UNIVERSAL DESIGN FOR LEARNING AS A DIGITAL MEDIA DESIGN RESOURCE FOR TEACHERS OF BILINGUAL DEAF STUDENTS WITH SPECIAL NEEDS

By

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To my husband Rick and our daughter Fiona for their love, encouragement, and patience throughout this journey; to my parents for instilling in me an infinite love of learning; to Papa for his passion for asking questions; and to the remarkable students and colleagues with whom I am privileged to work every day.
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<td>AEBPD</td>
<td>ASL/English Bilingual Professional Development</td>
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<td>ASD</td>
<td>autism spectrum disorder</td>
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<td>ASL</td>
<td>American Sign Language</td>
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<td>BP-DBL</td>
<td>best practices for Deaf bilingual learners</td>
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<td>CAST</td>
<td>Center for Applied Special Technologies</td>
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<td>CEC</td>
<td>Council for Exceptional Children</td>
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<td>CTML</td>
<td>cognitive theory of multimedia learning</td>
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<td>DCT</td>
<td>dual coding theory</td>
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<td>DI</td>
<td>differentiated instruction</td>
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<td>DSM-V</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 5th Edition</td>
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<td>ESL</td>
<td>English as a second language</td>
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<td>ID</td>
<td>intellectual disability</td>
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<td>MCEs</td>
<td>manual codes of English</td>
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<td>NCDB</td>
<td>National Consortium on Deaf-Blindness</td>
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<td>PD</td>
<td>professional development</td>
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<td>PLC</td>
<td>professional learning community</td>
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<td>PTLC</td>
<td>professional teaching and learning cycle</td>
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<td>SDC</td>
<td>School for Deaf Children</td>
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<td>SEDL</td>
<td>Southwest Educational Development Library</td>
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<td>SFC</td>
<td>School for Communication</td>
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<td>SLD</td>
<td>specific learning disorder</td>
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<td>TBI</td>
<td>traumatic brain injury</td>
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This instrumental case study examined universal design for learning (UDL) as a digital media design resource for teachers of bilingual Deaf students with special needs. Ten teachers from a school program for bilingual Deaf children with special needs engaged in professional development (PD) provided through the professional teaching and learning cycle (PTLC) on the application of UDL to this population of students. Through the stages of the PTLC, teachers learned about UDL, used this knowledge to incorporate specific UDL guidelines into a lesson plan including a digital media component, and implemented that plan with their students. Teachers reconvened to analyze their use of UDL and adjust their practice.

This study involved analysis of data sources including interview, document, artifact, rubric, survey, and research journal. In examining the role of UDL, the data revealed that teachers utilized the UDL principles, tiers, and individual guidelines to make design decisions. They were guided by their grounding in Deaf education, their experiences and backgrounds with this population, and the learning needs of their students. Teachers utilized the structure of the UDL guidelines to reflect on their teaching practice and push themselves and their students to higher skill levels.
In examining the feature of PD and teacher learning, the data revealed that the presence of five critical features of PD was more relevant to the success of the PD than the structure of the PTLC. The presence and strength of these five critical features – content focus, cohesion, duration, active learning, and collective partnerships – supported and hindered teacher learning in various ways.

This study is significant because it explored digital media design for a population underrepresented in the literature. Bilingual Deaf students with special needs demand unique and specialized instruction across all areas of language, literacy, academic, social, and life skill development. This study illustrated that UDL is a powerful tool that can be utilized as a design resource for teachers of bilingual Deaf students with special needs to provide instruction that increases opportunities for success.
CHAPTER 1
INTRODUCTION

The school day begins much like any other. Three high school students arrive on their district buses. The first student, Dani, enters the school independently. She puts her things away in her locker and brings her home/school communication book into the classroom. Dani knows her morning job is to set up the schedule chart for the day. She references the teacher’s lesson plans online to ensure that each activity is displayed on the chart at the correct time. She also writes out several therapies that will occur for herself or her peers, including speech-language, occupational, and physical therapy. Dani smiles when she notices that the class has art today. When this is completed, Dani grabs her morning work folder and sits quietly at her desk, concentrating intensely.

