities (Harris, 2008; Harris & Hofer, 2006) that
exist across a range of subjects. Historically, much of the TPACK-centered literature has centered upon pre-service teachers (Mishra & Koehler, 2006, 2009) but researchers like Archambault and Crippen (2009) are looking at in-service teachers more closely and with specific technologies, such as interactive whiteboards (Jang, 2010). Harris (2008) goes on to suggest that the identification of such activities in content areas must be paired with multiple methods in which digital and non-digital resources may be utilized to guide learning. As a foundation for TPACK, Shulman (1986) stressed that pedagogical approaches should address a range of learning activities across different areas of content.

Harris (2008) suggested utilizing a flexible structured approach to instructional planning and design – that keeps the needs and preferences of individual students at the forefront of all planning, delivery, and evaluation of instruction. This perspective, however, is a strong contrast to the traditional routines and foci of education, despite many advances in other professional industries and organizations, even within technology in and of itself. Mishra and Koehler (2006) noted that much traditional research has focused upon the technology and not necessarily how it has been utilized in the classroom settings. Additional research has been called for, strongly underscoring the importance in studying and understanding how technology is utilized (Carr, Jonassen, Litzinger, & Marra, 1998; Mishra & Koehler, 2008).

As the paradigm shifts away from historical teacher education and teacher preparation, which focus primarily upon content knowledge and mastery (Veal & MaKinster, 1999), more current teacher education has focused its efforts and research upon pedagogical techniques and strategies (Ball & McDiarmid, 1990). Simultaneously, many technological advances such as computers, mobile devices, tablets computers, dramatic Internet growth and proliferations, and a myriad of apps that support them, are not commonplace in schools, and some have the significant potential to change the fundamental nature and structure of education, policies and practices (Harris & Hofer, 2009). Consequently, teachers will not just have to learn how to operate existing tools, but they will need a repertoire of strategies and best practices to implement them through effective educational experiences.

At the time of Shulman’s work on PCK and prior to it, knowledge of pedagogy and content were considered exclusive and separate domains. In today’s instructional practice, technology too, in many instances, is viewed as an area isolated from PCK. More recent research (Hughes, 2005; Keating & Evans, 2001; Lundeberg, Bergland, Klyczek, & Hoffman, 2003;
Margerum-Leys & Marx, 2002; Zhao, 2003) however, has grown to value the integration of technology and how it is continuously intertwining and interconnecting with pedagogy and content.

From this research and Shulman’s (1986) PCK, Mishra and Koehler (2006) were able to purposefully conceptualize the additional components of the TPACK model: technological content knowledge (TCK), technological pedagogical knowledge (TPK), and collectively take all three components to build the framework. Additional components, such as content knowledge (CK), pedagogical knowledge (PK), and technological knowledge (TK) will be of ongoing relevance to instruction and imperative mechanisms to TPACK. CK will continue to play a dynamic role in the manner in which teachers understand the content areas and subject matter for the courses they teach (Ball, Thames, & Phelps, 2008). Ball and McDiarmid (1990) also stressed that teachers must acknowledge the characteristics of knowledge and how it is to be introduced, reviewed, and applied to different subject areas.

From the perspective of PK, teachers will continuously need to understand theories and applications for classroom management, the development, execution, and evaluation of lesson plans, curricula development, and student assessment (Shulman 1986, 1987). Teachers will continue to need to know the nature of their students, their socio-cultural needs, theories of cognitive and developmental learning, and how to apply this knowledge (Shulman 1986, 1987).

With pedagogical-content knowledge, teachers will combine content knowledge and knowledge of pedagogy, intertwining the content of subjects and theory and research-based pedagogical strategies. This collective understanding enables an innate flexibility to adjust instructional levels to meet the learning needs of individual students, their experiences, educational histories and strengths, thus, constantly maintaining the flow and interactions (Shulman 1986, 1987).

Technological knowledge (TK) will need to work with a range of specific technologies that range from operating systems, to hardware, and various software and applications across multiple devices (Koehler & Mishra, 2009). This knowledge extends to the maintenance and organization of files, and the ability to adjust and adopt new technologies as they are introduced (Koehler & Mishra, 2009). As content and technology change, so will TCK and the need for teachers to act proactively in mastering such knowledge and instructional expertise. Concurrently, TPK will change, as educators need to adapt pedagogical strategies in
conjunctures with evolutions in technologies and their capabilities (Mishra & Koehler, 2006, 2008).

Collectively, TPACK stresses the importance of effective teaching and intertwines a variety of concepts, knowledge, techniques and expertise within a constructive context, to individualize student learning experiences and instruction within a variety of group settings (Cox & Graham, 2009). Knowledge of students and their distinct, personal needs, goals, strengths and challenges will greatly influence opportunities for success, as ongoing assessment will also be mandatory for monitoring progress for students and helping teachers improve their practice (Harris & Hofer, 2009).

Technology will certainly play a part of teaching and learning within the twenty-first century, but not be the single solution that applies to all educators and all students. Many of the relationships amongst technology, pedagogy and content will continue to be complex in their nature and will require preparation and responses that are specific to cases at hand, individual resources, and site-specific opportunities. Research has historically validated that teaching and learning with any newly introduced or innovative technology work within a “transactional relationship” (Luaran, Alias, & Jain, 2014, p. 30). Accordingly, technology, pedagogy and content will need to be elements that cannot be viewed separately, but will need to be viewed as interdependent components necessary for effective teaching and learning. Thus, a change in any one of the three components of TPACK, such as a new technology or arena for learning and teaching, will result in changes in the other two elements. These components represent a balance that are certainly not static and are ever-changing. Effective teaching will be able to acknowledge and adjust to these constant changes, and the equilibrium of all three, core TPACK components (Koehler & Mishra, 2009).

Summary

In the areas of both TPACK and UDL research, little overlap exists to bridge these frameworks and detail how they may influence one another, especially within the context an inclusive classroom. Existing research has not offered insights to how specific TPK, TCK, or TPACK, collectively and individually, has supported instruction and learning in a classroom for students with and without high-incidence disabilities. Existing research (Abell, Jung, & Taylor, 2011) has utilized survey-based approaches to gather student perceptions. However, little
qualitative research currently exists to understand how TPACK supports UDL within a classroom setting.

Additionally, much UDL research has focused on graduate and postgraduate populations (Ashman, 2010), as TPACK research has generally also focused upon pre-service teachers, and not upon in-service teachers. As a case study, the method of this particular study seeks to build from specific insights gained through observations and interviews to build the connections linking TPACK and UDL. The specific methodology used in this study will be explained in the next chapter.
CHAPTER 3: METHODOLOGY

Introduction

Underscoring this study was the aspiration to understand and describe what and how a particular teacher leverages her individual TPACK to design and deliver instruction for students with and without disabilities in an inclusive setting and how that TPACK supports the principles of UDL. This chapter will provide an introduction and overview of the qualitative research approach selected (case study), followed by a description of the participant and context, a description of my role as the researcher, the research design and methods for data-collection, methods for data analysis and synthesis, ethical considerations for this study, and elements of rigor: credibility, transferability, dependability, and conformability. This methods section aims to describe the procedures for gathering information through interviews, observations, and the analyses of materials to garner insights on the research questions posited by this study: How does a Title 1 public school educator utilize TPACK in preparing UDL-based instruction; and, how does a Title 1 public school teacher utilize educational technology and TPACK to support an inclusive environment and the principles of universal design for learning (UDL)?

Specifically, I will detail the processes by which I have designed this particular case study and justify my rationale for and descriptions of its structure, the instruments and processes that were utilized for data collection and analyses, procedures and field notes for classroom observations, conducting and transcribing interviews, and steps for organizing and analyzing instructional support materials and related media. Collectively this chapter seeks to present a sound and transparent design for research that may be followed in future research centered on UDL, TPACK, and inclusion.

The Research Approach

Based on the research questions of interest to this researcher, a qualitative approach was selected. In this section I discuss the qualitative paradigm and its appropriateness for exploring these questions as well as the specific choice of the case study method for conducting the study.
The Qualitative Paradigm

Qualitative research can provide an appropriate structure for examining the issues, experiences, and characteristics of a particular individual or situation, such as a specific teacher within classroom setting. Qualitative research is a step towards examining an experience or an instance in its own environment, which provides opportunities for helping others view and understand a particular phenomenon (Merriam, 1998). Such research can play an important and critical role in identifying individual “processes and practices that exist within a specific setting, location, time, context, event, incident, activity, and/or experience” (Leech & Onwuegbuzie, 2007, p. 559). Qualitative research can play an important role in shaping the development of theories and demonstrating how a series of events or routines occur in a particular environment with a set of conditions and resources (Denzin & Lincoln, 2005).

This study employed a qualitative approach that emphasized perspectives, narrative descriptions and observations within a specific inclusion classroom at a Title 1 school that incorporated a range of technologies. Through this experience, I have grown immensely as an observer, interviewer, and researcher, which, in turn has deepened my understanding of the specific phenomena within this particular case. Although my findings are not directly generalizable to other educators or to other inclusive settings, my insights may help refine future qualitative and quantitative research designs. Findings may influence the manner in which educators and stakeholders view, implement, support, and evaluate professional practice and related professional development. Additionally, conclusions from this research may influence teacher roles and perceptions related to UDL and TPACK within inclusive settings, and inform how they might be further researched.

The Case Study

Case studies involve a linear yet iterative set of processes (Yin, 2009) where planning begins the investigation and stages of design, preparation, collection, analyses, and sharing remain interconnected and ongoing. Generally speaking the case study serves as the usual methodological approach for answering “how” and “why” based questions. Yin also noted that case studies can be especially useful with contemporary true-to-life situations and events, especially when the investigator does not have much control over the phenomena that is being researched. Data are usually collected over extended periods of time in the form of direct
observation and interviews with individuals who are intertwined with the events of the phenomena being observed (Yin, 2009).

Case studies are conducted by determining a potential problem and employing the use of purposeful sampling strategies to select individuals and locations to investigate a research issue (Creswell, 2007). The participant in this study was selected because of my prior knowledge of her technological prowess, her instruction at a Title 1 school, and the fact that she had an inclusion-based setting for students who were receiving both special education and general education services in the same classroom. Case studies also add onto areas of literature where content is lacking (Creswell, 2007). Consequently, I chose to pursue this research problem due to the fact that little research existed to bridge the gap between TPACK and UDL.

Case studies are within the context of a “bounded” system (Creswell, 2007), and thus, the participant of my study represented a clear example of an atypical case within a specific context, her classroom. Access was gained through a gate keeper (in this instance, the principal of the participant’s school) and by gaining the confidence of the participant, which in my instance was established through a professional relationship established through prior collaborations in professional development settings. The consent form for this study (see Appendix A) underscored our trust and rapport by establishing that the participant could withdraw from this study at any time. It provided the overall purpose and procedures that I was to use, as well as efforts that were to be taken to ensure confidentiality, minimize risks, and to maximize benefits for this specific research.

Further, multiple, triangulated sources of evidence gathered through the use of a case study can support prior theory-based constructs (Leech & Onwuegbuzie, 2007; Yin, 2009) such as UDL and TPACK. These data were to take the form of observations and field notes, interviews that were scheduled and mutually agreed upon, pictures of the classroom, and copies of digital artifacts that the participant herself had designed and delivered for the purposes of supporting inclusive-based instruction in her classroom.

Yin (2009) noted concerns with case studies: they are often criticized for a lack of rigor; they provided little ground for generalization to ongoing scientific research; and, that case studies often required too much time and produced an overwhelming amount of data. However, findings of case studies may relate to the theoretical frameworks that may then lead to ongoing quantitative and qualitative research. Both Schramm (1971) and Yin (2009) underscored that
case studies strive to describe sets of decisions and subsequent actions, with specific results. Case studies may thus be implemented to explain connections and possible causality within current settings. They may be utilized to describe actions and contexts in which they unfold, possibly to depict situations from an evaluative perspective and to bring light to many subjects, practices, individuals, characteristics, and events.

In order to address many of the concerns with case studies, elements of rigor must be integrated. A significant goal of this particular study was to expand upon the theoretical frameworks and literature of both TPACK and UDL, not to provide sweeping generalizations for current and future educators within inclusive settings. For this particular case study data were collected through observations, semi-structured interviews, and reviewing artifacts developed for and used in instruction.

**The Research Context**

In order for others to better understand the context of this study, it is important to understand both the physical setting and the players involved. In this section, I will describe the participant selected for the case study and the school and classroom settings. In addition, I will explain my own role as a researcher and the context in which the participant and I became acquainted.

**The Participant**

The participant in this particular case study was an individual within a public school setting that was similar to other Title 1 elementary schools across the State of Hawai‘i. She was considered a unique or atypical case as a result of the amount of technology that she had personally invested into her classroom and her advanced levels of technological knowledge. Such significant personal investments included the personal purchase of a netbook for each student; the implementation of advanced a SMART Board interactive whiteboard, a student response system, and several subscriptions to web-based educational services.

The participant was classified as a highly qualified educator for the Hawaii Department of Education (HDOE) due to her professional qualifications. She held a state teaching license and undergraduate and graduate degrees in education. At the time of this study, the participant had been a teacher for over eight years at this particular site, the duration of her professional
career as an educator, and had recently completed a M.Ed. in educational technology. She had taken a number of technology-centered professional development courses offered through the HDOE, including two classes that were taught by this researcher.

The participant grew up on the mainland, but had strong personal ties to O’ahu and Hawai‘i. Although she grew up in a moderately white, middle-class community, she was often discriminated against because of her disability, cerebral palsy. Although growing up amongst these social challenges, the participant sought to connect with all individuals and to make a lasting difference in the world by becoming an educator, where she has served for over eight years. Despite continuous challenges with her health and a decline in mobility and other areas of her health, she continued to teach throughout the duration of this study. However, at the close of this study, it was noted that due to many of these health-related issues, she took an indefinite medical leave to address long-term health concerns.

During the time of this study (the 2012-2013 academic year) the participant led an inclusive first grade classroom with approximately 15 students. She taught all core subjects (English language arts, mathematics, science and social science) in collaboration with a special education teacher with additional instructional support from an education assistant (EA). As mandated by her school administration, her curricula primarily emphasized mathematics and English Language Arts, with little emphases on the arts, social science, and earth/physical sciences. For the purpose of this particular study, I focused on her implementation of lessons, strategies, and activities for her English Language Arts class during the last 10 weeks of the spring semester.

As previously mentioned, my familiarity with the participant was that of an instructor, which involved professional communication and collaboration through technology-centered professional development. Within these technology-centered professional development courses, it was evident that the participant enjoyed the classes, developing content with technology, and sharing her knowledge of technology with respect to her professional practice as an educator. Through her technological, pedagogical, and content knowledge, the participant may be viewed as a critical case, which may “make a point quite dramatically” (Patton, 2002) as to how technology-related efforts can be integrated and utilized within inclusive settings at Title 1 schools.
Prior to this study, my professional relationship with the participant was established through the HDOE’s professional development program: PDE3 (Professional Development Experiences that Education and Empower). Therein, I was the instructional designer and instructor for a series of educational technology courses: specifically, an introduction to SMART Notebook, an advanced SMART Notebook course, and a course on comprehensive assessment with the SMART Response Interactive Student Response System, otherwise known as ‘clickers.’ The participant of this study was a participant, as a DOE employee, for the advanced SMART Notebook course and the SMART Response course. Simultaneously, I was also a SMART-certified Education Consultant as I worked for a local company that sold and distributed and serviced SMART-brand products, in addition to other audio-visual technologies. The courses that I delivered and oversaw were an enjoyable and collegial opportunity to connect with educators across the state, and at the same time, provided the participants of the courses an opportunity to develop and refine strategies and equipment for technology integrations while earning official DOE and PDE3 credit for their efforts.

In delivering these courses, I was able to create a number of professional relationships across the State of Hawai‘i, across the public, independent and charter sectors of K-12 education. These classes and related workshops required adherence to state standards and national education technology standards (NETS) for both students and educators. Additionally, participants were expected to customize open and available content to be delivered across various SMART-interactive platforms, and in doing so, build a personal learning results portfolio (LRP) that was to be evaluated in accordance with the course syllabi and occasional PDE3 reviewers, for randomly selected participants at the end of each course section.

The participant of this particular study was an active participant in her courses, and regularly attended optional meetings for online support and consultation. Within the face-to-face sessions of the DOE courses, the participant showed an enthusiasm for the technology and a willingness to help other educators with their educational technology-related questions. Consequently, as the instructor for these courses, I became familiar with her technological interests and savvy. Additionally, I became aware of her related efforts in designing instructional content for her classroom (and as I discovered in this study, her help for other educators at her particular school site). I recommended her to visit an online community that I learned of, Teachers Pay Teachers (TPT). This site is an online community that serves as a resource center
for other educators and a market place for educators to sell and exchange original teaching resources. Through this introduction to TPT and primarily through her own efforts and passion for technology, the participant of this study quickly arose as a significant contributor to the site, establishing very high ratings and feedback from peer educators from around the world.

As I became increasingly aware of the participant’s growth and interest in education technology, I also became very curious about what her actual practice looked like, in conjuncture with the range of tools and strategies that she both developed and shared. Additionally, my previous experience as a special education teacher for a number of years and with respect to my personal experience with family members who received special education services, I was curious to further my research and interests in special education and education technology. When I came to understand that the participant was leading an inclusion-based setting at her school, I saw this as an opportunity to investigate how the design of technology-based lessons and curricular units might be developed and functionally delivered to support inclusion within the public sector.

Thus, as I gradually became aware of what I wanted to research for my doctoral dissertation, I strove to refine my proposal for my research and in doing so, saw universal design for learning as a lens to investigate inclusion. Through my research on teacher development and technology integration, I saw the technological-pedagogical-and-content, TPACK, (Mishra and Koehler, 2008) model as a viable framework to provide triangulated efforts with UDL for researching how this particular educator prepares and delivers instruction at a Title-1 setting.

The participant was amenable to my curiosity about her practice and extended an open invitation, as also echoed by her administration, to visit and observe at her particular school site. Through this generosity, and my desire to grow as a researcher, I began the processes for completing the applications for the institutional review board (IRB) at the University of Hawaiʻi, Mānoa and the Hawaiʻi Department of Education’s (HDOE) Board of Data Governance. These efforts will be described further later in this chapter.

It is also significant to note that the participant was born with cerebral palsy. Due to health complications as a consequence of side effects from medication, she utilized a mobility scooter to navigate the classroom and school campus. In the pilot interview, she noted that her personal experience with a physical disability and exclusion from particular school experiences when growing up, gave her a stronger sense of empathy for students with exceptionalities and a
desire to make her classroom more inclusive. Her own experiences contributed to the unique perspective of this participant.

The purposeful selection of this participant was due to the belief that her practice and related work-samples would produce information-rich anecdotes of how technology is atypically adopted and utilized within an increasingly typical classroom setting (inclusion-based) and Title 1, school environment. Insights from this investigation could possibly lend opportunities for further investigations that are centered in other environments and that also utilize the TPACK framework. Additional findings may help facilitate how UDL is further researched and supported by TPACK.

The School

The school in which this study occurred was a public school accredited by the Western Association of Schools and Colleges, Accrediting Commission for Schools (WASC/ACS). It is a Hawaii Department of Education (HDOE) K-5, Title 1 school, classified because of the poverty level of its student population. At this school, during the time of this study, approximately 81.8% of the students received free and reduced lunch; 27.3% of the students were classified as non-native speakers of English (ESL/ELL); and 13.1% of these students were receiving special education services. Of all students, the largest ethnic population, 39.7%, was classified as Native Hawaiian, followed by 28.8% of students who were ethnically identified as Filipino.

The area around the school displayed elements of poverty, such as underdeveloped buildings and visible homelessness. Elements of poverty permeated both the residential neighborhood near the school and the surrounding commercially zoned areas. The roads around the school were in need of paving and not marked for street crossing. The school itself was a ground-level institution reminiscent of early-1960’s American institutional and government architecture. The parking lot had loose gravel and fading paint on the parking stalls. Fortunately for the participant, the ground-level design and covered walkways provided greater accessibility for her mobility scooter across the school campus. The participant’s classroom was located a few doors down from the school administrative office.

At the time of this study, it was noted from Hawaii State Department of Education Strive HI Performance System that the school had received a Continuous Improvement Index Score of 258 out of 400 possible points. Additionally, the school had achievement scores for students in
the following areas: 72% Math Proficiency, 72% Reading Proficiency, and 44% Science Proficiency. Another important statistic is the students’ percentage for Readiness (Chronic Absenteeism), which remained at 23%. It was noted that 95% of Non-High-Needs students were classified as Proficient, and, 68% High-Needs students were considered Proficient, respectively. These scores, collectively, represented a 28% gap reduction based on a two-year gap reduction measure.

Teachers at this particular site primarily taught K-5 general education classrooms, with a curricular emphasis that began to shift its focus upon Common Core State Standards. Administration at this school encouraged a great deal of collaboration and articulation, with ongoing alterations to instruction for improving student academic performance and well-being. The school site provided after-school activities that were offered through A+, a local after-school tutoring service and initiative.

**The Classroom**

Before the official start of the school day, the participant’s students met in the cafeteria where a breakfast was offered daily. They were then led back to the classroom by the teacher assistant. Two front doors served as the entrance and exit to the participant’s classroom, serving as bookends to the classroom’s front windows, which were noticeably protected by security fencing (see Figure 3.1). Upon entering the classroom one passed through a foyer with holes underneath the windows, for student backpacks, and on top, were cages for the classroom pets (2 mice and a hamster) beside sorting shelves for additional classroom materials. Also in this area, was a larger table for group work, and student bathrooms (one for boys and one for girls) on one side and a larger steel sink on the opposite wall (see Figure 3.2).
Figure 3.1. Entrance to the Participant’s Classroom

Figure 3.2. Foyer and collaborative space for the students.

The foyer opened up into the larger classroom area with higher ceilings and a clustered arrangement of student tables with chairs. The trapezoidal student tables were arranged in threes, with approximately four or five students per cluster, or “table center” as they were referred to during instructional time, each distinguished by the color of the supply bin at each cluster (i.e. red, purple, or green). Collectively, they formed a disjointed u-shape (allowing the instructor and students to freely navigate throughout the classroom). At the center of the back wall was the SMART Board interactive whiteboard, with its own computer behind it, and beside it a smaller, single, student desk used by the “Computer Monitor,” a student who assisted with classroom
technology. Usually this task was assigned on a weekly basis. In the back corners, were the teacher’s desk and the desk of the assigned teaching assistant (see Figures 3.3 and 3.4).

![Image of classroom layout](image1)

*Figure 3.3. Classroom physical arrangement and layout at the entrance.*

![Teacher desk in the back corner](image2)

*Figure 3.4. Teacher desk in the back corner.*
Adorning and aligned against the walls stretched a colorful array of student work, instructional materials, other resources (i.e. the “Classroom Monitors” section for weekly student jobs, or manipulatives utilized for counting days of school, telling time, etc.), a range of additional cubby-spaces for organizing instructional materials, and an extra mobility scooter for the participant. In one corner, was the secure charging station for student netbooks (see Figures 3.5 and 3.6).

Figure 3.5. Teacher desk with various supplies and instructional technologies.

Figure 3.6. Design of the classroom wall-space.
Along other walls were visual prompts and reminders for students to follow schedules that were often written in dry-erase marker but often paired with physical manipulatives, for time-telling practice and counting money (see Figure 3.7).

![Figure 3.7. Sample materials and manipulatives for student interaction](image)

At the student desk centers, there were a range of visual cues, tools and manipulatives including number lines, the alphabet, a ruler, keys for counting money, a small-shared bin with crayons, pens, pencils, markers, SMART Response student response system ‘clickers,’ workbooks, and netbook computers when students were permitted to use them (Figure 3.8). Underneath the desk clusters were the color-coded larger bins with additional books, workbooks, and boxes of additional supplies. Each desk-cluster was distinguished by the color of these coordinated smaller and larger bins (i.e. Red Group, Purple Group, or Green Group).
Figure 3.8. Student desks equipped with visual guides and resources.

Students and the teaching assistant (TA) usually returned from the cafeteria by the first bell at 7:50 a.m., and upon arrival, the participant (lead teacher of this particular classroom) left her doors ajar, permitting students to enter and begin their morning routine. The morning routine consisted of entering the classroom, dropping off homework at the classroom Homework Center (see Figures 3.9, 3.10, 3.11) for correction and verification of parent/guardian signature in the Homework Log, copying new homework assignments from the Homework Chart into students’ individual Homework Log, and beginning the “Morning Warm-Up” while seated at one’s assigned student desk-center, before the final bell.
Figure 3.9. Homework Chart and homework hand in space.

Figure 3.10. Homework chart with assignments and due dates.
After the final morning bell, the school p.a. system played taps, signaling students to stand by the side of their desks in preparation for the “Pledge of Allegiance.” Students then returned to their desks and completed their “Morning Warm-Up” which consisted of an interactive SMART Notebook file which was sent to each student’s laptop through a classroom, computer-management software called SMART Sync. As a result, the line between the physical learning space and virtual learning spaces would overlap and blur.

There were approximately 15 altogether in this classroom, four of whom had Individualized Education Plans (IEPs) for their high-incidence disabilities, including learning disabilities and attention-deficit-hyperactivity-disorder. These students were representative of the school’s population at large, with students from various ethnic and primarily lower, socio-economic backgrounds. Additionally, a few of the students were classified as English Language Learners. It is significant to note that out of the four First Grade classrooms at this particular school, this classroom represented the only inclusion-based setting for the entire school.

The Researcher

My primary role as the researcher in this study was to design, implement, and evaluate the processes relating to data collection and analyses. In the process of interviewing the subject of this study, I was responsible for maintaining and securing data and ensuring confidentiality, but also ensuring data integrity, correct transcription and interpretation. Additionally, in
collecting field notes and materials, my role was to respect and maintain the confidentiality of
the participant, staff, faculty and students at her school and within her classroom. The processes
of interpretation and data analyses comprised of coding and interpretation, drawing upon my
personal knowledge, experience, and perceptions. Efforts to minimize my bias will also be
detailed further in this chapter.