The second student, Kelly, is greeted by a paraprofessional at the bus. The paraprofessional carries a clipboard with a behavior data chart, a timer, and a visual first-then board. Before Kelly enters school, the paraprofessional uses American Sign Language (ASL) to remind her that the first activity of the day will be going to her locker, followed by morning exercises as prescribed by her physical therapist. These activities are displayed visually to Kelly on her first-then board. Kelly selects her first preferred reward of the day – playing with her pony figurines – to be earned by displaying preferred behaviors. As they walk into school, the paraprofessional starts the timer. It will ring every three minutes for the duration of the school day, at which point Kelly may earn a check for positive behavior. After visiting her locker and proceeding through half of her exercises, Kelly has earned the six checks necessary to play with her pony figurines.
The third student, Caleb, is greeted at his bus by the teacher. Caleb starts signing through the window before he has even stood up. Smiling, the teacher reminds Caleb that he needs to focus on his walking. As he disembarks the bus, the teacher tells Caleb, who is a hearing student, that she is so glad to see how enthusiastic he is to come to school. She guides him to his walker and buckles his gait belt around his waist to provide an extra measure of safety. The teacher takes Caleb’s bag from the bus, which contains his homework, lunchbox, and daily medications. Caleb’s first stop is to the school nurse, who assesses his health and tends to his medications. Then, he makes his way to the classroom, stopping frequently to greet peers and staff in ASL.

When Caleb arrives in the classroom, Dani and Kelly are ready to begin the school day. The teacher starts the day with a class meeting. She turns on the interactive whiteboard and uses a PowerPoint she created to discuss the upcoming special activities that week. Then, she hands the classroom iPad to Kelly, who checks the current temperature and forecast. Kelly shares this information with her peers, and Dani graphs the temperature on a paper line graph that stretches across an entire wall of the room. Caleb repeatedly signs something about Friday, and even with clarification, the teacher does not understand. Caleb then uses his communication device to create the sentence, “Friday Aunt P-A-U-L-I-N-E visit Texas.” Given this information, the teacher confirms that Caleb’s Aunt Pauline will be coming to visit from Texas on Friday. Just then, Dani flashes the overhead lights, signaling to everyone in the room that she needs their attention. She announces that she has language therapy and Kelly has physical therapy. Dani heads to her therapy independently, while the paraprofessional, carrying
the clipboard and timer, accompanies Kelly. The teacher and Caleb stay in the classroom to review some money-related math facts from the previous week.

This fictional vignette is typical of the classrooms that can be found at the School for Deaf Children (SDC) (all identifying information has been changed to protect confidentiality) in Massachusetts. SDC serves students from birth to age 22 with multiple disabilities. In the vignette, the three SDC high school students have very complex yet different disabilities. Dani is profoundly deaf and has language and cognitive delays. Kelly is hard-of-hearing and has significant motor, cognitive, and behavioral disabilities. Caleb is hearing but has cerebral palsy, making verbal communication not viable. He understands spoken English and ASL and expresses himself using ASL and a communication device. Other students at SDC have a variety of challenges such as learning and motor disabilities, autism spectrum disorder, or complex medical needs. This implies that all students need highly individualized instruction across all areas of learning and functioning in order to make progress.

Deaf students at SDC are taught using a specialized bilingual approach. They learn using ASL, written English, and possibly spoken English, depending on their abilities and interests. This approach was originally developed for traditional Deaf education classrooms in which students are Deaf but have no additional special needs. The students at SDC do not fit the description of the traditional Deaf education student because 90% of students at SDC have additional disabilities that add layers of complexity to their educational needs. Practitioners at SDC, and those in the wider field, should examine the ways in which this approach does and does not meet the needs of Deaf students with additional special needs.
In this chapter, the reader is oriented to my professional experiences, the role of language in Deaf populations, and the language and learning philosophy used at SDC. The suitability of this language and learning philosophy to design digital media is questioned, and a possible alternative approach, known as universal design for learning (UDL) (Meyer, Rose, & Gordon, 2014) is described. These arguments frame the research questions and design that guided this study.

**Researcher Background**

There were two primary areas that contributed to my interest in exploring UDL as a framework for digital media design for teachers of bilingual Deaf students who have special needs. The first was my educational background. I studied ASL, linguistics, and special education with a concentration in deaf and hard-of-hearing. This gave me a comprehensive understanding of language development and education, particularly in deaf children.

The second area that has contributed to this interest and inquiry is my professional experience. I have worked for over ten years at SDC in a variety of roles. As a Teacher of the Deaf, I worked with students from preschool through middle school age. Additionally, I worked as a Deaf Education and Media Specialist, supporting classroom teachers with teaching strategies and classroom management as well as student-centered media development and integration. It was during my time in the classroom and as a Media Specialist that I developed both a passion for and technical skills in media development and integration.

In 2015, I accepted the role of Curriculum Coordinator, which allows me to support teachers and classrooms even more comprehensively. In addition, I am responsible for developing professional development (PD) on the bilingual educational
philosophy used to design instruction for our bilingual Deaf students who are learning ASL as a first language and English as a second language, either spoken or written.

This educational and professional background has supported the development of my expertise and interests including the education of complex bilingual Deaf students and the use of digital media to provide highly adapted curriculum.

Language in Deaf Populations

A deaf child’s mode of communication refers to the choices made regarding the use of various communication approaches. The two major paradigms are the oral and manual approaches. The oral approach emphasizes speech, articulation and lipreading. The manual approach emphasizes the use of visual communication on the hands and includes ASL as well as manual codes of English (MCEs). All these modes of communication have been utilized at SDC at some point in history.

ASL is a natural visual language distinct from English; ASL is not English represented on the hands. It has a rich set of rules including syntax, morphology, semantics, pragmatics, and phonology, akin to any natural language (Fischer & van der Hulst, 2003; Schirmer, 2001). The grammar of ASL is different than the grammar of English. ASL uses a unique system of non-manual markers including facial expressions, eye gaze, and body movements that are part of the grammatical structure of the language. ASL is the natural language of the communities of Deaf individuals across the United States and Canada. Throughout this study, I will abide by the convention of writing the word Deaf with a capitol D when referring to the community of people who embrace ASL and Deaf culture (Schirmer, 2001). The word deaf with a lowercase d refers to the general population of individuals with hearing loss regardless of their communication and cultural choices.
In contrast to ASL, MCEs were developed with the goal of improving deaf students’ spoken English and literacy skills (Schick, 2003; Stedt & Moores, 1990). In MCEs, signs are often borrowed from ASL but are expressed following the spelling and grammatical structures of English. These systems do not utilize non-manual markers. It is important to note that an MCE is not a language in itself, but rather a manual representation of English. There is no viable community of MCE users in the United States akin to that for ASL users (Woll & Ladd, 2003).

The differences between ASL and MCEs are extraordinarily significant in the deaf education field, not only in the choice of an instructional language but also in the philosophy behind that choice. To many individuals in the Deaf community, the use of MCE is equivalent to a refusal to recognize the value of ASL and Deaf culture, and is viewed as a form of oppression (Woll & Ladd, 2003). Many Deaf adults strongly advocate the right of Deaf children to have access to ASL (Bailes, 2001). As with any discussion of culture, identity, and language, these issues are fraught with complication and nuance. The dialogue about communication modality in deaf education is likely to continue as actively as it has over the last several centuries.

**Language and Learning at SDC**

SDC has a rich history of educating deaf students from across the New England region. When the school was established in the late 19th century, the manual approach to communication was utilized. At that time, ASL was not yet formally recognized as a language and distinctions between ASL and MCE were not noted in the school’s history. Around the mid-1880s, the school made a switch to the oral method and remained fully oral until the mid 1970s when some classes began incorporating sign language again. Some of these classes used ASL while others used MCE. As a result of these
inconsistencies, the school officially adopted the use of MCE in 1992 and continued its use exclusively for seven years. However, given the lack of student success with MCE, SDC sought to make another official change. The full use of ASL was initiated in the 2007-2008 school year. Teachers participated in a two-year intensive training through Gallaudet University called the ASL/English Bilingual Professional Development (AEBPD) program, which is still taught in an accelerated format. The development of this program was supported by a U. S. Department of Education grant based at the New Mexico School for the Deaf. The program was described as “a national collaborative effort among educators and researchers who work together to respond to the educational needs of deaf and hard-of-hearing children and provide leadership in staff development” (Nover, Andrews, Baker, Everhart, & Bradford, 2002, p. 149). This program made no specific mention of how this philosophy applies to Deaf students with special needs.

Notably, the population of SDC has shifted considerably in the last two decades. Many deaf or hard-of-hearing children who would historically have been educated at a school like SDC are now mainstreamed in public schools. This is due to a complex relationship between public law, improvements in amplification technology, and educational climate. At the time of this study, over ninety percent of SDC students were deaf or hard-of-hearing but also had additional diagnoses, such as social-emotional, medical, physical, or cognitive issues, among others. Many of the students had a multitude of extremely complex needs that impacted language, communication, and learning. Therefore, SDC established a range of departments to meet the needs of its students, including speech and language pathology, occupational therapy, physical
therapy, nursing, counseling, behavior analysis, curriculum, assistive technology, vocational/transition, and vision. This collaborative approach has been a successful way to meet many of the therapeutic needs of the population. However, I questioned the ability of the school’s educational philosophy to meet the learning needs of these complex students.