My role as the researcher was to serve as the key instrument in asking the “right
questions” (Stake, 1995) and understanding and reporting transparently and honestly on this
particular case. I accepted the possibility of not finding answers, but rather understood that the
research might lead to further questions. In this investigation, I practiced and learned what Yin
(2009) stressed, the processes of being a good listener, exercising adaptability and flexibility,
having a firm grasp of the issues being studies, and avoiding bias (p. 70).

My rapport with the participant was essential in the collection of data. Rapport was
maintained through open communication, including outside of instructional time through the use
of email, text messaging, and phone calls. Previously my professional relationship with the
participant was that of a professional development instructor and coach for a series of HDOE
courses in which she enrolled. These courses were centered on the overview and implementation
of SMART technologies, i.e. interactive whiteboards, SMART Notebook – collaborative
learning software, and SMART Response – student response systems. In this role, I facilitated
trainings on these particular platforms and conducted the evaluation of portfolios, so that
participants, HDOE instructors, could receive professional development credit for undertaking
the course. As an education consultant at the time of getting to know the participant, I noted the
significant amount of personal time and attention the participant put into her work and the
breadth and depth of her technological prowess. Over the course of approximately two years, I
got to know the participant on somewhat of a personal level, enough to note how her physical
health ebbed and flowed. She used to arrive to our professional development classes and the
company where I previously worked (a distributor of educational technologies for the HDOE)
with the use of crutches. Well before the time of conducting this research study, the participant
no longer walked with crutches but used an electronic chair and scooter.

Despite much of the personal admiration, prior communication and collaboration with the
participant, and my sympathy for her health-related situations, within this study, my role shifted
towards that of an observer in the classroom, as an outsider, not as a participant or collaborator.
My goals during the study were to garner insights about her practice, how her TPACK did or did not support UDL in her classroom and how she prepared instruction for all of her learners. In an effort to maintain trust and ensure confidentiality, I kept communication open, and prepared my field notes, to share with the participant after the duration of the study.

Prior to this study, I was a special education teacher for a number of years at various Title 1 schools in Los Angeles. My research experience began with action research as a graduate student pursuing both my teaching credentials and masters in special education. I later pursued another master’s degree in Computer Education and Technology Leadership. After completing these degrees, I entered a doctoral program in educational technology at the University of Hawai‘i, Mānoa, where I undertook a number of qualitative, quantitative, mixed-methods, and advanced research methodology courses, and furthered my professional experience by accepting a graduate assistant position for the Distance Course Design and Consulting (DCDC) Group for the College of Education. During this time, I served as a research videographer for the department of Educational Psychology, for a particular project through the Center for Research on Education, Diversity, and Excellence (CREDE).

As a former special education teacher, who also served in various Title 1 settings, and as an individual with personal interests in technology, where my undergraduate studies focused upon Management Information Systems, I have always been interested in areas where the two sectors crossed. My interest in teaching and researching special education stemmed from personal experience with a sister who was born with spina bifida. My sister Ashley was often excluded from many of the activities and classrooms in which I participated, even though we attended many of the same schools and graduated at the same ceremony. Additionally, dyslexia has had a presence in my paternal family, where I have often heard of frustrations with academic challenges and discouragement that ensued in my father’s journey through school and higher education. Upon my initial graduate research, pursuing both a masters and professional teaching license in the state of California, as an emerging special education teacher, I became familiar with the principles of UDL and my passion for technology became reignited, as I continued pursuing a second masters in Computer Education and Technology Leadership. This rewarding journey culminated with the application process and acceptance into the Doctorate in Education with a focus in Education Technology, at the University of Hawai‘i, Mānoa. At this stage in my career and doctoral research, I took several additional classes in special education from the
Center for Disabilities Studies (CDS), where my passion for supporting all learners, educators, and UDL-research grew at a rapid rate. Simultaneously, I served as a lead instructional designer for a project that converted a face-to-face masters-level program in Vocational Rehabilitation and Counseling into the world of online learning. From this collective experience, it was set that my dissertation research was to focus upon UDL and technology.

**The Research Procedures**

In this section I will review how this study was conducted, including protection of human subjects, types of data collected, tools for data collection, and the specific steps or procedures followed. Such data collection, which began with a pilot study and semi-structured interviews, followed with direct observation, in an effort to garner insights about the connections between TPACK and UDL within this specific inclusion-centered classroom. Following these observations, semi-structured interviews played an integral role in understanding the classroom and related instruction, from the participant’s perspective, in her own words. And lastly, the collection and analysis of instructional materials further facilitated understanding TPACK connections to UDL and subsequent conclusions. Collectively, these three approaches to data collection and analyses served as the cornerstones for triangulation in this study. The sections that follow identify the steps taken towards the protection of human subjects, further descriptions of the types of data collected, and procedures followed.

**Protection of Human Subjects**

Prior to conducting this study, permission was sought from the Institutional Review Board (IRB) at the University of Hawai‘i, Mānoa and from the Hawaii Department of Education. Copies of the official approval letters can be found in Appendix B and Appendix C, respectively, The approval processes involved outlining the steps and sequences needed to comply with the standards and official guidelines for the study of human subjects, including the participant’s confidentiality and informed consent. I not only needed the consent of the participant, but because I would be observing in her classroom, I also needed parental consent for the students as well as student assent. Copies of the following documents used to secure consent and assent included:

1. Parent/Guardian Consent Form (Appendix D.)
2. Participant Consent Form (Appendix A.)

3. Student Consent Form (Appendix E.)

Along this path, I made a concerted effort to acknowledge and adhere to suggested ethical guidelines. During the observations, pictures that were taken as field notes during instructional time intentionally covered and concealed the faces and identities of the participant and students in her classroom. Additionally, following the final completion of this report and study, the data and recordings will be securely deleted.

**Types of Data and Tools for Data Collection**

Across an extended duration of time that spanned beyond an instructional quarter of the DOE school, data were collected through three primary methods: interviews with the participant, observations in the classroom setting, and the collection and analyses of teacher-created materials or artifacts. With respect to the participant’s qualification and strong experience and familiarity with technology, it was determined that the use of the Survey of Preservice Teachers Knowledge of Teaching and Technology (Mishra & Koehler (Appendix F) was not necessary, but rather the use of the UDL Guidelines Checklist (CAST, 2011) in Appendix G would prove to be more beneficial in guiding the observations, interviews, and collection and analyses of instructional materials. Collectively, transcripts of interviews, field notes from observations, and materials shared and consolidated within PDF files yielded over 800 pages of compiled data for analyses.

Observations were scheduled during the participant’s instructional periods for Language Arts across the duration of an entire HDOE instructional quarter for the final semester of the 2012-13 school year. Through the pilot interview, the schedule for interviews was established as viable, and it was determined that observations would be conducted on a weekly basis, every Wednesday morning approximately from 7:30 a.m. to 11:30 a.m. Collectively, nine observations in all were conducted.

Semi-structured, in-depth interviews were scheduled and conducted with the participant, following each direct observation. These recorded interviews were transcribed and analyzed for the corroboration of details and notes gathered through observations. The processes for transferring, transcribing and securely storing these interviews followed the procedures that were identified and established after the pilot study. Following the conclusion of the nine scheduled
observations and interviews, a few additional interviews were conducted in an effort to facilitate member checking, prolong engagement and to keep communication open.

Following the interviews, materials for each of the lessons were collected and shared between the participant and my computer via a password-protected Dropbox. Typically, these materials consisted of SMART Notebook files that were often hyperlinked with websites, audio files, and PowerPoint slide shows. The sub-sections that follow describe the processes for data collection in greater detail.

Pilot Study

The pilot study was helpful in getting me acclimated to the participant and her environments, both physical and virtual, in addition to preparing myself for the role of as the researcher. After official approval through the Institutional Review Board from University of Hawai‘i and the Office of Data Governance from the HDOE, I contacted the participant to schedule a pilot interview, and subsequently establish a mutually agreeable schedule for data collection. This schedule was comprised of dates and times for classroom observations, semi-structured interviews, and the analyses of instructional materials across the duration of an instructional semester for the HDOE. Additionally, the pilot interview proved to be a data-rich experience in establishing our roles within the study and to establish efforts to minimize the bias that might be at issue due to the relationship between myself, as the researcher, and the participant.

Following the pilot study, it was determined that I, as the researcher, was welcome to observe nine instructional lessons, following each observation with semi-structured interviews, and collection of materials utilized during these lessons. Through the implementation of a pilot interview, it was identified that observations would occur during the adoption of a new, Health-based curriculum. However, due to curricular mandates through the school administration, the instructional time and instructional focus shifted towards English Language Arts.

Observations

After conducting the pilot and immediately transcribing the interview material, I planned for my observations in the field. I knew that referencing the UDL checklist would be beneficial while taking fieldnotes, however, I did not know to what degree. As I progressed through this time frame of scheduled observations, I found that having a personal hotspot, a feature through my iPhone that connected my iPad with personal Internet access while in the field on campus,
provided me as a researcher an opportunity to additional resources, such as CAST’s resource sites via hyperlinks in the UDL Checklist (CAST, 2011).

Technology aside, I wanted to make sure that I entered the environment for this study, the participant’s classroom during instructional time, in a respectful manner and minimized the amount of disruption. Simultaneously, I wanted to take notes with my iPad, which was also a new experience for me as a researcher. By converting the UDL Checklist into a Pages document (Appendix G), I was able to use subsequent sections as mini-frameworks within the UDL Guidelines for my observations while also referencing UDL examples. Toggling between the UDL checklist, related resource sites, and the SMART Notebook iPad app soon became second nature. During this time, I was able to take a great many meaningful pictures, record quick anecdotes and create concept maps to help me retain as much of the information that unfolded as possible.

The data became voluminous as a whole, and particularly individual files with the photographs took up much space. I named files with conventions to represent each of the nine observations, in a manner that was easy to store securely and organize efficiently for back up. After completing each observation, I transferred and compiled my fieldnotes into a comprehensive PDF that I could continuously reference and analyze. This compiled PDF file was imperative for me to see how my fieldnotes evolved over time and grew with a newly formed skillset of electronic note-taking that felt natural and was efficient, with minimal distraction (although some of the students were initially curious about the presence of my iPad). Additionally, for the purposes of scrolling, markup and additional note-taking, the PDF was an efficient form for peer and expert review sessions and mobility.

I conducted a range of ongoing general observations, during classroom instructional times, which were scheduled and confirmed by the participant. These observations generally lasted three to four hours, and included multiple official periods of instruction, over the course of ten weeks during a quarter of the official HDOE 2012-13 school year. Over 40 hours were spent in observation time.

This method of recording observation data was tested during the pilot study. It was determined that the use of the iPad to take field notes with the SMART Notebook iPad app (See Figure 3.12) and a Pages copy of the UDL Checklist (see Figure 3.13) and CAST resources (see Figure 3.14) for reference would be beneficial during the observations.
Figure 3.12. Screenshot of the iPad’s SMART Notebook app utilized for direct observation and fieldnotes.
Figure 3.13. Screenshot of the iPad’s Pages app to reference the UDL Checklist in real time.
Interviews
The semi-structured interviews for this study stretched across the same duration as the observations and were quite often conducted following observations. They allowed the researcher to gain meaningful information directly from the participant in her own, personal words. As a researcher, my practice and active-listening skills increased with each of the
interviews. I learned to refine my prompts during these sessions, and also learned to improve my note-taking skills via my iPad.

The use of the iPhone’s Voice Recorder app proved to be functionally useful and quite efficient for transcribing and organizing files. The recording quality sufficed and the transferability of the files from the iPhone to iTunes was minimal, as was the process to upload the .m4v file to MovCaptioner. Listening and transcribing the recorded interviews via MovCaptioner brought me closer to the data and to the participant’s view. The processes were not technically demanding but required a longer period of time than previously anticipated. Regardless, having the interviews transcribed verbatim and compiled into a comprehensive PDF file was useful for further analyses, the coding processes, and ongoing review.

The time coding feature from MovCaptioner was an advantage that helped me in the analyses that followed, as direct words from the participant were presented in discrete segments that were later imported into Excel, and later Google Drive Spreadsheets. Having the data in this particular form further assisted with the coding processes as viewed through the frameworks of UDL and TPACK. The digital nature of this data was of significant value when going through the processes of peer review and expert review. In these instances, data were arranged in workbooks that represented each interview (as was the case with the compiled observations and materials analyses). The nature of this data created the opportunity to share, discuss, arrange, and interpret the data into meaningful findings (to be shared in the chapter that follows).

The interviews for this study were semi-structured in the design and implementation, and were usually conducted following the each of the observations during and the collection of instructional materials after instructional time. These resources were reviewed thoroughly and continuously, before, during and after the collection of data. In the pilot study, it was confirmed that these interviews were to be conducted during the participant’s teacher-break time, which usually lasted approximately twenty minutes, after each of the scheduled observations. As mentioned, the interviews were conducted and corresponded with the theme of each observation, which also aligned directly with each of the nine major principles of UDL and the UDL Checklist. Thus, the UDL checklist served as a guide for each of the nine-scheduled observations and subsequent, semi-structured interviews. Questions were loosely developed to probe the participant’s perspective on each of the nine major tenets and their sub-points, and to follow-up on the meanings derived from what was just observed. After these interviews, I would record a
few of my thoughts and anecdotes to infuse a greater sense of reflexivity for my study and to extend the opportunity to build stronger inferences and greater detail for my study.

To record these interviews and personal reflections, I employed the use of my iPhone with the VoiceMemos app, which comes free with every iPhone. Initially, I conducted a pilot interview which was recorded with an iPhone VoiceMemo app (See Figure 3.15), transferred to iTunes as an .m4v file, securely stored in both DropBox and Google Drive, and transcribed and exported as transcripts with timecode to .txt files with MovCaptioner (See Figure 3.16). The .txt files were securely stored via a personal, password protected DropBox account and Google Drive.

*Figure 3.15. Screenshot of the iPhone’s Voice Memos app utilized for recording the semi-structured interviews.*
In addition to the observations and semi-structured interviews, the participant generously shared materials, and as the researcher, I securely stored the electronic files for further analyses during the duration of this study. These files, which were electronic in nature, were shared via a password-protected Dropbox folder and were generally SMART Notebook files with attached PowerPoint files, audio files with stories, interactive worksheets, and digital images and text therein (see example in Figure 3.17).

The SMART Notebook materials were quite often a big component of the students’ morning routine and format for instructional resources that were distributed on a regular basis to their individual student netbooks and the computer that controlled the SMART Board during additional shared, group activities. Since these files were in SMART Notebook software, it was advantageous for me as the researcher to compile the files into a sequential, collective file, like the interviews and the observations, into PDF (Figure 3.18) which, as mentioned, made the analyses processes secure, replicable, easy to navigate and present to my colleagues for peer-review and review by a UH professor.

Materials and artifacts from each of the instructional lessons and activities were examined to describe the nature of their design, instructional purpose, and their roles in supporting UDL with respect to the participant’s TPACK. These artifacts included teacher-designed SMART Notebook files, Microsoft PowerPoint files, image and sound files, instructor
designed spreadsheets for tracking and monitoring progress, as well as snapshots from the participant’s instructional website.

Figure 3.17. Screenshot of SMART Notebook utilized for collecting and consolidating instructional materials and exporting them into PDF format.

Figure 3.18. Screenshot of the consolidated PDF of instructional materials for Lessons.
Researcher Reflections

Another critical component of my role as researcher was to collect as much data as possible, to reach a point of saturation in my pool of data. This point was reached after approximately five of the nine weekly observations, including over 40 hours of in-the-field observations, nine semi-structured interviews, and the collection of related materials that corresponded to these observations and interviews, as previously described. Following each of these observations, I immediately recorded narrative descriptions and reflections to detail the instructional practice, strategies and actions observed during instructional time. These reflections were recorded via my iPhone’s VoiceMemo app and later transcribed through the use of MovCaptioner software and hand-coded via Microsoft Excel and Google Drive - Spreadsheets. Additional personal voice memos and reflections were undertaken after the completion of all observations and interviews and collection of artifacts. These additional reflections helped ensure elements of rigor, and will be discussed further in this chapter.

Data Collection, Organization and Analysis

In the data collection phase, materials were placed into a series of password-protected sub-folders that served as the foundation for organizing materials. Files were then compiled into consolidated PDFs for observations, interviews, and materials for further analyses and coding, in conjunction with the data logs that were created via Microsoft Excel and Google Drive – Spreadsheets (See Figures 3.19 and 3.20). As previously mentioned, the data for this study were collected from multiple sources and examined with an aim towards answering both research questions:

- How does a Title 1 public school educator utilize TPACK in preparing UDL-based instruction?
- How does a Title 1 public school teacher utilize educational technology and TPACK to support an inclusive environment and the principles of universal design for learning (UDL)?
Figure 3.19. Screenshot of Google Drive where folders and files were created, stored and organized for data analysis and the creation of data logs and back up

Figure 3.20. Screenshot of a Data Log within Google Drive – Spreadsheet, where interviews, fieldnotes, and materials were analyzed, logged and coded.

The range of data recorded included electronic files and physical artifacts, verbal expressions, physical descriptions and gestures, and more. These provided rich examples for answering the questions, and positing future ones. Data were recorded directly from actual interactions, words, and artifacts during and outside of instructional periods and time. Data collection began with scheduled, sequential observations as agreed upon between the participant and myself, as the researcher.

This study entailed a great deal of technological investment and coordination on my behalf as the researcher. Specifically, I utilized the following equipment and strategies for data collection, management, and later analyses:
- **iPhone:** capturing interviews as .m4v files; personal hotspot for tethering my iPad in the field for observations and fieldnotes;

- **iPad:** fieldnotes and referencing CAST.org in real time
  - **Pages:** UDL Checklist (hyperlinked to CAST.org for examples and resources);
  - **SMART Notebook (iPad App):** fieldnotes (pen, highlighter shapes and camera tool); random thoughts and memos;

- **MacBook Pro:** collecting, securely storing via double-encrypted passwords, organizing, and analyses of data and files
  - **SMART Notebook (software):** materials analyses, consolidating fieldnotes from iPad and exporting into PDF Format, pen, highlighter shapes and camera tool;
  - **Adobe Acrobat Pro:** consolidating PDFs of interviews, observations, and materials for analyses;
  - **DropBox:** secure, password-protected back-up and storage;
  - **iTunes:** importing and organizing the audio recordings from the interview;
  - **MovCaptioner:** importing the audio files from iTunes folders for verbatim, manual transcriptions of all interviews (including the pilot); initially saved as .mcpt files for captions, but later exported transcriptions with time codes (for referencing) into .txt files;
  - **Notepad:** app for reviewing and reading transcriptions (in .txt file format) before organizing them into Microsoft Excel;
  - **Microsoft Excel:** initial coding and data organization;
  - **Google Drive:** further data analyses, code refinement, theme development, and extra levels of back-up and storage; peer reviewing and expert reviewing collaboration – inter-rater reliability;
  - **Keynote:** building the defense preparation and using it as a graphic organizer to help me scaffold my dissertation chapters and related processes and stages.

These tools were helpful in navigating throughout these previously described environments. They worked well collectively as a workflow and independently, as I was
fortunate to not experience many technological challenges and had no data breaches or loss. While working with my peer and expert reviewers, it was helpful to utilize these tools.

**Data Analysis Strategies**

Qualitative research addresses the questions about who, where, how many, how much, as well as the interconnectedness of different variables. Accordingly, the methods utilized for data analysis and triangulation in this study, the interviews, observations and field notes, as well as the review of instructional materials, served as the platform for analyzing the phenomena within this study. Analysis is the act of giving meaning to data (Corbin and Strauss, 2008).

The interviews served a critical role in understanding how the participant in this study thought and felt, in her very own words. The observations facilitated my understanding of her actions with a sense of immediacy, by being in her natural instructional setting, and a sense of depth that underscores much more intricacies within this case. The same can be said for the analyses of the participant’s instructional materials.

Interviews can posit interesting issues (Barbour & Schostak, 2004), as was noted between myself as the researcher (the interviewer) and the participant (the interviewee) with respect to power, social position, value, trust, meaning, interpretation, and uncertainty. Observations, may also lend themselves to misinterpretation and subsequent misunderstandings during the analysis of data. Consequently, during the filtering management, initial analysis, and higher level analysis of the data collected in this study, a concerted effort was employed to maintain the integrity and verification of the data obtained.

The analyses of data in the study focused on the real experiences of the participant and her efforts, with her combined knowledge of technology-content-and-pedagogy, to support inclusion. A significant challenge in the data collection and analyses within this study was to make sense of the voluminous data that was obtained, organized, and reduced to significant patterns in an effort to construct and report meaningful findings. The processes of analyses followed Bloomberg and Volpe’s (2012) Roadmap for the Process of Qualitative Analysis: An Outline (See Figure 3.21).

Across these steps I-IV, as identified by Bloomberg and Volpe (2012) new and specific understandings of UDL and its connections to TPACK began to emerge. These fresh perspectives developed for me as the researcher through the continuous analyses of the participant’s words, actions, and products. While going through this process, I reflected upon how future research investigations may be conducted and strengthened, and how too, I might grow as a researcher. I worked towards maintaining a sense of fidelity for my research by combining the different tools and logical rationale and sequence of efforts to refine my practice as a researcher. This process improved my ability to conduct the interviews, strengthened my
observation skills, and helped me obtain more insights about the materials and actions presented across this study. Also, with this process, I developed a stronger awareness of biases in the study, and applied strategies to minimize them.

The initial analysis of the data entailed consolidating the fieldnotes, transcripts of interviews, and the materials into a series of files (i.e. text, image and interactive files) arranged in respective folder categories for the purposes of file management. Initially, it was determined that such artifacts would then imported into HyperRESEARCH. HyperRESEARCH is a cross-platform qualitative analysis software, that enables researches to code and retrieve, build theories and conduct the analyses of data, in multiple file formats, allowing researchers to work with text, graphics, audio, and video sources. However, after the analyses of data from the pilot study and the first few observations, interviews, and review of instructional materials, it was determined that this tool was not especially helpful as I had thought. In fact, in learning the navigation of HyperRESEARCH, I felt detached from much of the data that I had collected and decided to hand-code the data within spreadsheets. It was determined that Google Drive – Spreadsheets could prove an effective and secure platform for analyses due to its features, such as revision history, auto-save, and the ability to collaborate with peer and expert reviewers, not to mention the capability of securely accessing and reviewing the data on multiple devices, such as my iPhone and iPad. Such mobile accessibility and the time-intensiveness of hand coding in these cloud-hosted spreadsheets brought me very close to the data and thereby established a strong familiarity.

This step preceded clustering and coding as suggested by much research (Fereday & Muir-Cochrane, 2006), and before comparing amongst varying themes and categories (Miles & Huberman, 1994; Rocco, 2003). The coding and cluster schemes followed the major categories that were in the UDL Guidelines 2.0 Educator Worksheet. The patterns that rose from this process were compared and presented in conjunction with the higher-level themes of this study, namely the guidelines for UDL and TPACK. For example the instructor’s actions and technologies that offered ways of customizing the display of information, and offered alternatives for auditory or visual information were coded as “MMR” as they provided multiple means of representation for educational content. As Miles and Huberman (1994) suggested for analyses, the data that were collected were placed into different arrays of PDFs and then into Excel and Google Sheets spreadsheets, as matrices for comparison and analyses across
components of both the UDL and TPACK frameworks. The data were arranged and managed in these spreadsheets and later analyzed chronologically with respect to each of the observations, interviews and collection of materials in the time and manner that were conducted and acquired. This organizational effort assisted with the display of the vast information collected and helped visualize the individual components (lines from interviews, notes from observations, and individual elements of the instructional materials that were collected). Additionally, the spreadsheets assisted with tabulation of frequencies in which patterns and the complex connections between TPACK and UDL-elements emerged.

**Familiarizing and Organizing**

The organization of the data was continuously refined even after the collection of the last artifact and transcriptions of the final interviews. Transcripts were read, reread, and reviewed several times before being placed into spreadsheets for line-by-line analysis. Additionally, field notes and materials were meticulously catalogued and comprehensively compiled into single PDF files before spreadsheets for analyses were created for critical review and coding. Analyses followed three stages: familiarizing and organizing; coding and reducing; and, eventually, interpreting and representing.

**Coding and Reducing**

Once spreadsheets were created with sub-worksheets created, key codes were determined both on an a priori basis and initial reading of the data. The codes served as temporary repositories, in an effort to remain open to the processes involved with the data analysis. I utilized verbatim transcriptions of interviews, observation notes, data logs, and a journal, to capture descriptive summaries, during multiple stages. In an effort to underscore my efforts for credibility (validity) and dependability (reliability), my analytic approach took a very transparent, systematic and organized path.

Initially, this process began by exploring all of the data that were collected in various, secure and electronic formats. This stage began with the verbatim transcripts of interviews and critical incidents from field notes. Combing through this data gave me a sense of the study as a comprehensive whole, before it was broken down into parts. I became very familiar with the data and this led me to see patterns and themes that emerged through the analyses. Ideas, thoughts and sketches were compiled into my dissertation journal as I reviewed the data (listening to
recordings, reviewing transcripts and organizing files). Specifically, compiling much of the transcripts, field notes, and materials into comprehensive documents, that were actually PDF’s with bookmarks, helped me summarize the data in a meaningful and personal way that established a helpful workflow. This workflow consisted of creating data logs for coding initially in Microsoft Excel and eventually into summaries via Google Docs – Spreadsheets.

After thoroughly coding materials, including the data logs of interview transcriptions, materials analysis, and field notes, data were further sorted and quotations were categorized. By taking much of the data logs from the Microsoft Excel platform and transforming it into a Google Docs – Spreadsheet, the logs were much easier to comb-through and organize data via the revision history tools and cutting and pasting into more refined superordinate, categorical headers. These spreadsheets served as “electronic flip charts” and helped me “visualize” my data, in conjunction with building the Keynote presentation for the defense of this dissertation. Quotations were pasted into newer, refined categories that were relevant to the research questions. This information was reviewed even further through re-reads. Additionally, the fact that every artifact was hand-coded helped me as the researcher get much closer to details that could not have been initially possible with the qualitative computer software, HyperResearch. Over the course of this study and time, I felt much more confident in my ability to obtain, manage, organize and retrieve meaningful data across multiple sources and to identify patterns of significance as a result.

Very quickly the “big ideas” and themes emerged from these summaries, which Creswell (1998) calls the “winnowing process.” In this phase, I was able to note commonalities across the data and develop a coding scheme. The frameworks for both TPACK and UDL were crucial in this effort (see Appendices M, N, and O). The coding consisted of identifying codes, or interesting/significant components of the data. In the organization of the data, specifically in both the field notes and transcriptions of the interviews, it was clear who said what, the interviewer, interviewee or other individual(s) in the classroom observed.

After this stage, additional open coding was then utilized and often, new themes emerged. Simultaneously, peer and expert-reviews were utilized to identify the relevance and appropriateness of the codes, with respect to the research questions. Quite regularly during the data analyses stages of this study, I met with fellow doctoral students and an expert reviewer, a UH faculty member who specializes in qualitative research, to share and discuss the raw data, its
organization within the spreadsheets and matrices for coding and analyses, as well as my rationale for subsequent coding and interpretations. Concurrently, I journaled and constructed data summary charts. These charts and related memos helped summarize and support initial findings in this study.

Enhancing the Rigor of the Study

In the tradition of quantitative research, researchers must address issues of validity, the depth to which something closely resembles the truth, and how it may be applied, internal and external validity, respectively. The quantitative researcher also must address the reliability, or the consistency of the data and, the objectivity, or neutrality of the study. Within the qualitative tradition of research, these issues are referred to as credibility, dependability, confirmability, and transferability (Lincoln & Guba, 1985). The subsections to follow will detail the efforts undertaken in this study to address these issues.

Credibility

Credibility determines how accurate and credible the findings are from the perspective of the researcher, the participant, and from readers of a particular study. This aspect is a significant component in the way a research study is designed and carried out (Creswell, 2007; Merriam, 1988; Miles & Huberman, 1994). To address the issues of credibility within this study, the following strategies and respective descriptions were undertaken as recommended by Ary, et. al (2014).

- **Data triangulation**: Three types of data were collected: observations, interviews, and materials.
- **Peer review/peer debriefing**: Several debriefing sessions were held with fellow doctoral students. These took the form of luncheon discussions and data reviewing sessions during the weekends on a weekly basis for several months.
- **Investigator triangulation**: A fellow doctoral student, my mentee in the ETEC doctoral program, accompanied me on a particular session for observation, interviewing and materials collection and analysis session. This event was later recounted with other peer and expert reviewers.
- **Member checks / participant feedback:** I checked with the participant of this study to gather feedback and to elicit verifications of my understanding. These feedback sessions were informal, but also imperative throughout the process for clarification and establishing consistency and understanding.
- **Low-inference descriptors and thick, rich description:** Thorough descriptions in this study were paired with a number of photographs, screenshots, descriptions, and direct quotes to illustrate the participant, her environments, and her actions in this study.
- **Extended fieldwork:** The observations, interviews, and collection of instructional materials spanned over ten weeks.
- **Pattern matching:** The data logs within this study helped serve as the foundation for pattern matching, in that the direct transcriptions of field notes, interviews, and descriptions of materials were paired against the theoretical frameworks of UDL and TPACK. Subsequently patterns emerged and were further identified as themes.
- **Reflexivity:** An informal journal and verbal dictations to my iPhone served as medium for continuously reflecting on the research process and recounting and sharing experiences with peer doctoral students. (Creswell, 2007; Merriam, 1988; Yin, 2009)

Furthermore, my bias as the researcher was consciously recognized, due to my personal experience and also my previous experience with the participant during my times of consultation and professional development. My journal played an important role in reflecting on the processes and experiences that I went through during the journey of this study.

**Confirmability**

Confirmability in qualitative research is connected to the concepts of neutrality and objectivity, to free research of bias (Ary et al., 2014). In an effort to remain transparent, the previously described actions were taken to develop audit trails, triangulation (in its various forms), peer reviewing processes, and reflexivity in this study. All these contributed to the efforts to ensure this study’s confirmability. The audit trail especially helped to identify how the collection of data, the consolidation of data, the display of the data, and the eventual conclusions (both development and verification) facilitated confirmability within this study. Peer reviewers,
with whom I met with on a near weekly basis for discussion and reflection as “critical friends” helped me. I was able to demonstrate to these individuals the cohesiveness of the evidence, and how data were collectively compiled to develop the narrative of my argument, and the coding schemes that helped develop these descriptions. Additionally, we discussed and considered alternate and contradictory explanations to the findings, before ultimately accepting the adequacy of evidence, as presented with the depth and saturation of the data collected, and consequently, the depth of the descriptions presented.

**Dependability**

Dependability, too, plays an important role in establishing the consistency and the extent to which the data and the findings would be comparable if the study were to be duplicated. Strategies for ensuring this trustworthiness included using an audit trail, replication logic, stepwise replication, code-recode, inter-rater comparisons, and triangulation (Creswell, 2007; Merriam, 1988; Miles & Huberman, 1994). With respect to the documentation in this study, an audit trail was established. The data were collected and systematically organized in a manner that followed the sequence of observations and field notes, the audio files of interviews and related transcriptions that followed, and the collection of materials. This system for research was presented to both peer and expert reviewers to share and explain my procedures in both a critical and collegial manner throughout these phases of research.

During much of the analyses of the data of this study, peer and expert reviewers and recoding played a critical role in establishing agreement. A coding-recoding strategy was utilized as I coded the data, left the analysis for a period of time, and returned to recode the data, and compared the two sets of data. This effort was done with data logs in Microsoft Excel but was done with greater efficiency later via Google Drive – Spreadsheets with the ability to create copies of the data logs and to see the revision history of these cloud-based documents over time. This cloud-based approach also ensured data security, back up, and the ability to view across multiple platforms (i.e., web-browsers and mobile devices with the Google Drive app, such as the iPhone and iPad). It is important to note that the triangulation employed, as previously described, also, helped establish the corroboration, the range of evidence collected in this study, in conjuncture with the efforts to ensure dependability of this study.
Transferability

Transferability is the degree to which the findings in any qualitative study can be related to other populations or situations (Creswell, 2007; Merriam, 1988; Miles & Huberman, 1994). The goal of this study was to provide rich and thorough descriptions of the participant’s preparatory and instructional efforts to support UDL with her TPACK in an inclusive setting, at a Title 1 school. Altogether, many of the findings in this study can be found as elements within other settings, with similar populations of students and with similar resources and instructional strategies at other schools. Perhaps the thick, rich descriptions can be applied to other situations at similar institutions and classrooms.

Many of the characteristics of the participant, such as her personal health-related situation, the technologies that she utilized due to the frame of time in which this study was undertaken (the history effects), and other resources and circumstances that were available due to setting effects, may be solely unique to her specific microcosm during this specific instance in time. It is also possible that the research process itself might have had a limit on the transferability of this particular study due to the nature of how data were collected and further analyzed.

To enhance the transferability of this study, again, many rich, thick descriptions were utilized. Additionally, limitations were addressed in this study and will be further detailed in this chapter. And to limit the aforementioned reactivity, a reflection on the research process was utilized and paired with detailed descriptions of methods within this chapter.

Limitations

This particular study does contain a few limiting components that are not too uncommon within the tradition of qualitative research. A concerted effort was undertaken to acknowledge these limitations and to proactively minimalize their influence upon this study.

In particular, this study is rooted within the thought processes and actions that were executed in my personal role as the researcher, as well the reflections that I developed along the way and the conclusions that I reached as an individual. Thereby, the biggest concern for this study was the researcher bias in conjuncture with the subjectivity at hand, and my own personal and professional experience.
Similarly, another limitation may be the history effects and potential participant reactivity, due to the fact that I had previously engaged with the participant on a number of occasions through professional development-based activities and my services as an education consultant. Consequently, it is possible that the participant did not divulge as much information or could have possibly embellished information, due to these historical factors.

In recognizing these limiting factors, I prolonged my engagement with the participant and employed member checking and follow-up interviews after the completion of our mutually agreed upon observations, interviews, and collection of materials. Throughout this study, communication and dialogue remained open, honest, and fluid to address any questions, issues or concerns. Additionally, the coding schemes that were developed were refined with the collaborative consultation with peer and expert reviewers as data were collected, organized, presented, and further analyzed on an ongoing basis.

Lastly, the fact that this study was taken of a particular individual, within a specific microcosm of the HDOE, within a particular window of time, brings up the fact that this study was restricted as a research sample. This teacher may be seen as unique with regard to her own personal situation as a person with disabilities, her early school experiences, her passion for technology, and her commitment of extensive personal resources to acquire technology for her classroom. Findings from the classroom of this unique individual may not transfer to other inclusion classrooms. With regard to this fact, it is fair to criticize this study due to the fact that it is not entirely applicable or generalizable to the HDOE or schools at large. Respectively, transferability was certainly addressed in this study and through the development and application of thick, rich descriptions, and it may be concluded that findings and strategies within this research study can be applied accordingly to other contexts and future research investigations.

Summary

This chapter provided an overview of qualitative research and elements of case study research with respect to the methodology that was used for this particular study. Additionally, it provided details on the research sample, including specifics on the role of the participant and the contexts and environments, both physical and virtual, in which she operated. The chapter closed by detailing my role as the researcher in this study and how data were collected and secured.
Additionally, this chapter gave an overview and in depth description of the methodology in this study. A qualitative case study methodology was utilized to portray the practices of a unique and atypical educator who utilized her TPACK to support UDL in an inclusive-based setting at a Title 1 school for the HDOE. This study integrated three primary forms of data collection: observations, interviews, and the analyses of materials. The data that were collected and organized were reviewed against previous literature, as well as the themes that emerged.

During the study I worked on efforts to both maintain and ensure credibility, transferability, dependability and confirmability. As a researcher I was able to explain and verify my interpretations during peer review and peer debriefing sessions that occurred on a monthly basis across six months with my peer reviewers, fellow doctoral candidates, and two expert reviewers who were both doctoral graduates and serving College of Education faculty and staff, at the time of this study.

Collecting data in these spaces and in these formats, with respect to the methodology as a whole, assisted the efforts to constantly establish member checks with my participant, in addition to my reflexivity as a researcher, in an effort to minimize bias and to remember our roles within this study. Reflecting, on a regular basis, on the process as a whole was beneficial to keeping the bias mitigated and to help me to report my findings fairly, honestly, and accurately.

The data collected were organized and presented in formats with a conscious effort to facilitate dependability and a clear, precise, logical and executable audit trail. Dependability was enhanced through collaborating with the peer and expert reviewers. Findings will be presented in the following chapter. These are organized by the two research questions.
CHAPTER 4. FINDINGS FROM THE DATA

Introduction

The purpose of this case study was to better understand how a teacher in the public sector, specifically at a Title-1 school, utilized her knowledge of technology-pedagogy and subject-specific content knowledge (TPACK) to support Universal Design for Learning (UDL) as she designed and prepared instruction within this specific and bound setting. Additionally, it sought to identify her related processes and efforts in delivering instruction and various learning supports for students within an inclusive setting. As the researcher, I believe that the findings from this study will help identify future strategies for preparing both pre-service and in-service teachers to understand UDL and its connections to TPACK, and conversely how TPACK may relate to UDL. Additionally, the use of the UDL Checklist may help facilitate a better understanding of experienced practitioners in the field and may assist educational researchers in broadening their application of TPACK and UDL as frameworks for qualitative investigations within the classroom.

Data emerged to highlight opportunities where content was represented in multiple ways with respect to perception, language, expressions, and symbols, and comprehension was enhanced through the use of technology. There were opportunities where the participant provided her students with multiple means of action and expression, including physical action, expression and communication, and executive functions. These data permitted exploration into how the participant, as an educator, provided multiple means of engagement by recruiting interest, sustaining effort and persistence, and facilitating self-regulation from her students.

This chapter will present an overview of the findings with greater detail and in-depth explanations and illustrative examples. Here, as the researcher, I will present a comprehensive description of the participant and her efforts to the readers of this study. The discussion will help others identify and understand the reality of her instructional situation, from her perspective, through use of her own words, a review of various materials that she prepared, and anecdotes from field notes. Various quotes taken from transcribed interviews will be utilized in an effort to portray the complexity of TPACK in supporting UDL practices. Moments that were of
significance through the lens of the researcher, myself, will be presented with details and elements described of both TPACK and UDL in the participant’s classroom inside and outside the instructional hours of the school.

**Planning for Instruction**

With respect to the initial question of this study, how does a Title 1 public school teacher utilize TPACK in preparing UDL-based instruction, four major themes related to her planning emerged from this study:

1. The participant intentionally created a variety of instructional materials and tasks for her class to meet different learner needs and preferences. (Designing for Differing Learning Needs)

2. The participant designed and organized the physical layout of and resources for her classroom in ways to ensure accessibility. (Designing for Action and Expression)

3. The participant utilized a range of web resources to plan and prepare for her instruction. (Using Web Resources)

4. The participant employed a variety software programs to create instructional content and prepare for activities. (Employing Different Software)

   In sum, the participant ensured instructional variety to meet varied learning needs and provided options for action and expression for her students using the web and various software programs to support her efforts to do so.

   The following table illustrates how and where these themes align with respect to the major tenets of the UDL Principles and with TPACK. Representation, Actions and Expressions, and Engagement are elements of UDL explained earlier in this document.
Table 4.1.

Findings within the UDL Framework for Planning for Instruction

<table>
<thead>
<tr>
<th>Finding</th>
<th>Representation</th>
<th>Action and Expression</th>
<th>Engagement</th>
<th>Elements of TPACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creates a variety of instructional materials (Design for Differing Learning Needs)</td>
<td>X</td>
<td></td>
<td></td>
<td>PK</td>
</tr>
<tr>
<td>Designs and organizes the physical layout and resources for her classroom (Design for Action and Expression)</td>
<td></td>
<td>X</td>
<td></td>
<td>TPK</td>
</tr>
<tr>
<td>Utilizes a range of web resources to plan and prepare (Using Web Resources)</td>
<td></td>
<td></td>
<td>X</td>
<td>TCK</td>
</tr>
<tr>
<td>Employs different software (Employing Different Software)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>TPACK</td>
</tr>
</tbody>
</table>

The sub-sections that follow provide further details and describe findings that emerged from the analyses of data, with respect to the Universal Design for Learning Guidelines’ (CAST, 2011) major Principles: Provide Multiple Means of Representation, Provide Multiple Means of Action and Expression, and, Provide Multiple Means of Engagement. These sub-sections discuss what emerged through the analyses of data with respect to the subtenants of each major category of the UDL Guidelines. The section concludes with a description of how the elements of UDL are supported by various elements of the participant’s technological pedagogical and content knowledge, her TPACK.

Planning Theme 1: Designing for Differing Learning Needs

The teacher used her pedagogical knowledge to create a variety of materials in such a way that they incorporated the principles of UDL and addressed the differing learning needs of her students. She incorporated technology in applying her pedagogical knowledge to do this
Principle 1, Guideline 1: Provide Options for Perception

The participant intentionally created a variety of instructional materials to meet differing learning needs and preferences of her students. She did so in a proactive manner and in doing so provided options for perception; language, mathematical expressions, and symbols; and, comprehension. Under the first major Guideline for UDL, Provide Multiple Means of Representation, the checkpoints provide specific ways to do so.

1.1 Offer ways of customizing the display of information.

Checkpoint 1.1 recommends preparing materials in ways that are malleable or customizable to provide options for “increasing the perceptual clarity and salience of information for a wide range of learners” (CAST, 2011, p. 14). The participant modeled this by developing materials in ways that size of text, background contrasts, color, volume, layout or other things could be manipulated by the learner.

I found this teacher consciously ensured such options during planning through my analyses of materials, and verified through interviews. The participant used SMART Notebook software for a variety of design-based reasons. With respect to the customization of the display of information, students could utilize tools within the teacher-developed file to adjust to their personal, preferred display preferences. With the development of this electronic file and format, students could zoom in and out as they needed, and utilize a great number of tools within the SMART Notebook software to provide additional, personal display customizations. For example, the following figure demonstrates how teacher-created materials inside of Notebook software allowed the students to use interactive pens that highlighted key text to their particular preference. Within these files, students could also adjust the zoom, text properties, and create their own text and shapes as well.
1.2 Offer alternatives for auditory information.

Checkpoint 1.2 suggests offering alternatives to auditory information and notes that sound design is important and that the human voice is effective for conveying emotion and significance. Strategies they recommend include speech-to-text, use of visual diagrams or notations of music visual analogies (e.g. emoticons), tactile alerts, etc. I observed this teacher developing materials to address by designing visual cues to help focus student attention. These visual cues within digital files took the form of directional arrows that were connected to text boxes that could be dragged across various screens and interacted with by students or instructional staff. The following figure demonstrates how three prompts for discussion were designed inside the SMART Notebook to cue the points of a discussion as they were revealed visually.

Figure 4.1. Sample digital page with customizable options for student personal display preferences.
1.3 Offer alternatives for visual information.

Checkpoint 1.3 recommends offering alternatives for visual information and notes that unfamiliarity with types of graphics, density of visual information, and cultural and contextual factors can impact ability to interpret visual information. Ways to address this include such things as providing textual or verbal descriptions, providing physical objects or spatial models, and providing auditory cues.

Similarly, the materials analysis revealed that the participant provided attached audio files to many of the scanned storybooks that she had consolidated into SMART Notebook files. The tools that she utilized to design this support are described further later in this document. The audio files could be played on student computers, at their preferred volume with headphones, by clicking the speaker icon on the pages in which they appeared. The following figure (Figure 4.3) demonstrates a typical page that the participant developed to include audio supports and thus, alternatives for visual information.
Principle 1, Guideline 2: Provide Options for Language, Mathematical Expressions, and Symbols

This guideline deals with the fact that learners vary in their facility with different forms of linguistic and non-linguistic representation. Vocabulary that can help clarify concepts for one learner may not be understandable to another. An equals sign (=) might help some learners, but might confuse another. A picture can mean completely different things to learners from differing cultural backgrounds. Next are examples of how this teacher designed her materials and strategies in ways to address these issues.

2.1 Clarify vocabulary and symbols

Checkpoint 2.1 recognizes that words, symbols, numbers, and icons are differentially accessible to learners with varying backgrounds. To address this, it suggests using strategies such as pre-teaching vocabulary, embedding support with hyperlinks, etc.

Ways this teacher planned for addressing these needs included preparing PowerPoint files that were attached to her SMART Notebook files. These PowerPoint files consisted of large digital pictures with text and provided options to reinforce key vocabulary words. Figure 4.4 demonstrates how the participant assembled digital pictures that were to be shared later with students.
2.2 Clarify syntax and structure

Quite often words and numbers may be assembled together to make new meanings; however the syntax of words in a sentence may not be completely evident to learners, especially young students who may not be familiar with such inferences. Consequently, students’ comprehension may lag as a result. Strategies that the participant utilized in the design of her materials to address this issue was the construction of graphic organizers after reviewing key vocabulary, or “story words” that would later appear in the context of group reading assignments. Figure 4.5 demonstrates how the participant constructed a file to “magically” reveal key vocabulary and Figure 4.6 shows the use of graphic organizers.
Figure 4.5. An interactive page to reveal key vocabulary words before reading a story.

Figure 4.6. shows how the participant constructed a graphic organizer for helping students predict future elements of a story.

Figure 4.6. A graphic organizer to support student predictions and comprehensions.
2.3 Support decoding of text, mathematical notation and symbols

Checkpoint 2.3 underscores the notion that to help students build the fluency that is necessary to decode words, expressions, and symbols, learners need ongoing exposure and relevant applications to such symbols so that they can both understand and apply them efficiently and effectively. Options that can help facilitate these processes include text-to-speech and offering the clarification of notation through the lists of key terms or symbols. The participant quite regularly designed interactive storybooks that had audio that accompanied the text. Additionally, the participant, with a coordinated effort of her classroom TA, taped a series of visual cues and tools to each of the students’ desks as a point of reference (i.e., a ruler, number line, the alphabet with both upper and lower-case letters). Figure 4.7 demonstrates how visual cues were placed upon student desks for students to refer to during instructional activities.

![Figure 4.7](image)

*Figure 4.7. Student desk with visual cues and resources taped for reference during instructional activities.*
2.4 Promote understanding across languages

Quite often the language in traditional standardized curricula is developed within a monolingual context. Many learners come from various linguistically diverse backgrounds, where English is often not the language spoken at home. Checkpoint 2.4 encourages providing options for key vocabulary. One way that the participant designed and modified existing curricula was through the digitization of worksheets that highlighted domain-specific and common terms, such as “map key” and related cardinal directions within social studies components of her Language Arts lessons. Through ongoing analyses of materials, I found how the participant transformed traditional paper-based worksheets into interactive instructional material to support such cross-linguistic understanding. Figure 4.8 illustrates how a social studies worksheet was transformed to highlight key vocabulary in map-based lessons.

![Figure 4.8. A traditional worksheet digitized for interactive use.](image)

Figure 4.8. A traditional worksheet digitized for interactive use.
2.5 Illustrate through multiple media

Checkpoint 2.5 stresses that all too many classroom materials are text-based. Often, these materials are lacking in the delivery of concepts using alternatives such as pictures, simulations, and objects. The participant designed and customized a great deal of content using multiple illustrations, photographs, as well as physical and virtual manipulatives. In my observations, I would often arrive early before the beginning of the school day and would find the participant at her computer refining digital content that was to be delivered and interacted with later in the instructional periods for Language Arts. Subsequently, in the analyses of her instructional materials, I would find that the participant would indeed include a variety of the previously mentioned, non-text-based elements.

Her daily “Morning Warm-Up!” was a digital file that the participant designed and assembled with various media, including sound, visuals, text, additional files (such as PowerPoint with key vocabulary and related pictures) and objects that were to be dragged, manipulated and presented in various settings (i.e., the SMART Board, student computers, and in tactile, paper-based forms at student desks). Figure 4.9 shows the participant at her desk, designing content for the check-in component of her “Morning Warm-Up!”

![Participant designing content with various media.](image)

**Figure 4.9.** Participant designing content with various media.

**Principle 1, Guideline 3: Provide Options for Comprehension**
Principle 1, Guideline 3 emphasizes the need to teach learners to convert information into meaningful knowledge. The participant created a variety of materials to introduce new content and to help students actively construct knowledge that may be used strategically. To develop such resourceful and knowledgeable learners, this guideline suggests the design and presentation of information to scaffold the access to build such knowledge and understanding. The following subsections represent the related checkpoints for this final guideline of providing multiple means of representation, and provide examples of findings that emerged from the collection and analysis of the data in this study.

3.1 Activate or supply background knowledge

This particular checkpoint emphasizes the fact that students are likely to assimilate information if it is delivered in a manner that triggers or supports prior knowledge. Often, there are inhibitors that impede or truncate this process of acquiring and developing meaningful information. To support the attainment of new vocabulary, which she called “Amazing Words” in her lessons, the participant would attach PowerPoint files that she would design and later deploy to her students. These files would pair the text of the vocabulary terms with pictures, in an effort to attach prior meaning or understandings of the words with their new vocabulary. Figure 4.10 illustrates how the participant would bundle such key words with pictures to facilitate the connections between prior and new knowledge.

Figure 4.10. Example “Morning Warm-Up” file, to highlight key vocabulary from the weekly “Amazing Words” list.
3.2 Highlight patterns, critical features, big ideas, and relationships

Expert learners often have little trouble identifying pertinent ideas and eliminating trivial details within instructional materials, settings, and activities. However, other students struggle with finding information that may be both relevant and important. Checkpoint 3.2 encourages the need to support students by identifying features that are essential and compound further learning. The participant’s use of graphic organizers supported the syntax and structure of words in a particular context. Simultaneously, as discovered through the interviews, the participant repurposed and altered graphic organizers to support key ideas and relationships in Language Arts. The following quote identifies how the participant did so in her processes of design and development of instructional materials:

“Yeah, actually, the ones [graphic organizers] I use, I actually got from one of the SMART Board trainings. One of the trainers gave them for free…so I could just put in the blank [graphic] organizer and add what I wanted on it….it helps the kids to think, to break down…those concepts for them. Beforehand they had no clue how to figure out what a story was going to be about! They would just guess nothing! So, we had, it took about 3-4 stories, where we’re looking at every single time we read something, we’re predicting…and we’re using the same organizer.”

3.3 Guide information processing, visualization, and manipulation

Checkpoint 3.3 acknowledges that successful learners are able to build knowledge when they have strategies and related skillsets to digest information. For those learners who do not process such information with automaticity, instructional materials with appropriate design may facilitate and foster these strategies with various supports. In designing and delivering (to be further discussed in the following major section of this chapter) her instructional materials, the participant provided materials with visual cues, gradually and in a sequential manner that explicitly detailed the steps in various instructional processes. Information was released progressively and in “chunks” that allowed students to reveal information as it was needed and within a manner that was interactive. Figure 4.11 is a snapshot of a SMART Notebook page taken from the “Morning Warm-Up” through the analysis of materials.
Figure 4.11. Use of “grouped” arrows and textboxes to reveal content with strategies discussed before reading a story.

The participant connected text-boxes with pertinent information to arrows. Before instructional delivery, the text-based content was hidden and during instructional times, the arrows served the purpose of prompting and guiding students to drag and reveal content in a successive manner.