This brings to light the overarching problem of practice. SDC utilized the bilingual language and learning philosophy as taught in the AEBPD program. However, the intended population of the AEBPD program (Deaf students without additional special needs) did not match the majority population of SDC (Deaf students with complex additional special needs). This problem of practice had a vast impact on all aspects of instruction at SDC. This study focused on how the problem of practice influenced one specific area: the design of digital media materials.

Incorporating ASL in digital media materials is a well-established best practice for promoting literacy development in Deaf children (Bailes, 2001; Horn-Marsh & Horn-Marsh, 2009; Knight & Swanwick, 2002; Padden & Ramsey, 1998; Strong, 1995). However, it also creates a challenge for practitioners who find the commercial availability of materials in both languages is limited. Therefore, many teachers at SDC created their own digital media instructional materials in ASL and English. For example, a teacher developed an e-book with a video-based ASL interpretation and audio-based English narration embedded in each page, along with the story picture and written English. In developing materials, teachers relied on best practices for Deaf bilingual learners (BP-DBL) that stemmed from the bilingual language and learning philosophy developed for Deaf students. However, given the population at SDC, the ability of BP-
DBL to successfully guide teachers in digital media design for this population was worthy of examination. The aim of this study was to look beyond BP-DBL and explore how UDL could contribute to teachers’ digital media design processes in the context of a school for Deaf students with special needs. Each of these approaches is described below.

**Pedagogical Approaches**

In this section, BP-DBL and UDL are described and examined in light of their suitability to guide digital media design for this population.

**Best Practices for Deaf Bilingual Learners**

In settings utilizing the bilingual language and learning philosophy, research-based best practices guide pedagogical decisions. As an example, Bailes (2001) concisely describes six principles for successfully educating Deaf bilinguals, as shown in Table 1-1.

Bailes’ (2001) principles all relate to the complex relationship between language and literacy for children growing up deaf, 95% of whom are born to hearing families who do not know ASL (Schick, 2003; Schirmer, 2001). The provision of linguistic access is a critical element of BP-DBL, such as providing language models in ASL and English and promoting metalinguistic awareness and knowledge in both languages (Bailes, 2001). If a teacher uses these BP-DBL to develop digital media, the outcome will be a tool that is highly accessible in ASL, spoken English, and written English. Yet pedagogically, this approach may not be sensible at all times.

The bilingual language and learning approach used at SDC does not demand that all information be provided equally in ASL and English at all times. Rather, teachers make conscious choices about when, how, and why to use different languages in the
classroom. This may be based on the individual characteristics of the students, the learning goals, and the environment. For example, a teacher may use the languages separately based on time (ASL in the morning, English in the afternoon), staff (teacher uses ASL, paraprofessional uses English), or physical place (English in the classroom, ASL in the lunchroom) (Baker, 2006). Or, the teacher may use both languages within a lesson purposefully and concurrently, such that the teacher consciously decides which language to use in order to address specific learning goals and reinforce concepts (Baker, 2006). These BP-DBL are designed to address issues of language use in the educational setting. However, language use within a digital media product may be quite different.

Spoken English and ASL are both examples of transient language: they disappear immediately after they are produced. Once something is said or signed, it cannot be repeated in exactly the same way; it is ephemeral. However, written English and videotaped ASL are permanent. They can be read or viewed repeatedly at will, such as a written English story or a videotaped poem in ASL. The BP-DBL described here focus primarily on ephemeral language use. But language used in digital media products will necessarily be permanent. The application of best practices developed for transient language use in the classroom to permanent language use in digital media products should be investigated.

BP-DBL makes no specific recommendations about how to make decisions regarding language use in the context of these language-permanent digital media designs. It merely recommends mindful provision of access to transient language learning opportunities.
**Universal Design for Learning**

UDL encourages inclusive classroom practice through curriculum design that customizes instruction by incorporating adjustable supports, scaffolds, and challenges while eliminating barriers to learning (Lapinski, Gravel, & Rose, 2012). There is a growing library of support (National Center on Universal Design for Learning, 2011; Rose & Dalton, 2006) for the use of UDL to design curriculum not only for learners with disabilities but also for typically developing learners. UDL’s flexibility, acknowledgement of individual learning differences, and dedication to the improvement of teacher practice made it an attractive choice for exploration in the context of this study.