3.4 Maximize transfer and generalization

Instruction within the classroom, in many instances, serves as the platform for developing and practicing understandings and applications before entering the world outside of school. Checkpoint 3.4 emphasizes this effort by encouraging supports for memory, generalization, and transfer. As a regular component of her “Morning Warm-Up!” the participant would continuously integrate graphic organizers to scaffold strategies and supports during her instructional efforts. This effort allowed for the opportunity for her students to embed new ideas into a familiar format and context, and to see the connections between their ideas during review and practice. Figure 4.12 illustrates the graphic organizer that the participant would repurpose and alter for stories that were to be integrated into her Language Arts lessons and future “Morning Warm-Up!” activities.
Collectively, the participant designed a range of materials that provided multiple means of representation by consciously providing options for perception, language, mathematical expressions, and symbols, as well as options for comprehension. These materials were designed to be paired with instruction to develop learners who were resourceful and knowledgeable. The following discussion of theme two describes findings that emerged related to how the participant designed the physical layout of her classroom and additional resources within the context to provide multiple means of action and expression.

From these examples, the participant’s TPACK permitted her to develop materials in different ways to support individual learning needs. Her knowledge of technology and its use to support pedagogy and content allowed her to create resources that were digital in nature, including SMART Notebook files, audio recordings, and PowerPoint slideshows to support student learning. Although the participant did not explicitly state or justify actions within specific reference to UDL or UDL-language per se, her actions were clearly in alignment with the guidelines and principles of UDL.

**Planning Theme 2: Designing for Action and Expression**

Navigating throughout the learning environment(s) within the 21st century entails skills not only necessary for interaction (both physically and virtually) but also for communication and
monitoring progress. The second major principle of UDL, Principle II – Provide Multiple Means of Action and Expression addresses these issues and suggests to educators the provision of options for physical action, expression and communication, and options for executive functions. Through the collection and analyses of data, it became evident that actions on behalf of the participant, before instruction took place, were made to facilitate and proactively address these options. The participant’s knowledge of technology and its appropriate pedagogical applications helped to guide her choices.

**Principle 2, Guideline 4: Provide Options for Physical Action**

In many instances, traditional print-based resources and the arrangement of students’ desks in rows, facing the teacher’s desk and chalkboard offers many obvious limitations to both learning and instruction. With such limitations in mind, and in large part due to her own physical disability, the participant arranged her classroom resources and student-centers to actively prevent such limitations and to foster a sense of “flow.” In the second of nine interviews, the participant laughed as she recalled sentiments about the classroom’s arrangement:

“It flows nicely…What was it that our vice principal said? “It has good chi.” …That’s what she said, “She’s got really good chi in there.” And so, a lot of these youngsters are so (energetic) and flopping all around and they need that space. And, the other thing I do or we do in the room, that some of the other inclusion classes don’t do, or we don’t do anymore, because of the way things changed…but it used to be that there would be my desk, and there would be another desk [pointing to the back side of the classroom] so that all three adults were up at the front [including the TA and the special education teacher who was displaced due to low enrollment].”

The participant’s design of the classroom allowed her students to navigate without interruptions to each other. It was obvious that the small clusters of student desks were intended for collaboration and the use of different materials and tools for various activities. Specifically, her investment in and organization of physical manipulatives, for example counting blocks, plastic-practice calendars and clocks, allowed for her students to access, interact and return them to their storage locations with ease. This effort on behalf of the participant helped provide both the physical space, activities, and options of tools to practice learning and demonstrate understandings.
4.1 Vary the methods for response and navigation

The participant made conscious decisions and efforts to arrange the instructional room to meet both her physical-navigation needs and those of her students. Checkpoint 4.1 stresses these options, by also noting that learners differ in the way they traverse the classroom, subsequently barriers can exist and the role of the instructor is to ensure that there are a variety or multiple means for navigation.

It is important to note that the participant’s instructional setting, which she organized, also included a variety of instructional materials, physical manipulatives, and technologies, much of which she personally purchased and deployed. These included a range of high-tech hardware and software: a SMART Board, a SMART Response student response system, SMART Sync (a computer lab management software), an ACER student netbook per student, a netbook storage unit, security and charging stations, a document camera, and a scanner-printer-fax multi-function machine. These devices were purchased and maintained from the participant’s personal financial means, and provided a range of alternatives to physical responses. These findings emerged from the interviews and observations from the classroom. Figure 4.13 identifies a plastic pointer tool that the participant purchased and used Velcro to attach to the side of the SMART Board, as a low-tech solution to allow students to interact with the high-tech content that she developed for her interactive whiteboard.

Figure 4.13. Plastic, low-tech pointer used to help students interact with content on the SMART Board.
The participant provided a variety of tools for her students to utilize and interact with and to build instructional content. These tools would later provide alternatives for physical response and interaction, and will be described in the following section of this chapter.

4.2 Optimize access to tools and assistive technologies

Checkpoint 4.2, stresses the need to provide options and tools that complement the customization of screens and the selection of software and hardware that work with various physical needs of diverse learners. With the personal investment from her own financial means, the participant purchased a classroom set of Acer netbook computers (at least one per child) for her classroom. The participant installed a series of software programs on these netbooks that would allow for students to use different tools for interaction, namely SMART Notebook and its various tools. The SMART Board itself, with much of the previously mentioned designed content, offered a range of different tools, such as an onscreen keyboard and buttons for mouse functions. The participant also purchased USB-headsets for each of these netbooks, and together these hardware and software investments allowed students to have optimal access to content. The headphones served as an additional assistive technological support that helped students focus on materials when wearing them, and, to isolate noise from computers that could have distracted other students in the class. Figure 4.14 shows how the participant organized headsets with a unique numbering system that helped students pair hardware with their personal netbook.
Principle 2, Guideline 5: Provide Options for Expression and Communication

As echoed by the UDLCenter.org, there is no platform for communication that works equitably for all learners, yet there are certainly platforms, namely traditional pen and pencil that limit the playing field for learners to express themselves and their understanding. Conversely, technology can play a crucial role in facilitating different options and avenues for expression and communication for learners within various environments and modalities.

5.1 Use multiple media for communication

Checkpoint 5.2 emphasizes the need to use diverse, alternative media for expression. Such multimedia and materials may include, but certainly are not limited to text, speech, drawings, illustrations, sculptures, design, film, music, dance/movement, visual art, or video. Other physical manipulatives may be utilized, including blocks, base-ten blocks; and virtually, a wide range of interactive web tools to solve various problems, paired with the usage of a variety of strategies.

In observing the participant’s classroom, I was able to see a range of physical manipulatives such as base-ten blocks, manipulatives for telling time (magnetic blocks that were utilized on a magnetic dry-erase board), counting sticks for telling the date and counting the days of school that have passed.
Additionally, on each of the student computers, the participant had installed SMART Notebook and SMART Sync. As collaborative software, SMART Notebook has a number of tools that can be utilized to communicate. Students can draw pictures, create text boxes, create shapes, use a variety of virtual pens/highlighters/crayons and utilize features found in word processing and presentation software packages. Figure 4.15 shows a student’s computer running SMART Notebook software. At the top of the screen are many of the tools within SMART Notebook, which allow students to construct artifacts and to compose within a number of different activities. Additionally, Figure 4.16 shows another student’s computer connecting to SMART Sync so that he/she may send and receive interactive files as part of the “Morning Warm-Up!”

![SMART Notebook software](image)

*Figure 4.15. SMART Notebook’s features that allow students to interact and communicate with the teacher.*

### 5.2 Use multiple media for construction and composition

Checkpoint 5.2 acknowledges that many schools still utilize traditional tools and format for facilitating learning, and therein exist many drawbacks. In an effort to combat these impediments, the participant in designing her curricula and related resources installed SMART Sync in conjunction with SMART Notebook upon each of her students’ computers. These two software applications allowed for the construction of multiple media to be shared and collaborated on across the classroom network of student netbook computers, the teacher’s laptop, and the SMART Board at the center of the classroom.
Figure 4.16. SMART Notebook and SMART Sync provide for collaboration and communication with virtual, digital tools.

5.3. Build fluencies with graduated levels of support for practice and performance

In addition to the provision of media tools for communication, construction, and compositions, Guideline 5, Checkpoint 5.3 lends supportive tips for scaffolding learners as they learn independence and fluency. In addition to utilizing high-tech solutions, the participant identified in an interview that she also designed low-tech solutions, resources and strategies, in conjuncture with much of the digital content that she designed, to build fluencies. She noted the following:

“So, then, what we do to support them, is whenever they have down time, they finish their Math worksheet early, or whatever, we let them do Mad Minute. [This is a] practice where they have [or] they take, you know, the same worksheet that they’ve completed as much as possible within a minute’s time and compare it to a master copy with the answers and it’s in a sheet protector. They take that and a dry erase marker…and, they practice and score themselves, and that’s the time to slow down and to work it out, and to memorize, memorize those facts. They’ll sit there, and I’ve seen them, where they’ll get a
group that really wants to progress, and they’ll get together, and they’ll race each other and they’ll check each other. And then, they’ll start to really get it and grow. You’ll see them [snapping her fingers with excitement] they’ll go from getting 10 right in a minute, to getting 12, 15, and they’ll do it in a short period of time…”

**Principle 2, Guideline 6: Provide Options for Executive Functions**

Executive functions allow students to help manage resources in their surroundings to support goals that are both short-term and long-term in nature. By scaffolding lower-level skills, educators may help pave the way for their students to focus on higher-level executive processing.

**6.1 Guide appropriate goal-setting**

In a conscious effort to guide appropriate goal-setting, as identified by Checkpoint 6.1, the participant, in her instructional planning, made conscious efforts to post goals, objectives, and schedules in an obvious place. Through my observations in the classroom, I too, was able to take note of these prompts and scaffolds for executive functions. Figure 4.17 presents a low-tech manipulative and impromptu supportive-prompts to remind students of their goals for the Morning Routine.

*Figure 4.17.* A Morning Routine message created to help students manage their goals for transitioning into the classroom and preparing for the day.
6.2 Support planning and strategy development

Checkpoint 6.2 encourages the “stop and think” prompts during instruction to support and gradually scaffold students in the development of their metacognition and strategies for planning and reflection. In the design of much of her materials, the participant of this study constructed sub-sections within the construction of her “Morning Warm-Up!” file, and thus opportunities to pause and think of the learning, and if necessary prompt for further clarification, support, or to move on. An example of the “Morning Warm-Up!” file can be found in Appendix L. Typically, these were SMART Notebook files that the participant designed and shared with students individually on their netbooks and reviewed as a whole group on the SMART Board after students have returned their work back to the participant upon completing their activities. This process is described further in the following section of this chapter; however, generally these files would support students in their planning and strategic development, by scaffolding English Language Arts content with the following sections:

- **Title Page:** prompting students to highlight phonemic sounds, write original sentences with the use of a text box tool, and to click a short story to be read aloud through a hyperlinked audio (.mp3) file;
- **An Oral Language** section with an additional story and supportive prompts and questions;
- **A Phonics Word Work** section where sentences were to be gradually revealed and practice reading;
- A series of digital worksheets that focused upon phonics and related practice;
- **A Reading** section that previewed key vocabulary words from an upcoming story;
  - A “Follow the Clues!” sub-section consisting of a graphic organizer to make predictions after scanning paper-based storybooks at their desks;
  - A page with the audio version of a story, also paired with questions for comprehension
- **A Language Arts** page to practice grammar (i.e., identifying adjectives in a sentence).
- **A Reading with Expression** section that consisted of several pages and sentences that prompted students to read with the proper verbal expression (i.e., exclamation and question marks).
- **A Preview** page to forecast the work for the day to follow.
• A **Group Time** section
  - This section of the SMART Notebook file began with a **Title Page** that would scaffold the remaining activities to be performed at the clusters of student desks, in addition to the evening’s homework;
  - An additional **Phonics – Word Work** page that would allow students to practice using newly introduced words by providing space for them to create new sentences using their computers and related tools;
  - A **Daily Fix-It** page that prompts students to correct grammatical errors in a few sentences;
• An attached PowerPoint file with the weekly **“Amazing Words”**
  - One page would provide the entire list of words (usually 8-10 words)
  - Two pages would follow and provide a key word on each, paired with its definition and an image.

**6.3 Facilitate managing information and resources**

Checklist 6.3 emphasizes the need to provide graphic organizers and templates for data collection and organizing information, as well as guides for practice and note taking to scaffold and structure information. The “Morning Warm-up!” described how the participant designed and structured this digital file and provided such information in a managed and structured format with resources in a variety of media-formats. In the analyses of her instructional materials, I was able to witness how the participant designed and organized the files that she pushed out to students. Figure 4.18 demonstrates the flow of each “Morning Warm-Up”, as described in the previous section.
6.4 Enhance capacity for monitoring progress

Learners perform better when they are aware of their goals and expectations, and where they stand with respect to these metrics. They need a clear understanding of the strides that they are making or not. Additionally, such information may inform instruction as formative feedback to guide instruction and feedback. To provide feedback, and in an effort to find additional ways to monitor student progress, the participant invested in the computer lab management software, known as SMART Sync. The software enabled her to see what and how students were doing on their individual netbooks, from a management screen on her laptop, without having to physically visit the student or prompt them for updates. She explained in an interview:

“It [the software] works wonderfully, ‘cause we can see who’s struggling and who’s not. I see it [student progress and performance] through there [pointing to her personal laptop]. And, notice when they came in from recess, I told them “Send your file” [back to the participant’s teacher computer using SMART Sync’. They sent it back, so I can open them up [and the program] organizes into days on my computer on my desktop. And, then, I can open that up and go, “Okay, I’m going to look at what they did on this day.” Okay, consult my plan book and look at where everything is and decide what to do next with instruction.

The SMART Sync laboratory management software helped the participant monitor her students while they were at their computers. This practice gave her a bird’s eye view of how students were interacting with content and if they were on task. Additionally, she could both monitor and intervene, either through group or private messages or by taking remote control of their netbooks.

Additionally, the IXL and AimsWeb subscriptions that the participant subscribed to helped both her students and herself understand and track student progress via the online tutorials and assessments. This tool helped provide ongoing information on present levels of performances and thereby helped establish new and evolving goals for each of the students to observe and strive for within their individual routines and online-learning activities.

Again, through her TPACK, the participant was able to support different options and platforms for her learners to choose from to interact and express themselves with content and
related conceptual understandings. The descriptions of the participant’s strategies and tools provided here, although some of these integrations were non-technological solutions, demonstrate how the participant was able to use her TPACK with discretion and expertise. She used SMART Notebook, SMART Sync, and other tools to steer and support goal-setting and to support planning, managing information and monitoring student progress.

**Planning Theme 3: Using Web Resources**

**Principle 3, Guideline 7: Recruiting Interest**

Nurturing and sustaining student affect is a critical component to the design of instruction. Teachers must first capture attention and then sustain the interest and effort, and develop the eventual goals of self-regulation for learners who are driven and motivated by purpose. Different factors and variables can certainly motivate different learners, and by providing options, a preemptive effort in the design of instruction can help address these issues. In preparing for her instruction, the participant collected a range of different web-based resources and services to support multiple means of engagement later in her instruction. Her technological content knowledge informed her choices of web resources.

**7.1 Optimize individual choice and autonomy**

At the forefront of the participants use of web resources were a few web-based services that the participant purchased subscriptions to, namely, Starfall, IXL, and AimsWeb. These three services differ in their scope and in their particular range of services. Starfall is a free website which supports a “systematic phonics approach, in conjunction with phonemic awareness practice.” IXL is a paid for subscription that provides Pre-K to 12 practice, interactive, adaptive learning and tracking in Math and Language Arts. Students are given individual accounts and passwords, and teachers are provided with administrative overviews of the students and their progress. Additionally, AimsWeb offers various products and services that primarily focus upon curriculum-based measurements for measuring progress, response-to-intervention, and tiered-assessments.

Through the interviews, it was revealed that the participant primarily utilized Starfall in her planning and instruction. She mentioned that as part of the morning routine, or morning business, she permitted students, after turning in their homework and completing their handwriting exercises, to pick-up their netbooks and access any of the three web-services. She noted:
“They go on Starfall and they have choices there. They can do this activity or that activity on Starfall. They have a math website and they get to choose what they want to work on, as well. So, that gives them some choices there, so, as well, those are the big things when they get a choice. They can also play math games, they can do IXL or they can go into Starfall…[or IXL] tracks them, so I can go in [and see] how much time someone’s been on a particular activity or concept and what kinds of questions they’re doing, how successful they are with it, those kinds of things…It does [give them feedback]. They get little prizes and games…for completing certain things in the website, for completing certain things or mastering things.”

Figure 4.19 provides a screen shot of the homepages of each of these web-services, IXL, AimsWeb, and Starfall.com, that were to be later integrated and utilized within instructional time and for students’ choices of activities.

Figure 4.19. Screen-shots of participant’s web-services, IXL, AimsWeb, and Starfall.com.

Through semi-structured interviews and exchanges such as these, and across observations during instructional time, I was able to conclude how in her planning that the participant was able to strategize and plan for providing multiple means of engagement later during her instructional time using web resources.

7.2 Optimize relevance, value, and authenticity

These web-resources were both age and ability-appropriate, as well as socially relevant, in their design and interweaving of activities for the student populations that were to later enter and utilize them in her classroom. IXL, AimsWeb, and Starfall.com each definitely varied in their scope and their ability to address specific skill-sets for students’ present-levels of performance and their respective goals for the week or semester. In her planning, the participant foresaw the time within her schedule to utilize these standards-based resources, in an effort to
compliment and supplement much of the text-based curricula that she had used in the past, and these collective actions allowed her students to have active, unique, yet grade-level appropriate content and digital, individualized experiences with these sites and tools, which they would not normally have, due to much of their socio-economic backgrounds and lack of technology over all at their school site. Thus, she knew in advance to plan for time, as part of the Morning Routine, which allowed her students to explore and experiment with these sites and later monitor their own progress.

7.3 Minimize threats and Distractions

These sites and resources were designed for individual students to be engaged with and to actively participate in the tutorials and activities. They varied in their levels of sensory stimulation, providing different sounds, visual cues and duration of activity. Starfall, in particular, had a range of animated graphics and sounds, often in song-form that would entice and engage learners. And, as mentioned previously, the participant also paired the usage of computers during this time with the purchase and advanced organization of personal headphones to plan on minimizing the auditory distractions that so many of these interactive games and lessons would later produce during instructional time.

Principle 3, Guideline 8: Provide Options for Sustaining Effort and Persistence

Students certainly vary in their individual levels for maintaining focus and concentration on tasks and routines within instructional time, and the participant knew this in advance. By interweaving web-resources, the participant knew that they would motivate and help the students enter the classroom early or on time to get started with the Morning Routine and the sub-sets of tasks.

8.1 Heighten salience of goals and objectives

Specifically within the planning stages of her instruction, the participant knew that IXL could track individual students and help them view their individual goals after-logging in and viewing their progress in an alternate format, other than progress reports and sticker-charts and colorful, instructional posters that adorned much of the physical classroom. IXL would individualize content into manageable lessons and instructional videos to guide students along personalized curricular activities, and later represent student progress along a visual pathway for mastering much of these Language Arts-based tutorials.

8.2 Vary demands and resources to optimize challenge
Simultaneously while knowing that IXL would engage students with sounds and visuals, the participant knew while preparing for the structure and duration of morning lessons, that IXL would also serve as an adaptive supplement to the curricula that would individualize content to each of her learners. Indeed, IXL had the ability to adjust to individual levels of performance and provide instructional content and related prompts and activities that would adjust to the students’ appropriate level of challenge and rigor, later during the Morning Routine. IXL would adjust the levels of difficulty and provide appropriate alternatives to match each of the individual levels of skill in the classroom. This approach was supported by the participant’s TPACK in understanding the value of this web-based technology and her prior pedagogical experience and mastery of grade-level content.

8.3 Foster collaboration and communication

Although these three unique web-based platforms were primarily designed for individual student use, the participant knew that appropriate small-grouping and the clustering of desks could help provide students with the opportunities to assist each other during these times, and later on during other routine-based activities during the Morning Warm-Up. Often, the participant designed student jobs, referred to as “Class Monitors,” to provide supplies, such as headphones, to peers at their assigned desk-cluster. In advance and in her planning, the participant knew that each of these groups and the Class Monitors would need clear responsibilities, goals, and procedures, and clear processes for logging into individual accounts for IXL and navigating throughout Starfall. At these desk-clusters and with these web-based and technological tools, students would later have the opportunity to ask each other questions and coach each other along, in the form of peer-tutors when working on the individualized content and web-activities.

8.4 Increase mastery oriented feedback

As described, IXL served as an adaptive supplement to the curricula that the participant designed and later delivered during much of my observations. The participant knew that this web-based service would later provide her with ongoing reports and statistics on the performance of her students as they progressed through the tutorials and individualized challenges, tracking their scores and duration on specific standards-based content. At the same time, the participant strategically knew that IXL and Starfall, too, would provide ongoing feedback on individual performance to the students themselves. This feedback to students would be immediate and
positive in nature that promoted continuous effort with encouragement and enticing visuals that would display students’ progress in a timely, accurate, and encouraging manner that would help students with prompts for improvement and sustaining their efforts. The feedback within both of these platforms would give informative, substantive hints and clues that were helpful in providing strategies rather than punitive or competitive scoring in nature.

Principle 3, Guideline 8: Provide Options for Self-Regulation

Consequently, through these web-platforms, the participant knew that an additional value was the range of ways that students could monitor and self-regulate their progress and efforts. These supplementary web-based resources were used in conjunction with many other activities that were high-tech, low-tech, and traditional in their design and eventual delivery during instructional time.

9.1 Promote expectations and beliefs that optimize motivation

In preparing for her instruction, the participant knew that different students throughout the morning activities would integrate these tools at different instances. She designed the integration of such tools to work in conjunction with her investment in SMART Sync, so that she herself could provide personalized prompts and support to students while they worked within these virtualized environments.

9.2 Facilitate personal coping skills and strategies

In her development of this particular strategy and curricular design, it seemed evident that these combined platforms, both web-based and via SMART Sync, that the participant could later use them together to facilitate guides, prompts, and reminders to later help students foster confidence and on-task behaviors of coping, managing stress and frustration, challenge, emotional support, internal controls and intra-personal encouragement. Students would be able to hear prompts and develop internal techniques and personal strategies to help themselves maintain focus and efforts to accomplish the personalized goals that would be shared in IXL, Starfall, and the other related curricular components as well.

9.3 Develop self-assessment and reflection

Checkpoint 9.3 underscores the need for students to monitor their progress and thereby adjust their emotions and behavior to progress. With this understanding and with knowledge of both the feedback and tools within IXL and Starfall, the participant knew that the activities would help inform students of their progress and thus help promote a personal monitoring of
their own progress. Again, when designing these curricula with these web-based supplementary materials and services, the participant knew in advance that a combination of the technology and personal interactions would serve as interdependent techniques to steer and support self-assessment and personalized student self-regulated strategies. This combination of staying on task with the web-based tools were to later work in tandem with the ticket-based reward system as well as the check-in center in which students would turn in their daily homework and parent/guardian signed logs. Thus, students would later, during instructional hours, have multiple levels of supports, scaffolds, and activities that promoted greater senses of self-responsibility and metacognition.

In her vast, instructional planning, the participant’s TPACK was a foundation for understanding and seeking web-based tools to work towards the provision of multiple means of engagement. Her understanding of technology and platforms, including hardware, software, and internet-based tools would prove to be essential in planning when combining her strong knowledge of lower-elementary level pedagogy and content knowledge. Her TPACK helped combine many different resources together that would combine and strategically be delivered later during her instructional moments. Her TPACK helped her in understanding which particular web resources to use and how to use them for student learning, in an effort to provide options for recruiting interest, sustaining effort and persistence, and self-regulation. By providing these options in the design stages of her instruction, the participant was able to leverage her TPACK to consistently support guidelines for UDL-based instruction.

**Planning Theme 4: Employing Different Software**

Another primary planning theme that emerged from this study was the use of different software and hardware products to create instructional content and prepare for activities. The participant personally owned a great deal of software. Much of this software was housed upon her computer that the HDOE officially issued to her along with a bundle of productivity tools such as Microsoft Office and Lotus Notes. On her own, the participant invested in several commercial software packages for instructional purposes and used them on a regular basis in order to create content. As she made her choices in technology applications for designing and delivering instruction, her technological, pedagogical and content knowledge were key.

Specifically, she utilized SMART Notebook collaborative learning on a regular basis and as a primary platform for the creation of content and as a springboard to launch other electronic
resources (i.e. audio files, PowerPoint files, websites). This software was installed on student computers, in an effort to provide students with options for perception, mathematical expression and symbols, and comprehension as described in UDL Principle 1, Guidelines 1, 2 and 3. Since students all had SMART Notebook upon their computers, they too had the capacity to see, hear, and interact with a variety of symbols and expressions in a wide range of contexts, and in accordance to their individual preferences.

In using the software to create different forms of electronic media, the participant described the long hours and the great amount of personal time that she invested including during her summer and vacation. In the third interview, the participant described her efforts:

“IT took, just to make the daily lessons, lessons from the [paper-based] teacher’s edition of instructional Language Arts content, it took me the entire summer to do the Reading and the Math content [to be converted from paper-based format into interactive files]. And, I was working 10-12 hour days on it. I was working so hard on it because it’s really a lot to do, when you consider that there’s three different disks [of instructional content] cd’s with sounds that I pull out to go on there and compile into organized, interactive SMART Notebook files. From the song, there’s one [c.d.], and there’s one that has another set of songs as well as phonics and rhymes – which is another set of songs. And then, there’s the one that has the story, the text.”

In other instances, she described extensive days of transcribing units from paper-based curricula into various digital formats. A program that she found helpful was Dragon Dictation software to dictate text-based content into SMART Notebook files for her lesson activities. She utilized a USB-microphone to dictate traditional flat text into a digital audio format, which could be transformed and repurposed and recycled for various activities and lesson content. She utilized the same microphone in conjunction with a free, open-source software called Audacity to create .mp3 audio files. These files would be attached to objects inside the SMART Notebook in order to make objects, such as pictures, interactive with custom-built sound. Quite regularly, she would apply this technique to add sound and narration to books that were scanned and traditionally not available in a digital or interactive format. These books, in their new electronic format, were presented to the class as a whole upon the SMART Board and also sent out to students’ individual computers via SMART Sync, as described in the following section. Thereby, she was able to provide alternatives for auditory information, as well as options for physical
action, in the manner in which students could interact with content, and to minimize threats and distractions by compiling this media into comprehensive, packet-based files.