UDL provides overarching principles, narrower guidelines, and specific checkpoints that guide curriculum development. Incorporating these UDL features creates expert learners who are purposeful, motivated, resourceful, knowledgeable, strategic, and goal-directed through the provision of multiple means of engagement, representation, and action and expression (Meyer, Rose, & Gordon, 2014). The specificity with which UDL describes curriculum development provides teachers with actionable recommendations regarding digital media design.

UDL provides design options for teachers that go beyond the affordances of BP-DBL. As described, BP-DBL are focused primarily on the complex relationship between language and literacy for Deaf children with no additional disabilities. The use of these recommendations to design digital media materials for Deaf students with special needs may not be a sound pedagogical choice. In this study, I wanted to explore whether the UDL guidelines provided structure that could give teachers a roadmap to making design decisions for a more complex population of students.
As a fictional example, Dani, Kelly, and Caleb’s teacher wants to create an e-book about moon phases for her students to use independently. Given BP-DBL alone, she might design the e-book with ASL, spoken and written English, and photos of moon phases all embedded on each page. However, a UDL engagement checkpoint would guide this teacher to optimize individual choice and autonomy (Meyer, Rose, & Gordon, 2014) such that students could select the language in which they wanted to receive that information within the e-book. This would address Dani’s primary mode of receptive communication (ASL) as well as Caleb’s two primary modes (ASL and spoken English). Another engagement checkpoint would guide the teacher to increase mastery-oriented feedback (Meyer, Rose, & Gordon, 2014). As a result, the teacher would be sure to incorporate a quiz within the e-book to determine specific strengths and needs regarding moon phases. For Kelly, the teacher could include both mastery-oriented content feedback as well as behaviorally-based feedback. These design elements, outlined by UDL, would not have been evident in a design by following BP-DBL alone.

Based on the affordances of UDL, it was worthy of investigation in a setting like SDC. However, before examining this framework, SDC teachers needed the opportunity to learn about UDL through structured PD.

Professional Development

As described, the problem of practice in this context was the use of a language and learning philosophy for a population for whom it may not have been appropriate. This study explored the use of UDL as an alternative framework to guide the design of digital media materials for Deaf students with special needs. This required that teachers at SDC be oriented to the concepts and terminology that encompass a UDL-based approach. This was accomplished through structured PD.
SDC identified itself as a professional learning community (PLC). Educators in a PLC “create an environment that fosters mutual cooperation, emotional support, and personal growth as they work together to achieve what they cannot accomplish alone” (DuFour & Eaker, 1998, p. xxi). Teachers and staff gathered in collaborative learning teams (CLTs) on a regular basis with the goal of achieving common objectives with high quality results. This study integrated PD on UDL into this existing structure. In addition, the study utilized the professional teaching and learning cycle (PTLC) to frame the PD.

The PTLC traditionally focuses on giving teachers the opportunity to collaborate on standards-based instructional methods (Tobia, 2007). This study applied that particular cycle to the examination of the use of the UDL guidelines in the digital media design process. The PTLC gives teachers the opportunity to collaborate and allows for frequent, repeated analysis and revision (Southwest Educational Development Library, 2008; Tobia, 2007) to the digital media design process. Teachers at SDC had the opportunity to participate in the PTLC to learn how UDL could be utilized to guide digital media design decisions for their Deaf students with special needs.

**Research Questions**

Based on this context and problem of practice, this study asked a primary research question along with two sub-questions. The primary question asked,

How did PD in UDL influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs?

In order to address the primary question, two sub-questions were posed. The first focused on the application of UDL to the digital media design process, while the second focused on the features of the PD and teacher learning. The sub-questions were:
1. How did teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program?

2. What features of the PD did participants feel supported or hindered their learning during the PTLC?

The goal of asking these questions was to determine how UDL can be used to develop digital media materials for Deaf students who have special needs and how teachers felt the features of PD supported or hindered teacher learning during the PTLC.

**Research Design and Limitations**

To address these research questions, I utilized a single instrumental case study approach. In this approach, the focus is on understanding an issue illustrated by a single bounded case that can be described within specific parameters, such as time, place, activity, definition, and context (Baxter & Jack, 2008; Creswell, 2013). An instrumental case study provides insight into an issue, phenomenon, or situation, or helps to refine a theory (Baxter & Jack, 2008). In this study, the single case selected as the unit of analysis was a group of participating SDC teachers. These teacher participants are thoroughly described in the context in which the case was embedded in later chapters.