The new digital content was much more transformable and provided options for language, mathematical expressions and symbols to be used. For example, vocabulary and symbols or syntax and structure could easily be presented upon the SMART Board and could be further manipulated and interacted with for greater clarification. With the audio files that she created and attached, she designed opportunities to support the decoding of text, mathematical procedures or notation and symbols.

The participant developed and used a SMART Sync virtual classroom to distribute content and monitor student activity. The hours she took to develop the virtual classroom assisted her in efforts to organize and administer much of the content that she had developed and refined. Thus the effective use of software and technology solutions enabled her to provide various representations of information to students to meet their learning needs.

As demonstrated through the examples in this section, the participant’s TPACK allowed her to choose and utilize different software-based tools and solutions in an effort prepare for instruction and activities, within an inclusive classroom. Although the participant did not directly or explicitly state, cite or reference specific UDL principles or guidelines, it is evident that she did use her TPACK, within the planning stages of her instruction, to meet and support different learning needs, options for action and expression, and different ways to engage her students within the content, and the integration of technology to support these efforts. Her specific choices and actions were based upon her TPACK with the intent to support all learners in her classroom.

**Planning Summary**

Collectively, the participant demonstrated that developing and sustaining TPACK to prepare for instruction involved a great deal of personal commitment, time, and innovative, independent effort. It is important to note that the participant of this study shared a strong sense of empathy towards the students in her classroom who were receiving special education services at the time of this study. She expressed her sentiments by stating,

that’s the one thing that really lends me or leads me towards inclusion…because, if you can get, you know, these kids that are, you, know, that you’ve labeled as “SpEds” that are needing extra support. If you can get them in the regular classroom and to where, the
[general education] kids are saying ‘Oh, they’re able to do things just like me.’ You know, ‘sometimes, they don’t understand things, just like me’. You know, or ‘Wow! That girl [with disabilities] is really good on that computer, and I can’t understand it to save my life!’

With this empathy and her TPACK, she continuously designed, prepared and refined her instruction. Her TPACK was key in her choices and supported development of materials and instructional strategies that were closely aligned with UDL-based instruction.

The participant’s efforts, her collective knowledge of technology, along with her previous pedagogical experience and familiarity with much of the instructional content, thus her TPACK, were an influence on the efforts and skills she utilized to prepare and develop instruction that incorporated many of the guidelines for universal design for learning. Her personal time, financial investments in equipment (both hardware and software), as well as her commitment and experience with professional development were factors that contributed to the design of her instruction. Such knowledge directly assisted the participant to utilize her TPACK in a professional manner that intertwined many of the elements of the UDL guidelines. Much of her design preparations for instruction, supported aspirations to develop resourceful, knowledgeable learners who would be strategic, goal-directed, purposeful, and motivated.

The section that follows describes how much of her instruction was actually facilitated with her TPACK to support UDL in her inclusive classroom, as triangulated via analyses of materials, semi-structured interviews and regularly scheduled observations of her classroom.

**Implementing Instruction Within the Classroom**

With respect to the second research question of this study, how does a public school teacher utilize TPACK to support UDL during the delivery of instruction in an inclusive environment, four major themes emerged from this study:

1. The participant utilized a range of different media to represent content (Media for Representing Content).
2. The participant used various technologies to monitor her students and to help students track their own progress (Technologies for Monitoring).
3. The participant supported both routine and choice through technology (Supporting Routine and Choice).
4. The participant fostered student-to-student and student-to-teacher collaboration using technology (Technology to Support Interaction).

Table 4.2 shows how these themes intersect with UDL and with respect to specific components of her TPACK.

Table 4.2.

*Findings within the UDL and TPACK Frameworks for Implementing Instruction*

<table>
<thead>
<tr>
<th>Finding</th>
<th>Representation</th>
<th>Action and Expression</th>
<th>Engagement</th>
<th>Elements of TPACK</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uses different media to represent content and to engage her students</td>
<td></td>
<td>X</td>
<td></td>
<td>TCK</td>
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<tr>
<td>(Media for Representing Content)</td>
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<tr>
<td>Uses various technologies to monitor her students</td>
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<td>TPACK</td>
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<td>(Technologies for Monitoring)</td>
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<tr>
<td>Supports routine and choice</td>
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<td>TPK</td>
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<tr>
<td>(Supporting Routine and Choice)</td>
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<tr>
<td>Fosters student-to-student and student-to-teacher collaboration using</td>
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<td>TPK</td>
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<tr>
<td>technology (Technology to Support Interaction)</td>
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With respect to these findings, the participant’s inclusive-based educational philosophy and the breadth of her TPACK was epitomized by the following excerpt from an interview:

You know, if you're going to, the goal is to include them in the regular education setting...you have to do that. And that means, the SpEd teacher has to be on board to teaching the whole class. You both have to be on board and supporting each other. With things that you in the classroom, you know and, not every time the special ed kids need the help...Sometimes, the regular ed kids need the help. And the special ed kids don't. A
perfect example, yesterday...no, Tuesday, we taught a lesson about trying to figure out "How much more monies someone had saved." And that was basically a lesson comparing that kind of thing. And so, what we did was we had someone save 12 pennies and someone else saved 7 [pennies]. So, we put it out on the SMART Board...all, nice and in a row, 12 pennies. Underneath, 7 pennies, and then we took these lines and then we connected the pennies from each line. "Oh, they both have it, it's the same." And we did this for the whole 7 pennies. And we said, "Okay. These are the ones that are different and remaining." We circled them and said, "How many are there?" "How many are there" So we counted up. Now, when go to, you know we did this a few times and then when we got to doing the journal page, my sped kids...not a problem, got it like that [snaps fingers]. My kids that usually have absolutely no problem with anything that we do - couldn't do it. Couldn't do it to save their life. [The difference was] Probably, that the activity was more kinesthetic. That it was more, you know....there were more steps. They [the general ed kids] were used to getting the content and having it right there conceptually and [delivered] on their desk. And the general ed kids, aren't used to taking all the steps to do things. Whereas, the sped kid are used to getting things different ways...So, the sped kids were [like], "Okay, I can do that. And I can do that, and I can do that."

"There's my answer." You know, they're used to working with more graphic things, because that's how we break it down for them. I really think that was the difference...but, I guess that sometimes they, the students receiving special education services are not the ones that need the help.

Through the observations, interviews, and materials collected and analyzed, as a whole, the data underscored much of her philosophy and demonstrated that her practice in the classroom threaded many components of UDL and TPACK with one another. The sections to follow will further describe these findings with respect to the three major contexts of the UDL Guidelines (2012, CAST): Provide Multiple Means of Representation, Provide Multiple Means of Action and Expression; and Provide Multiple Means of Engagement. Through the series of direct observations, ongoing semi-structured interviews and the analyses of materials insights and nuances were uncovered and documented. Accordingly, specific examples, details, and
summaries of these themes from the participant’s instructional efforts are presented in the subsections to follow.

**Implementation Theme 1: Media for Representing Content**

Across several observations, I witnessed the participant deliver instructional efforts and technological supports in a manner to help develop resourceful, knowledgeable learners. In many instances, the participant would deliver customized interactive crossword puzzles that provided options in the way that students would traditionally interact with text, through static print materials. This opportunity allowed for students to see the content in a larger format, at the SMART Board interactive whiteboard and at their individual desks, where they were instructed to utilize virtual tools to highlight vocabulary words. Content was illustrated across multiple media. Quite often, the content that was delivered helped clarify vocabulary with customized images that provided alternatives for visual information and that also supplied background (such as the vocabulary words from many of the hyper-linked PowerPoint files in the “Morning Warm-Up!”).

Figure 4.20 is a picture of a student’s netbook in the middle of the participant’s “Morning Warm-Up!” daily routine. Here, the student was provided with tools that give options for perception, and he/she began to customize the display of information with a few of the virtual tools in SMART Notebook. This lesson design and delivery provided her students with options for expression and communication. In this virtual environment, students were provided with multiple media for communication and multiple tools for construction and composition. For instance, the students could utilize various virtual pen tools, textboxes with various fonts, sizes, and colors, and shapes and clip art to illustrate their understanding and original ideas, in response to constructing a response to the prompts of the “Morning Warm-Up!” The participant provided options for recruiting students’ interests by giving them individual choice and autonomy during these exercises, and thus enhancing relevance, value and authenticity.
Through the analyses of materials that were deployed and utilized, it was also evident that the participant utilized graphic organizers, in a digital format that helped highlight the patterns, critical features, big ideas, and relationships in the stories that were read during Language Arts instruction. The participant delivered files to student laptops that also had attached audio files. At their netbook computers, students had options to utilize headphones and volume to provide alternatives for receiving auditory information via stories, online educational games and related, interactive assessments. Figure 4.21 represents typical components of the files and materials that she deployed to her students: audio, graphics, and interactive media.
Furthermore, in the interviews the participant corroborated the findings that emerged through observations as well as later through materials analyses. She validated how much of the content from the Amazing Words that were frequently reviewed in class were also launched and presented interactively via SMART Notebook and PowerPoint – where students “know where to tap” or recognize her voice via personalized audio recordings (that are traditionally not provided by the prescribed curricula, Reading Street). She justified much of her digital content, saying that it allowed her to “pause it when I need to…and (check on students, when) they look like they’re a little confused.” In these instances, she prompted students for further thoughts and verified understanding and comprehension, from these stories and activities, and adjusted her instruction accordingly.

With respect to the second tenant of the UDL Guidelines (CAST, 2011), the participant designed content that in its very nature allowed students to have a range of options for physical action. At the SMART Board, on their computers, and even with the paper, pens, crayons, and pencils at the students’ desks, students had a range of tools and activities that varied the methods for personal response and navigation across learning experiences and content. Such participant-designed files, like the SMART Notebook files with audio recordings of stories, and recognized
tools, such as IXL and AimsWeb, offered access to technologies that could serve assistive purposes on a variety of levels, with respect to individual needs.

Similarly, the conceptual design and technological nature of the content that was in various audio, video, and multimedia formats optimized various opportunities for personal expression and communication. The design and organization of the physical classroom also facilitated this opportunity. Within this physical and tactile environment, the participant with the collaboration and support of the classroom TA was able to facilitate positive-behavioral support plans and strategies, such as a ticket-system for compliant and on-task behaviors, and low-tech solutions that provided options for students’ executive functions.

Additionally supports were designed in the form of raffle tickets for small prizes. Supports for planning and strategy-development were low-tech in nature, and took the form of student jobs of the week, in which the participant designed three positions as “Student Monitors”, one of which was the “Computer Monitor” and empowered students to serve as technical support and assisting with instruction at the SMART Board. The participant was able to facilitate and manage information and resources as she collaborated with her students during instructional activities. For example, students would eventually assist in the revealing of instructional content as approved and coordinated by the instructor. The design of resources and classroom systems, as a result, intertwined the opportunity for her learners to eventually monitor their own progress, as they were sent files to their individual netbooks identical to files that were later to be presented to the class as a whole.

Through much of the data collected, it was very explicit that the participant provided a range of options for physical action for her students – with both the technologies she utilized and the activities that she facilitated. She was able to vary the methods in which students would respond and navigate the instructional content. For example, the files that she deployed as part of her “Morning Routine” were shared and opened on student netbooks. These files and the tools that they used to interact with this content (i.e., SMART Notebook and many web-based activities) allowed students to use a range of different tools. Such tools included virtual pens and highlighters, which were further customizable in their color, thickness and opacity. Thus, she optimized much of the students’ access to many tools that could be adapted as assistive technologies. Collectively, through this range of knowledge of both technology and content, she supported many processes and delivered a range of instructional techniques via several media to
develop learners who were resourceful and knowledgeable, strategic and goal-directed, and purposeful and motivated to work in her instructional setting and comply with her directives.

To summarize, the participant was able to use her specific combination of technological and content knowledge in order to integrate many different media during her instructional activities and lessons that support learning in her inclusive classroom. This TCK was utilized to support the first major principle of UDL, multiple means of representation, via integrating digitized worksheets, virtual tools, personalized recordings, and digital text to represent the instructional content in many different ways for her learners. Consequently, the participant was able to provide her learners options for perception, language, and comprehension, and thus support major components of the UDL guidelines during her instructional practice.

**Implementation Theme 2: Technologies for Monitoring**

Within her instruction, the participant varied the methods by which students responded and navigated much of the instructional content and activities during the intervals of this study. She often permitted opportunities for students to explore at their own pace, at their individual laptops, and varied many of the web-based and computer-based tools with which they interacted. Collectively, these opportunities gave her students many options for her students to monitor themselves and enhanced their capacity their progress. Concurrently, this effort also supported her students’ daily routine and frequently empowered her learners with choice.

IXL.com was an obvious example of this web-based platform that gave her students immediate feedback on their learning goals and related progress. The IXL platform, as an interactive, adaptive supplement to the participant’s curricula, provided a great deal of variability for individual students’ skill levels in both Language Arts and Math. Students could see their present levels of performance upon logging into the site and as they progressed through the interactive tutorials, assessments and activities. The First Grade level, covered mathematical concepts that were aligned to Common Core standards and included counting and number patterns, addition (with and without skill builders), subtraction (with and without skill builders), mixed operations, comparing, estimation, place values, fractions, geometry, spatial sense, data and graphs, measurement, money patterns, probability and statistics, sorting-ordering-classifying, and time (see Figure 4.22). The participant would often give her students the choice to interact with either Math or Language Arts-based content during the early part of her Morning Warm-Up activities.
Although there were not specific First Grade Language Arts tutorials offered via IXL, the participant would often encourage her students to challenge themselves by entering the Second Grade Language Arts section for online mini-lessons, games and quizzes (see Figure 4.23). Both the Language Arts and Math-based services in IXL not only gave the students feedback on their progress, but it also generated reports, both formative and summative in nature, to the participant as the instructor for the class as a whole, as well as individual levels of performance, mastery, and understanding.
The participant could monitor these skill-sets for students and track them in real-time. The participant expressed her appreciation for the use of these tools, and related their functionality for instruction and observation. Within a semi-structured interview with the participant, she noted that:

“They (IXL) literally have, based upon the Content and Performance Standards for each state (and Common Core), they literally have every skill you need to learn for that grade. And, when you buy a subscription, that gives you access (to materials, assessments, and information) not just to the grade that you’re in, because you don’t tell anyone (from the IXL service) what grade you’re in when you subscribe. You get access to the Pre-K to the 8th Grade. So, there’s another differentiated (or) another differentiation tool. Because, then, if I’m sitting here and I know that Student B can’t count by 5’s, then I’m going to have her go to the IXL service and practice counting by 5’s. And, if the 1st Grade is too hard, then, I’m going to have her go back down to the Kindergarten one and practice…and practice there, where she’s at, and then build her up, from there! Or, like Student C…Student C can tell time in his sleep! Down to the minute! Literally…you
should have seen him last time I did Time (Practice with the students)...So, going to the 1st Grade (content) he was bored! You know, he’s not getting anything new, so, going up to 2nd Grade or maybe even 3rd Grade (content, activities, and assessments in IXL), starting on Elapsed time with him...(as) another differentiation tool.”

Primarily through these scheduled and ongoing observations, I was able to directly see how the participant was monitoring her students in a variety of ways, the participant could see what was working and not working for her students in real-time, within both virtual and physical environments. She was well aware of how to technologically manage the devices and their interrelated connections (i.e., SMART Board, student laptops, her local network, and her personal computer) to collaborate upon content with her students, and to manage the pedagogical components of class (providing instructions, facilitating, and managing the class schedule, etc.). Thus, with the participant’s collective knowledge (TPACK) and application thereof, she was able to deliver instruction with immediacy and a flow to alter or sustain supports and efforts as students interacted with content, support staff and each other. These efforts helped both the participants and her students monitor their own progress individually, but also altogether as class support group.

Similarly, the participant would allow her students to log onto Starfall.com which supported the development of students motivation, phonemic awareness, systematic phonics, vocabulary, fluency and comprehension (see Figure 4.24). Although Starfall’s services were not as extensive as IXL, the students often enjoyed the range of choices and singing along with the songs and rhymes upon completing the online activities.
In conjunction with these web-based tools for monitoring and instructional supplements, the participant utilized a computer-lab management software (SMART Sync) to monitor her students in real time. While observing the participant, I noted that she spent a fair amount of time behind her desk while her students were going through their morning exercises at their computer. Yet, although she was physically distant from each of the student’s desk, the participant created the SMART Sync network that streamed the computer screens back to her personal laptop, where she could intervene if a student was struggling or off-task.

During her instructional time, she would present key words and concepts behind grammar in order to build consistency and fluencies for Language Arts related skills and standards, as she also paired them with graduated levels of support so that students could improve their practice and performance. During instructional time the participant utilized additional low-tech strategies and technologies to monitor her students and to provide options for monitoring progress with respect to the range of individual learning goals and styles. Often these strategies took the form of verbal praise to give students auditory and interpersonal feedback about their improvements. Additionally, the participant gave reward-based tickets for on-task behavior during Language Arts instruction and transition activities, such as standing in line or waiting quietly. In another interview, the participant shared, “We hand out tickets when they are good. Will hand out tickets, and then, normally at the end of the day, will draw certain number, and that will depend
on when they are really good. We will draw number right above the fridge – next to the homework chart. When they are really good, it goes up – it says you have to be up to a certain number (to receive prizes). And when they are not so good, it goes down.”

The participant also utilized a form for individual progress as they mastered certain components of Common Core standards. This form took the shape of a printed spreadsheet with cells that permitted checkmarks for mastery, room for growth, and additional comments (see Figure 4.25).

Figure 4.25. A form for tracking individual students’ progress in Language Arts.

Many of the web-based resources that were observed in the instructional setting and discussed via interviews, underscored the participant’s ability to provide options for recruiting interest, while also sustaining effort and persistence, and options for self-regulation. Thereby, the participant was able to leverage technology and technological related strategies to give students individual choice and autonomy as to what web-related resources that they wanted to utilize (i.e., Starfall, IXL, or AimsWeb). These resources helped the participant understand students’ levels of performance on many of the web-based assessments that she could observe either through her
personal laptop utilizing SMART Sync or by casually interacting and observing her students at their desks. To many students, through my eyes as the researcher, these platforms seemed enticing and engaging, in a way that optimized relevance, value, and authenticity to their activities and content in the classroom. Furthermore, students seemed to have fewer behavior-related issues and remained on task while engaging in these environments, and in tandem, the use of headphones helped minimize threats and distractions. Figure 4.26 captures the participant’s instructional screen while using SMART Sync to monitor her students’ work on their “Morning Warm-Up!” file.

![Field notes capturing the participant utilizing SMART Sync to monitor students’ computer-based activities.]

*Figure 4.26. Field notes capturing the participant utilizing SMART Sync to monitor students’ computer-based activities.*

The participant employed these tools, as well as SMART Notebook on the student computers, to help students sustain their levels of effort and persistence, as well as provide students with options for self-regulation. Students, for example, were able to check off examples in the SMART Notebook file on their personal netbooks after completing them, and then subsequently receive a digital confirmation after returning and submitting the SMART Notebook file to the teacher’s laptop via SMART Sync.
Collectively, these high-tech and low-tech solutions helped the students and the participant monitor their progress as a group and as individuals. Students were informed at regular intervals throughout many activities of their academic and behavior progress. Consequently, students remained focused at their desks and determined to complete activities and assignments until their completion and transitioning to the next project. Additionally, during much of her instructional efforts, options for executive functions were delivered across a variety of different contexts, goals, strategies, resources, and efforts to enhance students’ capacity for monitoring their own progress. The participant would supply physical manipulatives and graphical cues, such as number lines and handwriting tips that were taped to individual desks. Without her knowledge of technologies, supplies and related strategies, as noted in the analyses of much of her digital instructional materials, many of these choices that were given to students, as an ongoing part of the morning routine, would not have been possible.

Implementation Theme 3: Supporting Routine and Choice

It was evident that the Morning Routine, described earlier, often gave students many options and empowered them with choice. As part of the regular, ongoing Morning Routine students would enter the classroom, drag their names on the SMART Board to an interactive trashcan that would clank and dissolve their names to mark their presence (see Figure 4.27) and deliver their homework and parent/guardian logs from the night before (see Figure 4.28).
Figure 4.2. A picture of the Morning Check-In system on the SMART Board.

Figure 4.28. A picture of the table where students would return their nightly Homework Log, Homework Tablet, and Language Arts workbook as part of the morning routine.
Students would then be responsible for recording the night’s homework in their Homework Log, as the participant and teacher assistant would grade their previous assignments. After this point in time, students would practice handwriting (see Figure 4.29) and review their progress before picking up their personal netbook computers. Upon retrieving their assigned netbook from the secure charging station stations, students would have a small window of time to get online and navigate to various websites and web-based services such as Starfall and IXL, as detailed in the previous sections, see (Figure 4.30). After some time, approximately ten to fifteen minutes, the participant would finish grading the previous night’s homework, checking handwriting, taking official attendance and other administrative tasks, and then, issue students the personalized “Morning Warm-Up!” file.

Figure 4.29. Students practicing handwriting after turning in homework.
Another component of the classroom routines were the “Student Monitors” – which were student jobs of the week. Although students anticipated this routine with much excitement, they were randomly assigned various jobs throughout the week. These routine jobs consisted of leading the lines as they left for lunch and other activities, cleaning the dry-erase boards, providing the classroom supplies and books that were assigned to a particular, color-coded cluster of student desks, and serving as the Computer Monitor, to supervising and assisting with content at the SMART Board. This position fostered many interactions with technology that will be described further in the following section.
Collectively through her pedagogical style and arrangement of technology (her TPK), the participant empowered her students with a routine which students knew, followed and expected, while still providing a myriad of tools to choose from and interact with educational content according to their personal preferences. Students needed few prompts and reminders to get started with this Morning Routine and executed each stage systematically. Students selected content on their laptops that both engaged them and matched their personal interests and levels of performance. Without providing her students with such a flow and range of options with her TPK, such a classroom system would be difficult to implement.

**Implementation Theme 4: Technology for Interaction**

As previously described, the participant would often design interactive SMART Notebook files that were projected upon the classroom SMART Board, and also sent out to individual student netbooks via SMART Sync. These files were part of the “Morning Warm-Up!” that were sent out after some of the gaming and interactive assessments. During the scope of this study, it is also significant to note that the participant’s classroom had a set of the SMART Response interactive student response “clicker” system that wasn’t utilized during the periods for
observation. Regardless, the “Morning Warm-Up!” files that were sent to student computers contained a variety of multimedia that was utilized for multiple means of representation, action and expression, and engagement for her students. This range of technology kept both the students and the participant integrating and cooperating with a range of tools and unique strategies and activities.

In addition to the routines and choices that were delivered to the students, much of this was supported technology, which in turn fostered many forms of technological interactions, independently at student desk-clusters (see Figure 4.32), as well as student-to-student (see Figures 4.33 and 4.34) and student-to-teacher forms of collaboration (see Figure 4.35). Quite often, the participant delivered much of the “Morning Warm-Up!” at the SMART Board, with the collaborative-assistance of the student Computer Monitor and her classroom TA during the Language Arts class. The participant would visit the clusters of various student desks and give them individual feedback as they worked. Yet, simultaneously, she would count on the student Computer Monitor to illustrate and annotate upon the electronic documents, which were presented, interactively upon the SMART Board, so that the rest of the class, as a whole, could see. Students would continue to work with the files at their individual netbooks, sometimes paper-based reading books and then review this content collectively as facilitated with the participant. On occasions, activities required group participation and materials with pen and paper, and other such materials in their teacher-funded supply bins.

Figure 4.32. Student working independently at the netbooks.
Figure 4.33. Computer Monitor coaching a peer at the SMART Board

Figure 4.34. Field notes capturing students collaborating together on web-based activities.
In many instances, the participant would display instructional content upon the SMART Board, such as a worksheet that was scanned electronically and pasted into SMART Notebook, and would prompt her students to take turns and share writing on the worksheet (i.e. fill-in-the blanks or circling content with interactive pens, as prompted by the participant, herself). On a regular basis, the participant would also send these same files out to students’ individual computers and she would interact with them, more so as a guide or coach, rather than a traditional lecturer or providing singular, standardized and non-personalized content to her students.

Many of these activities were digital in nature, as described, but they were also tactile and worked on functional skills and projects such as handwriting, cutting with scissors, coloring, and taping group projects together (See Figure 4.36). Although these projects were low-tech in nature, they were often paired with high-tech solutions such as digital cameras and a classroom website to preserve and share many of the classroom projects, activities, and learning experiences.
Figure 4.36. An activity combining high-tech and traditional materials.

Technology was also utilized to support classroom discussions. In one instance, there was a story that mentioned an oak tree, but the text neglected to provide a visual. And in this same text, the participant noted how much of the content did not provide her students with much of a local context. In that instance, the participant utilized the web to search for images of oak trees and did a similar exercise after reading a story about squirrels (to which there are none in Hawaii). In this particular event, the participant utilized two browser windows to compare and contrast squirrels with the mongoose.

Within an interview, she noted:

“Varying things (such as materials, content, and routine) to make it local is important. And one of the kids actually asked, ‘Do we have oak trees here in Hawai‘i?’. (And I replied,) ‘We do!’”