This qualitative study involved several data sources: research journal, documents, surveys, interviews, artifacts, and rubrics. These sources were chosen based on the ability of each to provide particular information related to the research questions. The use of multiple sources contributed to the rigor of the study (Creswell, 2013).
During the study, teachers created a document reflecting the learning goals and targeted UDL checkpoints they would incorporate into their digital media design. The design artifacts were collected as a data source as well. Artifacts have the strength of being stable and unobtrusive, and can be used to corroborate and augment evidence from other sources and support the development of inferences (Yin, 2014). A researcher-created rubric was used to assess each artifact for the presence and strength of UDL guidelines. The use of a rubric was a consistent method of assessment used with each participant in the study (Rochford & Borchert, 2011) that allowed me to explore the characteristics of the digital media designs.

One survey was used during the study. The use of a survey allowed for the collection of information on observations, attitudes, and perceptions across participants. The design of the survey followed Harlacher’s (2016) five-step process for questionnaire development. Teachers were asked to complete the survey immediately after students engaged with the digital media materials. This survey focused on student response to the digital media materials and provided teachers an opportunity to gauge constructs including student motivation, knowledge, independence, and educational success.

Teachers also had the opportunity to participate in an individual interview. Interviewing provides access to people’s stories and a deep understanding of their perspectives and the meaning taken from an experience (Patton, 2002). Questions explored the teachers’ design process given their knowledge of the UDL guidelines and students’ response to the material. The use of the interview allowed me to examine design decisions and explore why teachers perceived some guidelines and checkpoints as worthy of inclusion while excluding others. Teachers’ views on the structure of the
PTLC were explored during interviews. This provided the opportunity to discuss the impact of the PTLC on their learning.

Throughout the research process, I maintained a journal to record my reflections, thoughts, and emerging ideas. The research journal was guided by topics including the research process, as well as participants’ knowledge, collaboration, design process, and teaching practice. Additionally, reflections included a robust discussion of potential biases and challenges (Creswell, 2013). This was relevant given my dual role as a researcher and Curriculum Coordinator in the setting.

It was critical to consider the limitations of this study. One potential limitation of this study was that it was performed in my own professional context. With over 10 years of experience at SDC, I had established biases, knowledge, and opinions that I needed to mindfully acknowledge and study in relation to the conclusions I drew about the impact of UDL on the digital media designs of teachers with whom I worked very closely. Studying the practice of individuals with whom I had a professional relationship had the potential to raise issues of power imbalance between myself and the participants. This was addressed through the use of multiple strategies of validation (Creswell, 2013), as described above.

**Significance**

This study contributed significantly to the fields of Deaf education and educational technology. This project involved an investigation into the use of UDL as a design resource for teachers of bilingual Deaf students with special needs. While UDL has been applied to Deaf populations (Stahl, 2006), there was little evidence that it has been used as the guiding element for the development of digital media materials specific to this population. The research questions were asked within the context of the
PTLC in order to provide structured, meaningful, small-group training to teachers in a specific instructional setting.

In addition, this study was useful in my professional context. SDC teachers were given the opportunity to learn about and implement an evidence-based framework with the potential to influence their daily teaching practice. This study also contributed to the body of knowledge regarding how PD can be structured with teachers of bilingual Deaf students with special needs, such as the teacher participants at SDC.

Table 1-1. Best practices for Deaf bilingual learners (Bailes, 2001)

<table>
<thead>
<tr>
<th>Principle</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Provision of language models in ASL and English</td>
</tr>
<tr>
<td>2</td>
<td>ASL as the first and natural language for Deaf children</td>
</tr>
<tr>
<td>3</td>
<td>World knowledge as a prerequisite for written English literacy</td>
</tr>
<tr>
<td>4</td>
<td>Promoting metalinguistic awareness and knowledge in ASL and English</td>
</tr>
<tr>
<td>5</td>
<td>Valuing approximations in both ASL and English</td>
</tr>
<tr>
<td>6</td>
<td>Involvement of parents in the literacy lives of deaf children</td>
</tr>
</tbody>
</table>
**Definition of Terms**

- **BEST PRACTICES FOR DEAF BILINGUAL LEARNERS.** A set of practices that guide educational and linguistic decisions for students who use a visual language such as American Sign Language (ASL) as a primary mode of communication (Bailes, 2001)

- **DEAF PERSON (lowercase d deaf).** An individual with an educationally significant hearing loss that interferes with access to classroom instruction and impacts the ability to communicate, learn, and develop peer relationships (Johnson & Seaton, 2012) through speech and listening alone

- **DEAF PERSON (uppercase D Deaf).** An individual who makes the linguistic and cultural choice to utilize American Sign Language as their primary mode of communication through which to understand their world and interact with others (Schirmer, 2001)

- **DEAF BILINGUAL.** An individual who uses American Sign Language and English (spoken or written) both expressively and receptively (Strong, 1995) in everyday life

- **BILINGUAL.** An individual who uses two or more languages in everyday life (Grosjean & Li, 2013) for different purposes, in different domains of life, and with different people (Grosjean, 2010)

- **PROFESSIONAL LEARNING COMMUNITY.** An environment for educators that fosters mutual cooperation, emotional support, and personal growth as they work together to achieve what they cannot accomplish alone (DuFour & Eaker, 1998)

- **PROFESSIONAL TEACHING AND LEARNING CYCLE.** A training cycle that proceeds through six steps (Study, Select, Plan, Implement, Analyze, and Adjust) to give teachers the opportunity to collaborate on instructional methods, and allows for frequent, repeated analysis and revision (Southwest Educational Development Library, 2008; Tobia, 2007)

- **UNIVERSAL DESIGN FOR LEARNING.** A framework to improve and optimize educational practice for all people that 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. This reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains high achievement expectations for all students (Meyer, Rose, & Gordon, 2014; U.S. Department of Education, 2008)
CHAPTER 2
REVIEW OF LITERATURE

The goal of this literature review is to establish knowledge and develop an argument that supports this study’s line of inquiry. The review is organized to address three broad questions:

1. Who are the students in this population?
2. How do the students in this population learn?
3. How do practitioners learn in a professional context?

Following the in-depth examination of these questions, the gaps across the literature are reiterated and presented within the conceptual framework guiding this study.

The organization of this literature review is presented visually in Figure 2-1.

The Deaf Student

There is no single definition or description that fits the diversity of the population of deaf students. The goal of this section is to provide foundational knowledge of the characteristics of the population, bilingualism, bilingualism in Deaf students, and a description of deaf students with additional special needs. This addresses the question: Who are the students in this population?

Characteristics of Deaf Students

From the perspective of educational institutions, a hearing loss becomes important when it is educationally significant. From a legal standpoint, an educationally significant hearing loss is "any hearing loss that potentially interferes with access to classroom instruction and impacts a child or youth's ability to communicate, learn and develop peer relationships" (Johnson & Seaton, 2012, p. 43). For many deaf children,
an educationally significant hearing loss impacts the accessible modes of communication, as described below.

Many deaf individuals rely on visual communication such as ASL, a rule-based language distinct from English with a development that parallels that of spoken language (Schick, 2003). Children exposed to ASL from birth by ASL-fluent parents develop the language naturally. These children display common but modified early language characteristics including manual babbling, manual articulation errors, lexical development, and syntactical agreement (Marschark, Lang, & Albertini, 2002).

However, 90–95% of the 10,000 deaf children born annually in the United States are born to hearing parents (Marschark, Lang, & Albertini, 2002; Mellon et al., 2015; Schick, 2003; Schirmer, 2001). This statistic has a lasting impact on this population. The majority of hearing parents with deaf children never achieve high fluency in ASL (Schick, 2003; Schirmer, 2001). This leads to a mismatch between the expressive spoken language modality of the parents and the deaf child’s ability to receive and process that modality (Hamers, 1998).

These language and communication characteristics of deaf children have a direct impact on learning. Due to the communication mismatch, most deaf children begin school with delayed language when compared to their hearing peers (Karchmer & Mitchell, 2003). In many cases, this delay has lasting consequences: older students also display poor academic outcomes. More than 30% of deaf students complete school functionally illiterate (Marschark, Lang, & Albertini, 2002) and many achieve no higher than a third- to fourth-grade reading level (Paul, 2003; Wang, 2012). Deaf children of Deaf parents who use ASL do not experience the same challenges. With ASL access
from birth, these children perform higher on tests of performance IQ (Schirmer, 2001) and English reading (Karchmer & Mitchell, 2003). However, for the 90–95% of children who experience a communication mismatch, these learning challenges persist across all areas of functioning. Communication and learning have an integral relationship for young deaf children.

A deaf person’s choice of communication mode often depends on the communication partner(s), situation, context, and purpose of the exchange. Though some deaf individuals use speaking and listening to varying degrees, access is limited and often distorted (Schirmer, 2001) even with amplification such as hearing aids or cochlear implants. Success with spoken language is also impacted by individual factors including fatigue and motivation, and by environmental factors such as background noise (Bernstein & Auer, 2003). While some deaf adults use speechreading, or lipreading, as an effective way to access English, speechreading is an extremely difficult skill to attain (Lidestam & Beskow, 2006). Despite many advances in technology, such as hearing aids and cochlear implants, some deaf individuals’ limited and often distorted access to spoken language makes speaking and listening an ineffective and inefficient mode of communication.