By simultaneously utilizing web searches and image captures, with annotations available in her interactive, technological tools, the participant was able to make content contextually relevant to her students and thereby further facilitate her shared classroom conversations with her students.
As introduced in the previous section, the participant would designate a different student each week to serve as the role as the Computer Monitor. This position empowered the particular student to share the technological responsibilities of navigating the SMART Board, as directed by the participant. In many instances observed by myself, the student who served as the Computer Monitor would comply with such directives from the participant, as the teacher for the classroom, and assist other students as they interacted with content, such as electronically revealing hidden words and highlighting particular content. This routine would increase mastery-oriented feedback that was often peer-generated and fostered a stronger communal feel. In establishing such roles and responsibilities, the participant would simultaneously promote expectations and beliefs that optimized motivation for students to work and support each other.

Additionally, by watching their peer as the Computer Monitor and others interacting with content at the board, students were also able to interact with each other by developing self-assessment skills and monitor their own progress at their individual desks with related content on their netbooks. Thus, with these strategies at hand, she would invoke and sustain opportunities for peers to provide opportunities for students to serve as peer support providers and collaborators for one another. Students would also share their computer screens with one another at their desks and review each other’s co-created content via read-alouds and discussion. All of these accomplishments were collectively tied together through the participant’s TPK, as noted by her specific knowledge of deploying and supporting technology (devices, network, software, and files), as well as her ability to maintain the classroom’s flow and dynamics (peer assignments, physical arrangement of supplies, and grouping of students) from her proactive design and the implementation of her pedagogy.

**Implementation Summary**

Collectively, many activities were delivered with digital and technological components. The participant had a combined knowledge of technology-pedagogy-and-content that she used in delivering instructional lessons and activities in her classroom. Much of her TPACK formed the basis for the delivery of her “Morning Warm-Up!” with her students. This foundation for her “Morning Warm-Up!” routine, materials and technologies provided multiple means of representation, action and expression, and engagement during such instructional times.
Although the participant did not make explicit references to UDL with respect to her practice, it was evident that she sought to support all of the learners in her classroom with various levels of technological solutions and strategies when leading and delivering instruction within class time. Primarily, the participant focused on representing content and engaging her students in a multitude of ways. The instructional content and activities were comprised of many different technologies and digital files, and platforms that both enticed and supported her students during instructional times. Her TPACK supported her actions in both planning and delivering instruction, and those actions were aligned with principles of UDL.

Additional Interesting Findings

While not directly related to the initial research questions, during the course of the study, I noted some interesting findings. Three in particular are shared here. First, this participant seemed partly motivated to teach in the ways she did because of her own disabilities. The participant of this study had a particular empathy, understanding and desire to support students with disabilities. Much of this empathy came from her personal experience. Not all educators have the personal experience to relate to students with disabilities. Meo (2008), Rose (2011), and Edyburn (2010) collectively acknowledge the range of effort, knowledge, and drive needed to prepare instruction for all learners. As such, it is possible that the personal experiences of the participant played significant factors in her desire and motivation to support all learners, and to seek strategies and technological solutions to assist her efforts and the learning in her classroom.

Second, the participant’s passion for technology and her beliefs in its importance in helping all students learn led her to invest heavily of her own time and financial resources. (Bryant et al., 2014) echoed the potential of technology to support instructional planning to meet the needs of all learners. The participant of this study invested a great deal in the acquisition of technology, both hardware and software, for the planning and execution of instruction and learning in her classroom. As noted earlier within this study, the participant made such investments using her personal funds for these tools. For the HDOE, most classrooms and educators, at the time of this study, were not exposed to such tools or the requisite training involved with mastering their capabilities. Much of the software and media used by the participant required a great deal of time and professional training that are out of the norm for most teachers’ schedules and school budgets.
Third, the participant had extensive professional development about and a passion for technology. The participant exhibited a strong sense of design that helped her understand what was going to be feasible and relevant for instruction during much of her planning, gathering, and organization of materials that were both tactile and digital in nature. Again, not every educator has had the levels of training in both professional development and higher education to account for this level of TPACK, as evidenced by many members of her school-community seeking her assistance and asking to use materials she developed.

In fact, many of the materials that the participant created were well received externally and sought by others outside of her school. She seemed to be a key leader within an online network whose purpose was to share insights, tools and strategies. This discovery soon led to the realization that the participant’s instructional design efforts led her to collaborate and interact with a range of teachers, instructional staff, and stakeholders both in person and online. Through the interviews and through the participant’s profile page on TPT (Teachers-Pay-Teachers.com), it was later realized that the participant connected and collaborated with a number of educators virtually as well. Many of the comments on her TPT page praised the products she developed, and consequently led her to plan to develop additional content for upper-level elementary grades as well. This content and related media was also shared with other educators at her particular school site. The participant mentioned her goals for completing the rest of the K-5 curricula within SMART Notebook and PowerPoint, and sharing as she has with her school-site-specific team and the significant amount of her followers and educators online. Figure 4.29 depicts the large number of votes, followers, positive feedback, and consistently highly ranked scores for the overall quality, accuracy, practicality, thoroughness, creativity, and clarity of the materials and products that the participant produced, sold and shared via Teachers-Pay-Teachers.
Figure 4.29. A screen-shot of the participant’s profile and ratings page on Teachers-Pay-Teachers.com.

Summary

This chapter presented an overview of the findings that emerged from the analyses of data throughout this investigation. With respect to the first research question, how does a Title public school teacher utilize TPACK in preparing UDL-based instruction, the findings identified specific instances through observations, dialogue in semi-structured interviews, and results from the analyses of materials, how the participant creates a variety of instructional materials to meet differing learning needs; employs different software; designs and organizes the physical layout and resources for her classroom to provide for action and expression; and utilizes a range of web resources to plan and prepare.

The second question posited by this study: how does a Title 1 public school teacher utilize educational technology and TPACK to support an inclusive environment and the principles of UDL had findings that also emerged. With respect to this question, findings included: the participant supported routine and choice; she utilized different media to represent content; she
used various technologies to monitor students; and she used technology to foster student-to-
student and teacher-to-student collaboration. The chapter that follows will present a discussion of
these findings with respect to these research questions, as well as interpretations and implications
for practice, theory, and future research.
CHAPTER 5. DISCUSSION AND INTERPRETATION

The purpose of this exploratory qualitative case study was to investigate and describe how a teacher in the public sector used knowledge of technology, pedagogy, and subject-specific content knowledge (TPACK) to design instruction and support for students with and without disabilities, specifically through the lens of Universal Design for Learning (UDL). This study sought to identify how a teacher used TPACK to facilitate her instructional efforts within the context of a classroom designed for inclusion. Based upon the findings that were detailed in the previous chapter, this chapter provides insights into the impact of TPACK on designing and delivering instruction to support UDL in the classroom. Figure 5.1 graphically summarizes these insights.

Figure 5.1. The Influence of TPACK in Supporting UDL in both Planning and Instruction.
In essence, the participant’s TPACK (collectively as a whole and as individual sub-components) served as a toolbox for strategies that assisted her in implementing UDL principles in designing, delivering and reflecting on instruction within an inclusive classroom. The TPACK of the teacher led her to use technology to develop and implement strategies aligned to UDL principles to support various learners. Technology allowed for and supported multiple means of representation, multiple means of action and expression, and multiple means of engaging students in learning. Technology provided options for using multiple media for delivering content, provided mechanisms to allow not only the teacher to track student progress, but also the students to see their own progress and encourage self-regulation. The technology allowed students to have choice while still providing for routine and also supported teacher-to-student and student-to-student interactions. The participant utilized her TPACK to both design resources and strategies in preparing for instruction. Additionally, as also noted in findings within the previous chapter, the participant utilized her TPACK to implement, share, and reflect on the related strategies that she delivered after designing these instructional solutions.

The sections that follow in this chapter will synthesize these findings with the literature reviewed in this study in an effort to discuss how the participant used her TPACK to support an inclusive environment at a Title 1 school. She used her TPACK expertise to create and produce learning resources, to provide instruction and expand options and choices for her students, to ensure greater accessibility, to extend the monitoring of her students, and to enhance interaction throughout the classroom. The participant of this study, however, represents a truly unique, atypical case and findings may not generalize beyond her specific setting. Her own status as a person with a disability, her passion for technology, and her willingness to invest her own personal resources (both time and money) into her classroom may not be reflective of the typical teacher. However, we can still learn from her case how TPACK may influence integration of UDL strategies in a classroom. Despite the uniqueness of the participant, this chapter will present recommendations for educators in the field, educational policy makers and administrators, as well as suggest future research to examine the use of TPACK and UDL to support all learners.
Planning and Delivering Instruction

Designing Instruction

As referenced by Figure 5.1, the participant used her TPACK with the intent to support all of her learners. Her TPACK skills enhanced her ability to design for differing learning needs, design for action and expression, utilize web resources in planning, and employ different software effectively. Consequently, the participant’s TPACK helped her support the major principles and tenants from the UDL guidelines. Her TPACK was evident during her instructional planning and in the ways she designed materials and activities for instruction.

In designing for differing learning needs, the participant was able to proactively recognize the behavioral and academic needs of her students, and plan for groupings and the design of her classroom work-stations for her students. She knew in advance how to prepare learning materials to meet diverse needs, anticipate the structure and flow of lessons, as well as determine the best physical layout for navigation and interaction during instructional time. Such TPACK may be effective for other educators, especially if they are provided with supports that help provide explicit understandings of the UDL framework (CAST, 2011).

When entering instructional design stages of preparing for an inclusive classroom setting, the participant recognized the need for supporting action and expression, and subsequently developed several opportunities for her students. The observations, interviews, and analyses of materials underscored these findings that were also presented previously. As noted, she designed physical and social activities to support the expression and communication of academic learning across multiple lessons and units. Perhaps, other educators and related stakeholders might benefit from designing for a range of actions. Edyburn’s (2010) ten propositions for UDL in the second decade of the twenty-first century may help steer these planning efforts to further greater UDL-integration into instructional settings.

With consideration to both the physical arrangements of the classroom designed by the participant and the range of web tools and different software that the participant combined with her TPACK, she was able to help develop advanced strategies, materials and environments that supported inclusion in accordance with UDL guidelines. Technology certainly played a significant role in the design processes observed and supported King-Sears (2009) assertions about the importance of technology. Technology was used to adapt instruction and develop
related technology-integrated strategies for use during instruction as described in the literature (Rao & Tanners, 2011). Advancements in technology will continuously open the opportunity to look at individuals and plan (Meyer & Rose, 2005). The participant used various technologies, including software packages and web-based tools. An understanding of these tools and environments was essential (Bryant et al., 2014) in the planning stages of instruction in order deliver, support, and evaluate instructional strategies that utilized such technological platforms. As the following section describes, direct actions during instructional implementation derived from such planning will need to evolve with technological supports, goals set from UDL guidelines, and from understanding the students, themselves, within the classroom.

**Delivering Instruction**

A symbiotic relationship exists between planning for instruction and its actual delivery. For example, the content that the participant integrated during her instructional lessons was a combination of remixed materials that had been digitized and original content, such as her voice recordings and digitized PowerPoint files, that gave her students different representations of content, in different modalities. This content was a stark contrast to the traditional print-based materials that permeated classrooms throughout the DOE at the time of this study. Consequently, the students in the participant’s classroom had a range of options and choices to view and interact with content. Had the participant not prepared her instruction for such variations, much of the media in the classroom would have remained flat and mono-dimensional, and not at all representative of 21st century media and literacy. It was the teacher’s TPACK that enabled her to construct and convey content using multiple forms of representation, a key theme of UDL. By assuring students could access content represented in multiple ways, this teacher was embedding UDL principles in her instruction, even though she may not have explicitly said so, but rather it occurred as a result of her TPACK. As presented in the literature review for this study and by Rose and Meyer (2002), tools, choices, and opportunities during instructional time can deepen student engagement and provide meaningful learning experiences for students.

The participant, with her TPACK, used complementary technologies to monitor the performance and behaviors of her students during instructional time. These technologies were web-based and provided reports on student progress in addition to the content for various instructional activities. This, too, represented a deviation from the typical educator’s practice at
the time of this study. The participant utilized web-tools with interactive sounds, graphics, and text as supplementary materials for her curricula, via subscriptions. These tools not only presented multiple means of representation, action and expression, and engagement for her learners, but also provided her with up-to-date statistics and reports on her students’ performance. Without the TPACK to initialize and plan for using such technologies for monitoring, educators may be unable to integrate such practices for instructional and pedagogical purposes. Since their seminal research in 2006, Mishra and Koehler have continuously revised and updated their definition of TPACK (2008) to acknowledge the challenges of teaching with technology. They have presented approaches to think about when integrating technology and implications for the framework itself (2009). They have gone on to also discuss specific implications for using TPACK as a framework 21st century learning (2011) and the continuous struggles that many schools and educators face with technology (2009). The findings presented within this study, with respect to the range of TPACK literature, demonstrates that a highly-developed TPACK and a willingness to adopt technology, are both integral components that can help steer efforts towards proactively and successfully intertwining UDL guidelines within instructional time.

**Supporting UDL with TPACK**

The instructional planning efforts of the participant occurred well beyond the span of the instructional year. Her investments included long hours during summer months and across different environment and programs, such as graduate work and other professional development opportunities, as well as significant personal financial investments in education technology. This study expanded upon the requests by Mishra & Koehler (2008) for additional research to describe how technology is utilized in classroom settings. Quite often, as observed in this study, there is little time during the instructional day to prepare for all of the technological tools that may be utilized to support UDL. It is likely that the combinations of TPACK and the resources and professional experiences of the participant expanded her ability to support inclusion using strategies reflective of UDL principles.

A combined knowledge of technology and subject specific content can assist with developing student affect towards learning by providing multiple means of engagement. The participant of this particular study understood the ways that her students would perceive,
comprehend, physically interact, express and communicate, and regulate themselves, well in advance. She designed and deployed media in ways that allowed students to hear personalized content and use virtual interactive tools to express their understandings and express themselves in unique ways that were not just bound to paper and pencil. In lieu of adopting pre-constructed curricula, the participant created various interactive tools with various technologies to create her own content and a combination of virtual and physical settings to monitor students, and recruit and sustain their interest and efforts. She undertook many of these tasks deliberately with passion and persistence, which extended well beyond the traditional expectations and the resources typically available to educators.

It is possible, however, that other educators and vested stakeholders within the field may learn to understand technology’s role in the planning and presentation of instruction and thus support the provision of multiple means of representation, action and expression, and engagement for all learners. The participant’s investment in time, effort, ongoing support and technological tools opened choices and opportunities for interaction between teachers and students, students-to-students and teachers with their peers in ways that were previously unanticipated and as supported by Edyburn (2010). Additionally, like the participant who gave her students the choice between different tools, online and physical in nature, technology can range in its scope and ability to give students various alternatives and autonomy in their decision-making (Collins & Halverson, 2009). Proactive planning on behalf of all individuals with vested interests in inclusive settings can pair technology and content knowledge to empower learners when designing and delivering instruction. This design process, and related skillsets, may help to develop opportunities for students to recognize the relevance, value and authenticity of what they are learning. Simultaneously, when preparing for instruction, educators may proactively recognize the potential of technology to mitigate distractions and other threats to the learning environment and progression.

Many tools can be utilized to take existing content and modify things, with digital tools, to change how content is represented and proactively meet the needs of students. One way that this was done by the participant of this study, was through the use of SMART Notebook, a SMART Board, SMART Sync, student netbooks with a secure charging station and headsets, web-based subscription services (such as IXL and AimsWeb) and open-source tools such as Audacity and Starfall. Information was presented in a variety of flexible formats so that
perceptual features could be varied. Similarly, digital sound, volume and speed were manipulated to adjust to meet the needs and preferences of individual learners. Additionally, the use of headphones with a range of sounds (both online and offline) fostered greater individual focus and minimized group distractions.

Options to auditory information may include visual diagrams, charts, notations, and/or prompts that may be placed around a classroom environment or even upon individual student desks. The graphic organizers and visual cues that were virtual, but designed by the participant, can serve as examples of how such options may be designed and delivered. Visual and tactile manipulatives can serve as cues or signals as options to sound as well. Manipulatives, like charts may be dispersed to individual desks or even mounted upon walls, or may be interactive in nature with interactive displays. Visual information may be supplant with a range options, including simulations and educational games that may be found through such web-based services as Starfall, IXL, and AimsWeb. However, planning with such resources requires the knowledge of these resources, the ability to manage student accounts and related administrative tasks, the financial means to subscribe to these services, and a combined knowledge of technology, content, and pedagogy to define and determine their integration and effectiveness.

The investment in educational technology resources such as a SMART Board, additional computing and networking equipment, computers for students, and lab-management software requires a fair amount financial funding and technological knowledge for installation and upkeep. It is significant to note, at the outset, that the provision of personal electronic devices, such as laptops or mobile devices, per student can foster a dramatic advantage in how UDL-based instruction is planned for and delivered. Instructional materials, lessons, and activities (and related strategies) may range in their costs and in their functionalities, however, many such resources can be customized, especially if they are digital in nature, to provide multiple means of representation, action and expression, and engagement. This study sought to respond to the call Edyburn (2010) made for research that describes technological advancements and the impact on UDL. The findings of this study suggest that the technological, pedagogical, and content knowledge (TPACK) of the teacher when combined with access to technology supports the use of strategies that are aligned with the principles of UDL, and thus support learning for students with different learning needs. Yet, perhaps collaborative and proactive planning with and amongst instructional designers, curriculum coaches, administrators, educational assistants, and
teachers themselves using the UDL Guidelines (CAST, 2009) and UDL Checklist (CAST, 2011) may also prove to be a crucial tool in the preparation and evaluation of instruction that aims to support inclusion.

**Providing Multiple Means of Representation**

In preparing for instruction, it was discovered that the participant’s efforts supported multiple means of representation through the creation of a variety of materials. By providing devices such as netbooks, students were able to adjust the display to individual preferences. Additionally, when content was digitally developed, learners were provided with alternatives for both auditory and visual information, either with customized visual supports such as graphic organizers before stories were read, or by providing personalized audio recordings that were digitized and supplemented text in different contexts. In line with Gardner (1985), findings support that the multimedia infused interactive curricula developed and delivered by the participant allowed for students’ multiple intelligences.

Students who have linguistically diverse backgrounds may benefit from graphics that can be presented or electronic files that can be deployed to individual student electronic devices. Vocabulary support may be embedded via electronic symbols, hyperlinked files, images, and sounds. Tools such as SMART Notebook offer the ability to highlight structural relations, in an effort to clarify syntax and structure. The development and integration of graphic organizers and concept mapping within lesson development, as done by the participant, may serve as a critical component in providing options for learners.

From this study, it appears that TPACK, when developed, can support the creation of UDL aligned instructional materials and implementation of UDL aligned instructional strategies. However, developing TPACK requires time to build the experience and to reflect on successes and challenges. Having the time to practice and develop TPACK knowledge, resources, and skills might help foster an understanding of how to better provide options for perception, language, mathematical expressions, and symbols, and options for comprehension, and thus multiple means of representation to develop resources for learners. This combination of using TPACK to support UDL aligned strategies might support populations with exceptional needs or who are of linguistically different backgrounds, as described by Raia (1997) and Earl (1998).
Efforts to make such provisions for multiple means of representation come through trial and error, as does the delivery of UDL-based instruction with technology. The teacher must focus on understanding how information can be displayed to learners and how it may be manipulated in a digital form for perceptual clarity. These instructional efforts may occur in collaborations between the instructor and the learners. Auditory and visual information are other factors that must be taken into consideration and active, conscious steps must be taken to address how they can be used to meet the needs of various learners. Actions must be taken before, during, and after instruction in order to determine alternatives for materials for these sensory applications. Often, low-tech and tactile solutions can serve as supplementary resources and strategies for supporting the instruction of all learners.

Technology that the participant used to create and deliver educational content and to engage students included clarification of vocabulary and symbols, and provided options for language, mathematical expressions, and symbols. As noted by Meo (2008), for diverse learners, UDL supports and resources can take various formats, including the web-based services that the participant subscribed to. Certainly, at the time of this study, classroom websites helped foster the aggregation of related resources and embed support. There were particular web-based resources that assisted with the clarification of syntax and structure, decoding of text mathematical notation and symbols, promoted understanding across languages (for non-native English speakers), and illustrated concepts and ideas across various media. Both high-tech and low-tech solutions complemented each other in the participant’s classroom. The routines used, group activities (including songs and stories) and low-tech manipulatives supported her more advanced technology based efforts.

By designing and delivering various experiences using various technologies, both low and high tech, the participant assisted her students in understanding content and build upon such foundations to generate new meanings. She utilized technologies to highlight patterns, critical features, big ideas, and relationships. These findings parallel suggestions of Rose and Meyer (2002) who suggest the integration of diagrams, outlines, graphic organizers, and routines to support learning.
Providing Multiple Means of Action and Expression

This study unveiled findings about how the participant designed a physical space, along with resources and various technologies to monitor her students, in a manner that provided options for physical action, expression and communication, and options for executive functions. These findings suggested that the participant’s collective TPACK and professional experience helped her in planning and delivering instruction aligned with UDL guidelines for multiple means of action and expression.

Furthermore, analyses of data in this study noted that different technologies, namely software and web-based services, could play a significant role in monitoring students and supporting their executive functions. Technology that is both high-tech and low-tech in nature can provide the prompts (such as the auditory and visual cues) and scaffolds (such as the interactive textboxes that were revealed in timely, supportive manners) to guide students’ attention and goals. Support can also take the form of online progress monitoring and instructional strategies for designing physical spaces for collaboration and a range of instructional manipulatives, both physical and virtual in nature.

Graphic organizers, such as the predictive story-elements that were built cooperatively with the class at the SMART Board demonstrated how information and resources may be facilitated or managed. The checklists and instructional prompts, as noted in the observations of this study, helped students to monitor their progress. Other such supports such as the visual interactive representations of progress that appeared in IXL and Starfall provided feedback to learners to help clarify their understanding of progress or challenges, formatively, in a way that informed, empowered and engaged learners. Findings from this study address calls from others (Rose, Hall, & Meyer, 2008) to expand upon the research for what UDL looks like in the classroom setting.

Providing Multiple Means of Engagement

As noted, the tools and strategies that the participant developed and utilized for providing multiple means of action and expression, were also utilized to help her with planning, preparing, and teaching, and demonstrated opportunities for students to have choices and to collaborate with one another. This intertwined and interconnected vision and efforts of the participant provided options for recruiting interest, sustaining effort and persistence, and providing options for self-
regulation for her students. This study offers insights to help understand how TPACK is connected to UDL. TPACK, as demonstrated by the participant, can foster the provision of options for designing and delivering instructional activities and lessons and supporting students’ self-regulation. Students appeared to be engaged through many of the technologies and technology supported events observed and analyzed in this study. Consequently, they required little prompting to begin the morning rituals and carried out their morning business independently and often cooperatively.

Although much instructional routine can be scripted and guided, there also exists opportunities for recruiting interest with individual choices and autonomy. Students within the context of this study were provided with such options through computer software and web-based services. These empowerments gave learners a sense of relevance, value and authenticity to both their tasks and the content that they interacted with and often built themselves. As a consequence, distractions were minimized and abated proactively.

Similarly, effort and persistence with activities that are independent and communal in their design can highlight goals in a variety of ways, and encourage learners’ commitment towards their attainment. Within this study, a positive reinforcement system was sustained by a ticket-rewards system and the electronic display of progress through the individualized accounts on web-based systems. These systems, served as platforms for adaptive curricula, which adapted to the levels of differentiation desired or needed by both the learners and the instructor. The establishment of specific student roles and activities was both social and technological in the design to create collaboration and communication. As a consequence, students were given chances to grow both intra- and interpersonally from such instructional design and support, before and during class-time.

Along the way, feedback was embedded in many different forms. As identified in many instances throughout this study, the feedback was provided individually and collectively as a group with both technological supports and instructional feedback. The feedback provided academic and emotional supports to raise expectations and motivate students to accomplish their best. Curricula such as the “I Was So Mad” story, which was scanned and integrated into a SMART Notebook file, paired with audio recordings of the teacher, displayed on the large screen of the SMART Board, and distributed to individual computers was designed help support and facilitate personal coping skills and strategies. Designing and delivering such curricula,
instructional prompts and complementary activities can help students nurture their own reflections and self-assessments for their emotions and behaviors inside the classroom and beyond.

This study found that the participant’s combined knowledge of technology, pedagogy, and content, within the particular and specific context of her classroom, along with various tools, collaborative strategies, and her experience sustained multiple means of engaging her students. These demonstrations expand upon Harris’ (2008) suggestions for using multiple methods and multiple resources to guide learning, and further the descriptions of TPACK that Mishra and Koehler (2008) have urged. The sections that follow provide recommendations with respect to how findings from this study may guide professional practice, policy development, administration, and further research.

**Recommendations**

The recommendations in this section are based on the findings, analyses, and conclusions of my study. These recommendations focus on the following: (a) recommendations for educators in the field, (b) recommendations for educational policy and administration, and (c) recommendations for further research.

**Recommendations for Educators in the Field**

Certainly, both pre-service (Schmidt et al., 2009) and in-service education could benefit from the understanding the interconnectedness between TPACK and UDL. Not every educator would have the unique and highly motivated drive of the participant in this study, but perhaps with flexible scheduling, manageable caseloads, and extended time and support for training and professional development, other educators could also develop their personal strategies for inclusion that infuse TPACK with current technologies and the understanding of UDL guidelines. Thus, developing and practicing educators could have a clearer understanding of UDL guidelines and confidence with integrating technology into the curriculum design and delivery within inclusive settings to expand options and choices for students, ensure greater accessibility overall, expand the monitoring of students, and enhance interactions in the classroom. Much like the actions exemplified by the participant in this study, future and existing educators through direct training, coaching and consultation on UDL and technology could learn to build interactions that exist between the teacher and students, between students themselves, as
well as the interactions amongst the teacher and other peer educators. For less experienced teachers, such specific trainings and professional development that focuses specifically on current UDL guidelines and practices and related technological supports and strategies could play a significant role for intentionally and clearly integrating UDL into inclusion-based classroom settings. Based upon this study, it would benefit teachers to focus on professional development that integrates technology in both planning and delivering for instruction, to underscore how UDL may be integrated both intentionally and proactively. Ideally, UDL and technology training would be intentionally intertwined together via professional development for both pre-service and in-service educators, their instructional coaches, and administrative staff as well.

In supporting inclusive environments, through such a technology-centered and UDL infused professional development, unique and personalized TPACK can be developed, and continuously nurtured, to address individualized learning needs with the ever-changing advancements of technology. A dedication to professional growth and professional development can also help focus on efforts that encompass a range of 21st century skills for educators and students alike. By continuously developing and innovating the art and science of instruction, both design and delivery, with technology, proactive efforts can be taken to produce greater accessibility within our instructional settings. Edyburn (2009, 2010) and King-Sears (2009) both recognized such efforts of educators to help build preemptive plans for diversity in the classroom and support UDL.

Communities that exist in-person, online, and various combinations thereof, can also play a significant role in the sharing of resources and practices, as was the case with the participant and the communities with which she interacted online and around her school’s campus. Such communities can build greater ties and recognition for innovations and instructional materials and provide models for using TPACK to develop UDL aligned instructional strategies (Meyers, Wood, & Pousson, 2007). When educators in the field are willing to share their expertise and practice, insights may further the support for peer practitioners, as well as pre-service teachers who are preparing for and developing their practices. Communities and resources, like Teachers-Pay-Teachers and online learning networks, such as TPACK.org and CAST.org, can certainly continue to pave the way for personal learning networks in education within the 21st century. As the researcher in this study, I suggest that communities should focus directly on developing their
TPACK and explicit understanding of UDL guidelines. Such efforts will in turn possibly help how technology may be integrated to expand access to content in multiple ways, support the monitoring of student performance, and enhance interactions, as previously mentioned: student-to-student, teacher-to-student, and teacher-to-teacher relationships and collaborations. Teachers must take the time to collaborate online and within their own schools to learn from one another to showcase and share how technology may be used to support student learning.

**Recommendations for Educational Policy and Administration**

A recommendation to draw from this study is that educators need to be provided with significant time, training, and permanent, individualized support beyond the instructional hours of the school calendar to support their planning and development. Providing for multiple means of representation, means of action and expression, and engagement, may certainly be developed in advance and intertwined during instructional planning. However, many such resources, such as time, current technology (including accessibility, related training, professional development, and help) are not readily available to educators. In these all too common instances, educators, on their own, often invest in materials, time, and effort to coordinate the availability and development of resources and strategies. Rose and Meyer (2006) have long called for such administrative vision to guide leadership, opportunities, instructional coaching, educators, resources, research, and other stakeholders in an effort to advance change in the implementation of UDL-practices, with the support and integration of technology. It is well-past time for federal and state-level educational policies to fiscally, administratively and proactively address the instructional needs of educators.

To advance such knowledge and practices that are necessary to support inclusion in the 21st century, and thus intertwine TPACK and UDL in their planning and instruction, it is possible that educational policy and administrators could specifically address challenges such as time constraints, large caseloads, and the lack of technology and related areas. Ideally, such legislative policies and administrative backing could provide incentives and innovations for professional development that extend beyond the traditional academic calendar. Within such a strategy, educators could be supported with an increase in the amount of time allotted for training and through improving the quality of technologies that currently reside in the classroom. Additionally, professional development opportunities could be expanded to show specific and
research-based examples of UDL aligned instructional strategies supported by technology across various classrooms and schools.

UDL principles could be used as a foundation to steer policies across administrative, instructional and support levels. A shift in policy may directly influence professional practices and efforts to innovate and reform instruction and learning in the 21st century (CAST, 2011). Such a shift could incorporate the integration of the UDL Educator Checklist (CAST, 2011) and possibly assist administrators in both coaching, integrating and measuring the successes of UDL-curricula and activities intentionally designed with respect to the UDL guidelines. Similarly, standards for technology such as the National Educational Technology Standards (NETS) can play a complementary role in advancing public education, especially in serving those who need such services the most, at our Title 1 schools. While the participant in this study may be an outlier or an exemplar, she represents what can happen when a teacher who has TPACK also has access to a range of technologies and strategies in a particular context with a diverse array of students. Such a model may serve as catalysts for change and as an inspiration for reaching the ideal potential for professional practice in the classroom.

**Recommendations for Further Research**

Ongoing research can certainly play a significant role in identifying the trends and issues that permeate the design and delivery of instruction within inclusive settings. Such research could identify more typical practices and evolve in accordance with ongoing changes in technology and updates in UDL-related practice. As for the influences of TPACK on UDL, this relationship will undoubtedly continue to be of interest with increases in diversity in the classroom and incessant advances in technologies.

Research can help further an understanding of the roles that UDL and TPACK can play within education in the 21st century. Crucial to this UDL-research development are trans-disciplinary communities, journals and conferences that may complement and compile a range of research efforts. CAST.org is one particular community and resource that may serve as a springboard for these efforts in research. CAST explicitly calls for researchers and practitioners to come together in sharing what UDL looks like within actual settings, and to describe best practices and relevant contributing factors. Another online community that exists is TPACK.org, where, similarly, TPACK-related research and resources are presented to researchers and practitioners, alike, in the field. TPACK-centered research can certainly help identify, highlight,
investigate, and report much of the areas mentioned above. Indeed, TPACK and UDL are complementary frameworks that may help identify how inclusion may be supported with explicit training and professional development within specific instruction contexts and settings.

By combining TPACK with UDL for further research, efforts may underscore further connections (or possible incompatibilities) between the two frameworks that may exist. This would be important for educators who are entering the field during pre-service stages or directly for educators who are actively practicing in the field. It is also possible that future TPACK and UDL integrated research may explore and intertwine additional frameworks for educators’ instructional efforts to support learning opportunities for culturally and linguistically diverse children and students.

**Summary**

The research presented in this study represents not just the encapsulation of a significant and timely qualitative investigation, but also the culmination of my doctoral journey and personal development throughout my entire graduate education. The opportunities within this project have enriched my appreciation for practitioners within the field, administration, faculty and additional support staff that assist their efforts. This experience has challenged but reinvigorated my passion for supporting all learners through research and establishing greater connections between researchers, especially emerging researchers like myself, and participants in the field.

In this journey, my understanding of the roles of technology within research also broadened with the applications of my iPhone, iPad, and research tools (i.e., Google Scholar, Google Drive and related Add-Ons). I also learned the values of collegial, “critical friendships” that helped foster criticism and support during this journey. There were many personal challenges along this journey and my colleagues played integral parts (both online and in person) in supporting efforts towards completion and maintaining personal balance and health along the way.

At the close of this study, I have many more questions than when I began this adventure. I would like to further my understanding of how open educational resources, mobile, virtual learning environments, and wearable technologies may advance learning opportunities for students and communities who are challenged socio-economically and developmentally.
Additionally, I would like to pursue research-based endeavors to investigate UDL and TPACK across global communities and cultures around the world.

This research study sought to identify the practices of an atypical teacher within an all-too-typically underfunded and under-resourced public, Title 1 school environment. It presented an overview and in-depth look at her professional practice, with which she exerted extreme passion and an inspirational, and truly commendable, amount of personal effort, resources, and expertise to support a visionary practice in the classroom. Her planning, her practice, and all of the elements, variables, and factors therein reveal the potential for innovation and expertise within the classroom to support all learners. The TPACK of this particular individual, within this particular setting and instance in time, as determined by this study also demonstrates intricacies of TPACK and how it is developed, utilized, and specifically, how it connects with UDL on a variety of complex levels and contextual systems. TPACK and UDL can collectively play significant roles in the design, delivery and research of inclusive based instruction. The time to further and realize these initiatives and to support all learners and stakeholders in their success lies within the present moment. Both practitioners and researchers, alike, can work collectively to help further both TPACK and UDL frameworks, perhaps in combination, so that they can enhance practices in the field and inform research and instruction forward.
APPENDIX A – Participant Consent Form

University of Hawai‘i
Consent to Participate in Research Project:
Using Technological, Pedagogical, and Content Knowledge (TPACK) to Support Universal Design for Learning (UDL): A Case Study

Aloha, my name is Kimble Handyside McCann, M.A. I am a doctoral student at the University of Hawai‘i at Mānoa (UH), in the Department of Educational Technology (ETEC). As part of my doctoral program and professional interests, I must conduct research. The purpose of my current research project is to describe how and why a special education or similar teachers uses their technological-pedagogy-and-content knowledge to support instruction for students with exceptional needs in their specific classrooms. I am asking you to participate in this project because of your experience as a teacher for students with exceptional needs and your participation in a technology-centered professional development course for educators.

Project Description – Activities and Time Commitment:
If you participate, you will be invited to participate in the following three research-based activities: an interview, general observations, and analyses of instructional materials.

I will conduct one personal, face-to-face 30-60 minute interview. I will record the interview using an iPhone with a recording application. I am recording the interview for accuracy and transcription purposes. If you participate, you may be the sole participant for this case study research project. One example of the type of question I will to ask is “How do you use technology to support your instruction in the classroom?” If you would like to preview a copy of all the questions that I want ask you, please let me know now.

During this research project, I will also observe your instruction in a specific class, for 4-5 times for the duration of an instructional period. Throughout these observations, I will take field notes and attempt to remain unobtrusive so as not to disrupt your class while you are teaching.

Additionally, I will look at your instructional materials as artifacts for your instructional efforts. Such materials may include (but are not limited to the following): SMART Notebook files, SMART Teacher files, MS Office files, emails/blogs/wikis/podcasts, multimedia, video and/or audio files, teacher-created assignments and instructional materials.

Benefits and Risks:
I believe that there are no direct benefits to you participating in my research project, however the results of this project might help me and other researchers learn more about an educator's perspective on using technological–pedagogical–content knowledge to support teaching and learning for students with exceptional needs.

I believe there is little or no risk to you participating in this project. If, however, you are uncomfortable or stressed by answering any of the interview questions, general observations, or analyses of your instructional materials, you can skip the question, take a break, stop the interview, or withdraw from the project altogether.

Confidentiality and Privacy:
During this research project, I will keep the all the data from the interviews, field notes from my observations, and copies of your instructional materials in a secure location. Only I will
have access to the data, although legally authorized agencies, including the University of Hawai'i Committee on Human Studies, have the right to review research records.

If you would like a summary of the findings from my final report, please contact me at the number listed near the end of this consent form.

**Voluntary Participation:**

Participation in this research project is voluntary. You can choose freely to participate or not to participate. In addition, at any point during this project, you can withdraw your permission without any penalty.

**Questions:**

If you have any questions about this project, please contact me via e-mail (kimbleh@hawaii.edu). If you have any questions about your rights as a research participant, in this project, you can contact the University of Hawai‘i, Committee on Human Studies (CHS), by phone at (808) 956-5007 or by e-mail at uhirb@hawaii.edu.

Please keep the prior portion of this consent form for your records. If you agree to participate in this project, please sign the following signature portion of this consent form and return it to Kimble McCann.

---

**Signature for Consent:**

I agree to participate in the research project entitled, “Using Technological, Pedagogical, and Content Knowledge (TPACK) to Support Universal Design for Learning (UDL): A Case Study.” I understand that I can change my mind about participating in this project, at any time, by notifying the researcher.

[ ] I do not agree to have my interview audio recorded.

**Your Name (Print):** ________________________________

**Your Signature and Date:** ____________________________
APPENDIX B – Official Letter of Approval from the University of Hawai‘i Committee on Human Studies

UNIVERSITY OF HAWAI‘I
Committee on Human Studies

January 13, 2012

TO: Kimble McCann
   Principal Investigator
   Educational Technology (ETEC)

FROM: Nancy R. King
       Director

Re: CHS #19861: “Using Technological, Pedagogical, and Content Knowledge (TPACK) to Support Universal Design for Learning (UDL): A Case Study”

This letter is your record of CHS approval of this study as exempt.

On January 13, 2012, the University of Hawai‘i (UH) Committee on Human Studies (CHS) approved this study as exempt from federal regulations pertaining to the protection of human research participants. The authority for the exemption applicable to your study is documented in the Code of Federal Regulations at 45 CFR 46 (2, 4).

Exempt studies are subject to the ethical principles articulated in The Belmont Report, found at http://www.hawaii.edu/irb/html/manual/appendices/A/belmont.html

Exempt studies do not require regular continuing review by the Committee on Human Studies. However, if you propose to modify your study, you must receive approval from CHS prior to implementing any changes. You can submit your proposed changes via email at uhirb@hawaii.edu. (The subject line should read: Exempt Study Modification.) CHS may review the exempt status at that time and request an application for approval as non-exempt research.

In order to protect the confidentiality of research participants, we encourage you to destroy private information which can be linked to the identities of individuals as soon as it is reasonable to do so. Signed consent forms, as applicable to your study, should be maintained for at least the duration of your project.

This approval does not expire. However, please notify CHS when your study is complete. Upon notification, we will close our files pertaining to your study.

If you have any questions relating to the protection of human research participants, please contact CHS at 956-5007 or uhirb@hawaii.edu. We wish you success in carrying out your research project.

1960 East-West Road, Biomedical Building, Room B-104, Honolulu, HI 96822-2303
Telephone: (808) 956-5007, FAX: (808) 956-8683, Website: www.hawaii.edu/irb, E-mail: uhirb@hawaii.edu
An Equal Opportunity/Affirmative Action Institution
APPENDIX C – Official Letter of HDOE Approval to Conduct Research

STATE OF HAWAII
DEPARTMENT OF EDUCATION
P.O. BOX 2290
HONOLULU, HAWAII 96804

OFFICE OF THE SUPERINTENDENT

May 1, 2012

Mr. Kimble McCann
4757 Kahala Avenue
Honolulu, Hawaii 96816

Dear Mr. McCann:

I am pleased to approve your study request to study the use of technological, pedagogical and content knowledge (TPACK) to support Universal Design for Learning (UDL). I understand that your study will investigate both how and why a specific special education teacher(s) and/or other/similar teacher(s) use their knowledge of technology, pedagogy, and content to support UDL in their classroom. Your hope is that your study will provide a greater understanding of how technology may be researched and assisted through training, and how both teachers and students may be supported within the field of education.

I also understand that the selection of the teacher you will invite to participate in your study was based on their utilization of various Technological, Pedagogical, and Content Knowledge (TPACK) and related Universal Design for Learning (UDL).

In accordance with the Family Educational Rights and Privacy Act (FERPA), your study is approved with the following conditions:

- Participation by the schools, students and school staff will be voluntary. Your activities will be conducted with the understanding and approval of the school principals. Participants may withdraw from the study at any time if it is found to be too intrusive.

- Student participation is contingent on obtaining written parental approval. Please submit the signed parental consent and student assent forms to the schools for their records prior to study implementation.

- Participation by the school staff is contingent upon obtaining their written consent. Please submit a copy of the completed participation form to the school office for their records prior to the implementation of your study.

AN AFFIRMATIVE ACTION AND EQUAL OPPORTUNITY EMPLOYER
• All study activities will take place during times agreed upon by the school administrators.

• Your study must not contain any person or school-identifiable information.

• Present a copy of your interview questions to the administrator for review prior to the implementation of your study.

• Oral instructions will be provided for all student activities.

• As the scope of the study is limited to one school, results should be interpreted with caution.

• Observations will focus on the content of the Technological, Pedagogical, and Content Knowledge to Support Universal Design for Learning. The observations of teachers must not be used for the purpose of teacher performance evaluations.

• Findings and recommendations of your study will be presented to the principal of the participating school prior to any printing or publishing.

• Findings and recommendations of your study will be made available to participants of your study upon request.

• Findings and recommendations of your study will be presented to the Complex Area Superintendent upon request.

• Findings and recommendations of your study will be presented to the Assistant Superintendent of the Office of Curriculum, Instruction and Student Support (OCISS).

• Findings and recommendations of your study will be presented to the Director of the Systems Accountability Office.

• Should your study extend beyond one calendar year of approval, please submit an application for renewal, prior to the expiration date accompanied by a current IRB approval letter.

• Approval for future research studies is conditional upon submission of a completed report to the Systems Accountability Office.

We look forward to reviewing the results of your study as it encourages the use of TPACK and UDL strategies that support student learning as well as promotes the use of assistive technology in the general education classroom for all students.
Best wishes for a successful research study. Please contact Lori Nagakura of the Systems Accountability Office at (808) 735-9250, should you have any questions.

Very truly yours,

Kathryn S. Matayoshi
Superintendent

KSM:LN:dw

c: Joyce Y. Bellino, Assistant Superintendent, OCISS
   Patricia Park, Complex Area Superintendent
   Theodore Fisher, Principal, Kaala Elementary School
   Data Governance Office
   Systems Accountability Office
APPENDIX D – Parent / Guardian Consent Form

Dear Parent/Guardian:

A. PURPOSE AND BACKGROUND

Kimble Handyside McCann, M.A., from University of Hawaii, Mānoa’s Department of Education Technology is conducting a study called Using Technological, Pedagogical, and Content Knowledge (TPACK) to Support Universal Design for Learning (UDL): A Case Study. I would like to involve your child in my study.

B. PROCEDURES

This study will include an anonymous observation of your child’s and his/her engagement in learning activities. Your child will be observed one hour, each day, for five days. At no time will your child be separated from peers or the teachers.

Your child will be observed in their teacher’s classroom at Kaʻala Elementary and will take a total time of about five hours.

C. RISKS/DISCOMFORTS

All information will remain completely confidential. No child will be identified by name. You are able to remove your child from the study at anytime and your child will continue to receive quality childcare in this classroom.

Confidentiality: Participation in research may involve a loss of privacy; however, my records will be handled as confidentially as possible. Only I will have access to my observation notes. The notes will remain locked on a secure computer, in my office. When the research project is complete, the notes and files for my project will remain secure for three years and then destroyed. No individual identities will be used in any reports or publications that may result from this study.

D. BENEFITS

There will be no direct benefit to your child from participating in this study. However, the information gained from this research may help education professionals better understand how technology supports learning.

E. COSTS

There will be no cost to you or your child as a result of taking part in this study.

F. PAYMENT
There will be no payment to you or your child as a result of your child taking part in this study.

G. QUESTIONS

If you have any questions or concerns about participation in this study, you should first talk with the investigator: (kimbleh@hawaii.edu) If for some reason you do not wish to do this, you may contact the Institutional Review Board, which is concerned with the protection of volunteers in research projects. You may reach the board office between 8:00 AM and 4:30 PM, Monday through Friday, by calling (808)956-5007 or by writing: Human Studies Program, UH Mānoa, 1960 East-West Road, Biomed Bldg., Rm. B-104, Honolulu, HI 96822.

Should you or your child feel discomfort due to participation in this research, you should contact your health care provider.

H. CONSENT

PARTICIPATION IN RESEARCH IS VOLUNTARY. I understand that I can choose not to have my child participate in this study, or to withdraw my child from participating at any time. Declining participation will not interfere with my child’s care or learning experiences in their classroom. I understand that by not participating in this study, my child’s classroom program will be the same all other students with the omission of data collected for this study. I also understand that at any time I can participate in parent activities and experiences.

I will discuss this research study with my child and explain the procedures that will take place. I will be given a copy of this consent form to keep.

[  ] I consent to allow my child to participate in your study
[  ] I do not agree to have my child observed

_______________________________________
Print Name

Signature of Parent/Guardian _______
Date_______
APPENDIX E – Student Assent Form

Student Assent Form * Student’s Name_______________________
  School_______________________

RESEARCH STUDY ON TECHNOLOGY

Aloha –

Do you remember the permission slip you took home for your parents to sign a few days ago?

The people I go to school with and I are interested in learning and technology. We are asking you, to work with us to find out more about it.

If you agree to this, I will ask if I can sit in your classroom, watch your classes, and take notes. I will try to not bother or interrupt you.

This is not a test or a graded activity. All you have to do is follow Ms. PARTICIPANT’s instructions and your daily schedule and routines.

Of course, you do not have to let me observe you in your classroom if you don’t want me to, even if your parents give their permission. If you do not want me to do this or your parents asked you not to do this, just tell me. If you do not want to be a part of my study, you will still have to complete Ms. PARTICIPANT’s classroom work, but I will not observe you or take notes about you. It is okay with me if you don’t want to be in the study, and no one else, not even your teacher will know. You can also change your mind if you want to stop being in my study.

Do you have any questions?
Again, this will not affect your grades if you choose not to be in the study. If you agree to this, I would like you to sign this paper.

______________________________________________________________________________  
Date________

The study on learning and technology has been explained to me and any questions I had have been answered. I would like to take part in the study.

________________________
(Student’s Signature)
APPENDIX F – Preservice Teachers’ Knowledge of Teaching and Technology

Survey of Preservice Teachers’ Knowledge of Teaching and Technology

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Center for Technology in Learning and Teaching
Iowa State University

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Michigan State University

Usage Terms: Researchers are free to use the TPACK survey, provided they contact Dr. Denise Schmidt (dschmidt@iastate.edu) with a description of their intended usage (research questions, population, etc.), and the site locations for their research. The goal is to maintain a database of how the survey is being used, and keep track of any translations of the survey that exist.

Version 1.1: (updated September 1, 2009). This survey was revised to reflect research results obtained from its administration during the 2008-2009 and 2009-2010 academic years. This document provides the latest version of the survey and reports the reliability scores for each TPACK domain. (This document will be updated as the survey is further developed).

The following papers and presentations highlight the development process of this survey:


How do I use the survey? The questions you want are most likely questions 1-46 starting under the header “TK (Technology Knowledge)”. In the papers cited above, these categories were removed so that participants were not oriented to the constructs when answering the survey questions. The items were presented in order from 1 through 46, however. The other items are more particular to individual study and teacher education context to better understand results found on questions 1-46. You are free to use them, or modify them. However, they are not the core items used to measure the components of TPACK.

How do I score the survey. Each item response is scored with a value of 1 assigned to strongly disagree, all the way to 5 for strongly agree. For each construct, the participant’s responses are averaged. For example, the 6 questions under TK (Technology Knowledge) are averaged to produce one TK (Technology Knowledge) Score.

Reliability of the Scores (from Schmidt et al, 2009).

<table>
<thead>
<tr>
<th>TPACK Domain</th>
<th>Internal</th>
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<tbody>
<tr>
<td></td>
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</tr>
<tr>
<td>Knowledge Area</td>
<td>Consistency (alpha)</td>
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<tr>
<td>----------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Technology Knowledge (TK)</td>
<td>.86</td>
</tr>
<tr>
<td>Content Knowledge (CK)</td>
<td></td>
</tr>
<tr>
<td>Social Studies</td>
<td>.82</td>
</tr>
<tr>
<td>Mathematics</td>
<td>.83</td>
</tr>
<tr>
<td>Science</td>
<td>.78</td>
</tr>
<tr>
<td>Literacy</td>
<td>.83</td>
</tr>
<tr>
<td>Pedagogy Knowledge (PK)</td>
<td>.87</td>
</tr>
<tr>
<td>Pedagogical Content Knowledge (PCK)</td>
<td>.87</td>
</tr>
<tr>
<td>Technological Pedagogical Knowledge (TPK)</td>
<td>.93</td>
</tr>
<tr>
<td>Technological Content Knowledge (TCK)</td>
<td>.86</td>
</tr>
<tr>
<td>Technological Pedagogical Content Knowledge (TPACK)</td>
<td>.89</td>
</tr>
</tbody>
</table>
Thank you for taking time to complete this questionnaire. Please answer each question to the best of your knowledge. Your thoughtfulness and candid responses will be greatly appreciated. Your individual name or identification number will not at any time be associated with your responses. Your responses will be kept completely confidential and will not influence your course grade.

DEMOGRAPHIC INFORMATION

1. Your ISU e-mail address

2. Gender
   a. Female
   b. Male

3. Age range
   a. 18-22
   b. 23-26
   c. 27-32
   d. 32+

4. Major
   a. Early Childhood Education (ECE)
   b. Elementary Education (ELED)
   c. Other

5. Area of Specialization
   a. Art
   b. Early Childhood Education Unified with Special Education
   c. English and Language Arts
   d. Foreign Language
   e. Health
   f. History
   g. Instructional Strategist: Mild/Moderate (K8) Endorsement
   h. Mathematics
   i. Music
   j. Science-Basic
   k. Social Studies
   l. Speech/Theater
   m. Other

6. Year in College
   a. Freshman
   b. Sophomore
   c. Junior
   d. Senior
7. Are you completing an educational computing minor?
   a. Yes
   b. No

8. Are you currently enrolled or have you completed a practicum experience in a PreK-6 classroom?
   a. Yes
   b. No

9. What semester and year (e.g. Spring 2008) do you plan to take the following? If you are currently enrolled in or have already taken one of these literacy blocks please list semester and year completed

<table>
<thead>
<tr>
<th>Literacy Block-I (C I 377, 448, 468A, 468C)</th>
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</thead>
<tbody>
<tr>
<td>Literacy Block-II (C I 378, 449, 468B, 468D)</td>
<td></td>
</tr>
<tr>
<td>Student teaching</td>
<td></td>
</tr>
</tbody>
</table>

Technology is a broad concept that can mean a lot of different things. For the purpose of this questionnaire, technology is referring to digital technology/technologies. That is, the digital tools we use such as computers, laptops, iPods, handhelds, interactive whiteboards, software programs, etc. Please answer all of the questions and if you are uncertain of or neutral about your response you may always select “Neither Agree or Disagree”

<table>
<thead>
<tr>
<th>TK (Technology Knowledge)</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I know how to solve my own technical problems.</td>
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<tr>
<td>2. I can learn technology easily.</td>
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<tr>
<td>3. I keep up with important new technologies.</td>
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<tr>
<td>4. I frequently play around the technology.</td>
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<tr>
<td>5. I know about a lot of different technologies.</td>
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<tr>
<td>6. I have the technical skills I need to use technology.</td>
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</tbody>
</table>

CK (Content Knowledge)

Mathematics

<table>
<thead>
<tr>
<th>Mathematics</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree or Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>7. I have sufficient knowledge about mathematics.</td>
<td></td>
<td></td>
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<td></td>
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</tr>
</tbody>
</table>
8. I can use a mathematical way of thinking.

9. I have various ways and strategies of developing my understanding of mathematics.

Social Studies

10. I have sufficient knowledge about social studies.

11. I can use a historical way of thinking.

12. I have various ways and strategies of developing my understanding of social studies.

Science

13. I have sufficient knowledge about science.

14. I can use a scientific way of thinking.

15. I have various ways and strategies of developing my understanding of science.

Literacy

16. I have sufficient knowledge about literacy.

17. I can use a literary way of thinking.

18. I have various ways and strategies of developing my understanding of literacy.

PK (Pedagogical Knowledge)

19. I know how to assess student performance in a classroom.

20. I can adapt my teaching based-upon what students currently understand or do not understand.

21. I can adapt my teaching style to different learners.

22. I can assess student learning in multiple ways.

23. I can use a wide range of teaching approaches in a classroom setting.

24. I am familiar with common student understandings and misconceptions.

25. I know how to organize and maintain classroom management.

PCK (Pedagogical Content Knowledge)
26. I can select effective teaching approaches to guide student thinking and learning in mathematics.

27. I can select effective teaching approaches to guide student thinking and learning in literacy.

28. I can select effective teaching approaches to guide student thinking and learning in science.

29. I can select effective teaching approaches to guide student thinking and learning in social studies.

**TCK (Technological Content Knowledge)**

30. I know about technologies that I can use for understanding and doing mathematics.

31. I know about technologies that I can use for understanding and doing literacy.

32. I know about technologies that I can use for understanding and doing science.

33. I know about technologies that I can use for understanding and doing social studies.

**TPK (Technological Pedagogical Knowledge)**

34. I can choose technologies that enhance the teaching approaches for a lesson.

35. I can choose technologies that enhance students' learning for a lesson.

36. My teacher education program has caused me to think more deeply about how technology could influence the teaching approaches I use in my classroom.

37. I am thinking critically about how to use technology in my classroom.

38. I can adapt the use of the technologies that I am learning about to different teaching activities.

39. I can select technologies to use in my classroom that enhance what I teach, how I teach and what students learn.
| 40. I can use strategies that combine content, technologies and teaching approaches that I learned about in my coursework in my classroom. |
| 41. I can provide leadership in helping others to coordinate the use of content, technologies and teaching approaches at my school and/or district. |
| 42. I can choose technologies that enhance the content for a lesson. |

| TPACK (Technology Pedagogy and Content Knowledge) |
| 43. I can teach lessons that appropriately combine mathematics, technologies and teaching approaches. |
| 44. I can teach lessons that appropriately combine literacy, technologies and teaching approaches. |
| 45. I can teach lessons that appropriately combine science, technologies and teaching approaches. |
| 46. I can teach lessons that appropriately combine social studies, technologies and teaching approaches. |

<p>| Models of TPACK (Faculty, PreK-6 teachers) |
| 47. My mathematics education professors appropriately model combining content, technologies and teaching approaches in their teaching. |
| 48. My literacy education professors appropriately model combining content, technologies and teaching approaches in their teaching. |
| 49. My science education professors appropriately model combining content, technologies and teaching approaches in their teaching. |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>50. My social studies education professors appropriately model combining content, technologies and teaching approaches in their teaching.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>51. My instructional technology professors appropriately model combining content, technologies and teaching approaches in their teaching.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>52. My educational foundation professors appropriately model combining content, technologies and teaching approaches in their teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>53. My professors outside of education appropriately model combining content, technologies and teaching approaches in their teaching.</td>
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</tr>
<tr>
<td>54. My PreK-6 cooperating teachers appropriately model combining content, technologies and teaching approaches in their teaching.</td>
<td></td>
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</tr>
</tbody>
</table>

**Please complete this section by writing your responses in the boxes.**

73. Describe a specific episode where an ISU professor or instructor effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content was being taught, what technology was used, and what teaching approach(es) was implemented.

74. Describe a specific episode where one of your PreK-6 cooperating teachers effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content was being taught, what technology was used, and what teaching approach(es) was implemented. If you have not observed a teacher modeling this, please indicate that you have not.
75. Describe a specific episode where you effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content you taught, what technology you used, and what teaching approach(es) you implemented. If you have not had the opportunity to teach a lesson, please indicate that you have not.
# APPENDIX G – UDL Guidelines Educator Worksheet – v.2

## I. Provide Multiple Means of Representation:  
Your notes

<table>
<thead>
<tr>
<th>Provide options for perception</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1.1</strong> Offer ways of customizing the display of information</td>
<td></td>
</tr>
<tr>
<td><strong>1.2</strong> Offer alternatives for auditory information</td>
<td></td>
</tr>
<tr>
<td><strong>1.3</strong> Offer alternatives for visual information</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for language, mathematical expressions, and symbols</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2.1</strong> Clarify vocabulary and symbols</td>
<td></td>
</tr>
<tr>
<td><strong>2.2</strong> Clarify syntax and structure</td>
<td></td>
</tr>
<tr>
<td><strong>2.3</strong> Support decoding of text, mathematical notation, and symbols</td>
<td></td>
</tr>
<tr>
<td><strong>2.4</strong> Promote understanding across language</td>
<td></td>
</tr>
<tr>
<td><strong>2.5</strong> Illustrate through multiple media</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for comprehension</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>3.1</strong> Activate or supply background knowledge</td>
<td></td>
</tr>
<tr>
<td><strong>3.2</strong> Highlight patterns, critical features, big ideas, and relationships</td>
<td></td>
</tr>
<tr>
<td><strong>3.3</strong> Guide information processing, visualization, and manipulation</td>
<td></td>
</tr>
<tr>
<td><strong>3.4</strong> Maximize transfer and generalization</td>
<td></td>
</tr>
</tbody>
</table>

## II. Provide Multiple Means for Action and Expression:  
Your notes

<table>
<thead>
<tr>
<th>Provide options for physical action</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>4.1</strong> Vary the methods for response and navigation</td>
<td></td>
</tr>
<tr>
<td><strong>4.2</strong> Optimize access to tools and assistive technologies</td>
<td></td>
</tr>
<tr>
<td>Provide options for expression and communication</td>
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<tr>
<td>------------------------------------------------</td>
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</tr>
<tr>
<td>5.1 Use multiple media for communication</td>
<td></td>
</tr>
<tr>
<td>5.2 Use multiple tools for construction and composition</td>
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</tr>
<tr>
<td>5.3 Build fluencies with graduated levels of support for practice and performance</td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for executive functions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Guide appropriate goal setting</td>
<td></td>
</tr>
<tr>
<td>6.2 Support planning and strategy development</td>
<td></td>
</tr>
<tr>
<td>6.3 Facilitate managing information and resources</td>
<td></td>
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<tr>
<td>6.4 Enhance capacity for monitoring progress</td>
<td></td>
</tr>
</tbody>
</table>

**III. Provide Multiple Means for Engagement:**

<table>
<thead>
<tr>
<th>Provide options for recruiting interest</th>
<th>Your notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1 Optimize individual choice and autonomy</td>
<td></td>
</tr>
<tr>
<td>7.2 Optimize relevance, value, and authenticity</td>
<td></td>
</tr>
<tr>
<td>7.3 Minimize threats and distractions</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for sustaining effort and persistence</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>8.1 Heighten salience of goals and objectives</td>
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<tr>
<td>8.2 Vary demands and resources to optimize challenge</td>
<td></td>
</tr>
<tr>
<td>8.3 Foster collaboration and community</td>
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<tr>
<td>8.4 Increase mastery-oriented feedback</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for self-regulation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>9.1 Promote expectations and beliefs that optimize motivation</td>
<td></td>
</tr>
<tr>
<td>9.2 Facilitate personal coping skills and strategies</td>
<td></td>
</tr>
<tr>
<td>9.3 Develop self-assessment and reflection</td>
<td></td>
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</tbody>
</table>

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APPENDIX H – Timeline

• **Month of October 2012**
  
  o Defend Proposal
  
  o Corrections to Chapter 3
  
  o Distribute and collect:
    - Parent Consent Form (see Appendix D)
    - Participant Form (see Appendix A)
    - Student Consent Form (see Appendix E)

• **Months of November & December 2013**
  
  o Pilot: Collect First Round of Data (During DOE Quarter 2)
    - Observations
    - Materials Analysis
    - Interview
  
  o Register for EDUC 800

• **Months of January and February 2013**
  
  o Transcribe interview, notes from pilot interview, initial observations, and materials analysis
  
  o Prepare for Official Round of Data (During DOE Quarter 3)
    - Observations
    - Materials Analysis
    - Interview

• **Months of March, April and May 2013**
o Collect Third Round of Data (During DOE Quarter 4)
  ▪ Observations
  ▪ Materials Analysis
  ▪ Interview

• Months of June – December 2013
  o Continue to organize, transcribe, and code interview, notes from observations, and materials analysis
  o Work with Expert Reviewer and Peer Reviewers to review data, codes, and themes

• Months of January 2014 – January 2015
  o Finish Analyzing and Organizing Findings
  o Finish Conclusions and Recommendations
  o Apply for Spring Graduation
  o Submit Draft to Chair and Committee
  o Defend Dissertation
APPENDIX I – Pilot Interview Transcripts

Transcripts of Pilot Interview pt1

Check RESEARCHER: Okay, Ms. PARTICIPANT, thanks for meeting with me!
RESEARCHER: You've been a teacher for a while PARTICIPANT: 8 years now;
RESEARCHER: a couple of years, 8 year, wow! Okay. RESEARCHER: Did you start off in the Hawaii DOE? PARTICIPANT: Yes. RESEARCHER: Oh. PARTICIPANT: I actually started off at this school. RESEARCHER: Oh, Okay. RESEARCHER: Okay, wow. PARTICIPANT: Yeah. RESEARCHER: And was that... RESEARCHER: Was this your undergraduate major? Were you an Education, Early Childhood... PARTICIPANT: I wasn't an Early Childhood (major); I just went for the K-6 elementary. RESEARCHER: K-6 elementary. PARTICIPANT: K-6 Elementary teaching degree. RESEARCHER: Okay, Perfect. RESEARCHER: And on graduation, did that... did that degree pair with it a teaching credential. PARTICIPANT: Yes, well... I had to take another test to get the teaching credential. RESEARCHER: Okay, was that the Praxis? PARTICIPANT: Yes, the Praxis. RESEARCHER: The Praxis, oh that's great! RESEARCHER: So that was about years ago. PARTICIPANT: Yes. RESEARCHER: And you've been at this school... since... PARTICIPANT: I've been at this school the whole time. RESEARCHER: And primarily, prior to this 1st Grade... classroom, you've taught...
PARTICIPANT: I started in 4th Grade RESEARCHER: Okay. PARTICIPANT: And, because I was "low man on the Totem Pole", I bumped down to 3rd and then, I bumped to 1st And, then I was bumped back up to 2nd (grade). I stayed there for three years and then I was bumped back down to 1st. And, this was my second year since that last bump. RESEARCHER: Okay. RESEARCHER: Okay. PARTICIPANT: (laughs) So... RESEARCHER: So, a couple of bumps there. PARTICIPANT & RESEARCHER: Yeah. PARTICIPANT: A couple of moves, it's a roller coaster again. Both: laugh. RESEARCHER: Yeah. RESEARCHER: Have you always... been in an inclusive setting? PARTICIPANT: No. RESEARCHER: Okay. PARTICIPANT: The inclusion... has been for the last two years. RESEARCHER: Okay. RESEARCHER: And how did that come about? PARTICIPANT: Um, ... RESEARCHER: Well, for you - as opposed to the
district level (change). PARTICIPANT: I kind of wanted it, and basically it was to support me, because of my disability, they felt it would be better for the students to have, you know, somebody somebody else ...(inaudible)... with, with things like going around and monitoring behavior. RESEARCHER: Oh, really? PARTICIPANT: Yeah. RESEARCHER: Oh really, interesting. Okay. PARTICIPANT: Yeah, and help out with getting the... students, you know, the help they needed. RESEARCHER: And you were receptive to that? PARTICIPANT: Yeah. Oh yeah, I'll take another (adult) body in the classroom, no matter how I get it. Both: (laughter). RESEARCHER: Great. RESEARCHER: So this is your second year... PARTICIPANT: Second year doing inclusion. RESEARCHER: Okay, and last year... it was 3rd grade? PARTICIPANT: No, last year it was with 1st Grade. RESEARCHER: Okay, this your second year with 1st Grade. PARTICIPANT: Yes. RESEARCHER: Second year with... inclusion. PARTICIPANT: Yes. RESEARCHER: And so, with the inclusion (model), you have a special education teacher... PARTICIPANT: (agreeing). RESEARCHER: With you, and he's a floater. PARTICIPANT: (agreeing) RESEARCHER: He's a floating teacher. PARTICIPANT: Yes, this year. Last year... Because, we had enough sped teachers, last year, it was full time. RESEARCHER: Full time? PARTICIPANT: Full time special ed teacher and full time special ed, educational assistant. RESEARCHER: Okay. RESEARCHER: So this year, is there another 1st Grade classroom (that he's supporting)? PARTICIPANT: No. There is a ... what happened was that because our numbers, the number of kids in the school, we lost our ...a special ed position. RESEARCHER: Okay. PARTICIPANT: So, this year, because of how many special ed kids there are on each grade level, it was determined that 1st Grade and 2nd Grade would have to share the special ed teacher. RESEARCHER: Mmm. Okay. So, 1st and 2nd (grade will share the special education teacher). PARTICIPANT: Yes. But, I still have the special ed EA in my room all the time. RESEARCHER: Okay. And, so she's with you.... PARTICIPANT: The whole school day. RESEARCHER: The whole school day. PARTICIPANT: Yes. RESEARCHER: And... prior to or throughout your time here your 8 years here, do - did you .... have .... you finished a masters program, too. PARTICIPANT: Yes. Yes. It was a masters program that was... good gracious, about 3 years ago. RESEARCHER: Yeah. PARTICIPANT: Something like that. RESEARCHER: So, you started it about 3 years ago, and you finished... PARTICIPANT: I finished about it about 3 years ago. RESEARCHER: Okay, you finished it 3 years ago. Oh, okay. RESEARCHER: Okay. PARTICIPANT: And, I started it 2 years before that. So, yeah.
RESEARCHER: Okay, and was that in... ED Tech? PARTICIPANT: Yes, that was educational technology. RESEARCHER: Okay, great. And that was an online program? PARTICIPANT: Yes, it was with Grand Canyon University. It was completely online. RESEARCHER: Okay, that's right - okay. RESEARCHER: And have you, have there been many... in-services on inclusion? PARTICIPANT: Actually, no. RESEARCHER: Okay. PARTICIPANT: There haven't been any... but I believe that if you're going to have another person in the class, you really need to have it be, especially if your going to have (students with) special ed (services) in the classroom ....students in the classroom, and you're trying to include them... that you can't, as much as possible you can't treat them differently. RESEARCHER: M-hmm. PARTICIPANT: You know, if you're going to if you if you're going to, the goal is to include them in the regular education setting... you have to do that. And that means, the sped teacher has to be on board to teaching the whole class You both have to be on board and supporting each other. With things that you in the classroom, you know and, not every time the special ed kids need the help... Sometimes, the regular ed kids need the help. And the special ed kids don't. A perfect example, yesterday... no, Tuesday, we taught a lesson about trying to figure out "How much more monies someone had saved." And that was basically a lesson comparing that kind of thing. And so, what we did was we had someone save 12 pennies and someone else saved 7 (pennies). So, we put it out on the SMART Board... all, nice and in a row, 12 pennies. Underneath 7 pennies, and then we took these lines and then we connected (the pennies from each line). "Oh, they both have it, it's the same." And we did this for the whole 7 pennies. And we said, "Okay These are the ones that are different (and remaining)." We circled them and said, "How many are there?" "How many are there" So we counted up. Now, when go to, you know we did this a few times and then when we got to doing the journal page, my sped kids ...not a problem, got it like that (snaps fingers). My kids that usually have absolutely no problem with anything that we do - couldn't do it. Couldn't do it to save their life. RESEARCHER: What do you think the difference was? PARTICIPANT: Probably that (the activity) was more kinesthetic. That it was more, you know, ....there were more steps. They (the general ed kids) were used to getting (the content) and having it right there (conceptually and on their desk). And the general ed kids, aren't used to taking all the steps to do things. Whereas, the sped kids are used to getting things different ways... So, (the sped kids) were (like), "Okay, I can do that. And I can do that, and I can do that." "There's my answer." You know, they're used to working with more graphic things, because
that's how we break it down for them. I really think that was the difference...but, I guess that sometimes they (the students receiving special education services) are not the ones that need the help. RESEARCHER: Yeah.

Transcripts of Pilot Interview pt2

RESEARCHER: By providing, and I can email you this too. PARTICIPANT: Okay.
RESEARCHER: And this isn't/doesn't necessarily...I'm not here to make a judgment.
PARTICIPANT: Right. RESEARCHER: I'm here to see what elements are existing as far as...how content is represented. PARTICIPANT: Mhmm. RESEARCHER: Like, is it either in a book or is either on the SMART Board. And how are kids acting and expressing themselves. But more so, I'm interested to see how as a teacher, you're, you're kind of facilitating (instruction)...but that doesn't mean that even if you're doing these things, great or bad It's just (kind of like) a fly on the wall to see... PARTICIPANT: To see what's happening.
RESEARCHER: To see what's happening (in agreement). Yeah. PARTICIPANT: Okay.
RESEARCHER: And, as you probably know more so than me that the DOE is making a bigger push towards inclusion. PARTICIPANT: Yeah. RESEARCHER: So, I'm hoping to just observe and see PARTICIPANT: Mhmm (agreeing). RESEARCHER: to see how that's going about.
RESEARCHER: Yeah. PARTICIPANT: Yeah. RESEARCHER: And... PARTICIPANT: Yeah, I definitely love the inclusion setting. I do. I wholeheartedly and having my disability, with cerebral palsy, I was a SpEd kid. My whole career, and not's because I didn't understand the thing (?) it was because... I had trouble walking...and you know, so, if I was pulled out for things - that or when I was pulled out for things, that stamped me as "different" - you know.
RESEARCHER: Mhmm (agreeing). PARTICIPANT: You know, it wasn't fun - to put it mildly.
PARTICIPANT: (laughs) RESEARCHER: Do you think that impacted your teaching? Or your perspective on education? PARTICIPANT: Yeah, I do and that's the one thing that's the one thing that really lends me or leads me towards inclusion. Because... If you can get, you know, these kids that are, you know that you've labeled as "SpEds" that are needing extra help and needing extra support. If you can get them in the regular classroom and to where, the kids are saying "Oh, there able to do things just like me." "You know, sometimes they don't understand
things, just like." You know, or "Wow! That girl is really good on that computer, and I can't understand it to save my life!" And that has happened. RESEARCHER: Mhmm (agreeing).

PARTICIPANT: You know, where we have the SpEd kids that are having the regular-ed kids with something on the computer. Because, the regular ed kids are having trouble. You know, I mean... So, it shows them, as they interact that Everybody has things they can do well. Everybody has things that they don't do well. You know, so, it gives them that ...that bridge and that connection, so that then, they're less likely to tease them, pick on them, bully them. You know, all of that stuff. RESEARCHER: Is there a particular subject or a period - an instructional period that may be (a window) that maybe epitomizes that PARTICIPANT: Well, we try to epitomize it with everything. RESEARCHER: Yeah. PARTICIPANT: What I would say the biggest thing that leads us to - you know - that helps you to teach and to except every everyone, would be our health period. RESEARCHER: Mhmm (agreeing). PARTICIPANT: Which we try to include - as much as we can (from a curricular standpoint) But officially in the school, it's a - 1-day a week, it's Wednesdays. RESEARCHER: Oh really? RESEARCHER: Okay. PARTICIPANT: Yes, and we have to kind of fit it in there (yes). However we can. And, First Grade really is lacking on Wednesdays because we what's called: "Collab" where the teachers are pulled out for an hour and a half - and ours happens to be on Wednesday. At the end of the day. RESEARCHER: Mhmm (agreeing). PARTICIPANT: So we've got 'em from 7:50 to 11:45 - and that's the only day where we're allowed anything other than reading and math So, yeah, we gotta squeeze it in. So, yeah, we gotta squeeze it in. RESEARCHER: Interesting, as a fly on the wall, so to speak... PARTICIPANT: Mhmm (in agreement). RESEARCHER: Would... that be an interesting course to observe? Or is there another class... or subject that you would like to highlight? Or... PARTICIPANT: Yeah, I think the Wednesdays would be interesting. Interesting to observe. We're actually as school, we're going to pilot a new health program. RESEARCHER: Oh, really? PARTICIPANT: A character ed program and kind of see how that Works school-wide. So that might be interesting to see... RESEARCHER: Okay, PARTICIPANT: How that works out. So yeah.... RESEARCHER: So, if it's okay with you, I would love to come in and observe - PARTICIPANT: Yeah. That's fine. PARTICIPANT: Like I said, other than that Monday, Tuesday, Thursday, Friday... is all Reading and Math - and that's pretty much it. So... RESEARCHER: Not much room for science or art. PARTICIPANT: Officially On the school schedule, that's what we're supposed to be doing. - Is reading and math. RESEARCHER: Okay.
PARTICIPANT: If we finish, math early, then I can kind of squeeze in some Science or Social Studies, but Yeah... RESEARCHER: Not too often. PARTICIPANT: Yeah. Because, as you saw when you came, they were still doing math. On days when it's a difficult concept, like what the sub was teaching today, that's fairly normal. So, because we have to really get into these strategies and procedures, and you know. And it takes a while. RESEARCHER: Now, maybe we can talk about, like curricula Do you have a Health curricula? Or is this a... PARTICIPANT: Well, that's what we're piloting this coming semester. RESEARCHER: Okay. PARTICIPANT: Because, we haven't up until now. RESEARCHER: Interesting. PARTICIPANT: Yeah, so.... RESEARCHER: And this would still be the inclusive setting for the kids. PARTICIPANT: Yes, yep! RESEARCHER: But this time, kind of introducing a new subject, Health. PARTICIPANT: Yes. Yep! RESEARCHER: Mmmm PARTICIPANT: So... RESEARCHER: Well, if it's okay with you, I'd love to sit in and observe those (Health courses). But also maybe conduct some ongoing interviews like this. PARTICIPANT: Okay. RESEARCHER: So we can talk story and get your perspective. PARTICIPANT: Okay. RESEARCHER: And maybe along the way, see what materials you're using and sample those... PARTICIPANT: They're getting 'em to me. They're going to get 'em to me sometime soon. RESEARCHER: Interesting. PARTICIPANT: Yeah. I can take a look at 'em. RESEARCHER: That's awesome, okay. Perfect. Thank you. PARTICIPANT: Anything else? RESEARCHER: (bell ringing in the background) I think that's it, right now. But maybe, I can text you over PARTICIPANT: Okay! Kimble: You know, when it's good (time to do so) and we can catch up. PARTICIPANT: Okay. RESEARCHER: But yeah, I'm so excited about this. PARTICIPANT: Yeah. RESEARCHER: To observe, and you know, I kind of I know historically we've had that collaborative kind of relationship and now it's kind of different - You know, as far as observing (in comparison to professional development course time together). PARTICIPANT: Yeah. RESEARCHER: But, I'm not making any judgments. PARTICIPANT: (Laughing) Yeah, I know. RESEARCHER: Cool. PARTICIPANT: Yep.
APPENDIX J – Field Notes Example File
APPENDIX K – “Morning Warm-Up” Example File
### APPENDIX L – Data Log Example File – Interviews

![Data Log Example File](https://example.com/data-log.png)

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<th>Interview</th>
<th>Timecode</th>
<th>Quote</th>
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<th>UDL-1</th>
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<tbody>
<tr>
<td>Interview 3</td>
<td>[00:00:00:00]</td>
<td>PARTICIPANT: They have some...extension exercises...</td>
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<td>Interview 3</td>
<td>[00:00:04:00]</td>
<td>RESEARCHER: Starfall classes? PARTICIPANT: Reading strategies...no, Pearson Success</td>
<td>instruction; curriculum</td>
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<td>Interview 3</td>
<td>[00:00:06:00]</td>
<td>RESEARCHER: Oh, Pearson Success stuff? PARTICIPANT: They're the ones...that's the website</td>
<td>curriculum; technology</td>
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<td>Interview 3</td>
<td>[00:00:12:00]</td>
<td>for the reading strategies... RESEARCHER: Oh, okay.</td>
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<td>picture of student desk-cluster; arranged in geometrical shapes; easy flow throughout the</td>
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<td>3</td>
<td>classroom; print materials along the wall</td>
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<td>picture of student work; picture-puzzle worksheet; student desk is adorned with resources</td>
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<td>5</td>
<td>(i.e. number line, alphabet; right-hand and left-hand visual cues)</td>
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<td>6</td>
<td>PICTURE: a corner of the classroom-wall, showing &quot;Classroom Monitors&quot; student jobs;</td>
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<td>laptop charging/storage station; around the corner more cozy space and open windows</td>
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<td>8</td>
<td>Picture: Student desk center; students use it to copy nightly homework assignments; the wall</td>
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<td>above shows materials various print-poster materials (i.e. motivation keywords and a</td>
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APPENDIX N – Data Log Example File – Materials Analysis

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Consistent with the other lessons, this lesson begins with the check-in routine. Students drag their names from the “absent” section to the “present” trashcan.

Here, this page from a sister in their “morning warm-up” – They are to highlight keywords (for example adjectives) – then write their own original sentence. And then they are to launch an audio story through the speaker icon of a SmartBoard for the story entitled “A Clever Way Out”.

This page begins the “oral language” section of the lesson. Students are prompted to click on the hyperlink to launch the “Amazing Words” and then, the teacher provides a series of questions about the stories that they are about to read – “Mrs. Chicken and the Hungry Crocodile” big book.

Here, is another interactive page – for the “phonics: word work” section of the lesson.
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