Communication mode choices, such as speech and listening or ASL, and family and learner characteristics share a complex relationship in how they impact the academic, social-emotional, and linguistic development of deaf learners.

**Bilingualism**

Bilingualism is the use of two or more languages in everyday life (Grosjean & Li, 2013) for different purposes, in different domains of life, and with different people (Grosjean, 2010). The goal of using bilingual teaching strategies is not to attain full
fluency in both languages. Rather, it is to achieve communicative competence, or the use of language to accomplish communication goals (Baker, 2006; National Capital Language Resource Center, n.d.) in each language. Necessary levels of communicative competence are determined by the context of use. Scholarly academic language demands a different level of competence than social and familial use (Baker, 2006). An individual is considered communicatively competent, and thus bilingual, if the use of each language accomplishes specific contextual goals.

Bilinguals display many cognitive advantages linked to bilingualism. One advantage is greater divergent and creative thinking. This involves being able to describe a variety of uses for objects and is determined by fluency, flexibility, originality, and elaboration (Baker, 2006). Another cognitive benefit of bilingualism is greater metalinguistic awareness, or the ability to think and discuss characteristics and structures of language (Bialystok, 1991). Bilinguals also have greater communicative sensitivity, or an increased awareness of the social nature and communicative functions of language (Baker, 2006). These cognitive advantages are observed across Deaf and hearing bilinguals.

Bilingualism in Deaf Students

For many Deaf children who experience a communication mismatch at home, ASL used at school becomes their first language. These children may be educated in school programs utilizing a bilingual language philosophy tailored to Deaf learners. A Deaf bilingual is an individual who uses ASL and English (spoken or written) both expressively and receptively (Strong, 1995).

Deaf bilinguals fit the definition of bilingualism (Grosjean & Li, 2013) by using two languages in everyday life for specific communication goals. For example, a student
may primarily use ASL at school and English at home. While access to spoken language may be limited by the communication mismatch (Hamers, 1998), the student is achieving communicative competence by using each language for particular purposes. Additionally, Deaf and hearing bilinguals share many characteristics such as a high level of diversity, an unlikelihood to view themselves as bilingual (Grosjean, 1998), little recognition of their bilingual status by the general public, and qualitatively different acquisition processes for their first and second languages (Grosjean, 2008). These characteristics also demand unique approaches to learner assessment (Baker, 2006).

Despite fitting the overall definition, Deaf bilinguals also display many differences from hearing bilinguals. The use of ASL does not prepare children for the task of developing English literacy skills in the same way that spoken English does. This is because the building blocks of ASL are different than those of English (Padden, 1998). Hearing children learn language and foundational literacy skills through natural interactions at home. Children learn “how English works,” such as phonemic awareness, phonology skills, and syntactic rules, and bring a vast amount of English knowledge to the task of developing English literacy (Muter, Hulme, Snowling, & Stevenson, 2004). Many Deaf children do not have this advantage because the communication mismatch prevents fluent early language exposure (Hamers, 1998). Therefore, while Deaf bilinguals share some characteristics with hearing bilinguals, there are fundamental differences as well. Based on these differences, it is not always appropriate to apply bilingual teaching strategies developed for hearing learners to Deaf
bilinguals (Mayer & Wells, 1996). Figure 2-2 illustrates the similarities and differences between hearing and Deaf bilingual learners.

Despite significant research on bilingualism in Deaf learners (Bailes, 2001; Grosjean, 2010; Horn-Marsh & Horn-Marsh, 2009; Padden & Ramsey, 1998), there is a noteworthy challenge in adapting best practices of bilingual education for two spoken languages to ASL/English bilingual education. As a visual–spatial language with no written form, ASL presents a unique instructional problem. There is a paucity of educational materials available in ASL, forcing many teachers of the Deaf to create their own instructional materials. This becomes a particular challenge when Deaf students have additional special needs.

**Deaf Students with Additional Special Needs**

Identifying and educating children who are deaf and have additional special needs is a complex and challenging task. Over 40% of deaf and hard-of-hearing students have one or more additional conditions (Karchmer & Mitchell, 2003) such as intellectual disability, specific learning disorder, autism spectrum disorder, physical disability, or deafblindness. In children with these diagnoses, a “unique situation evolves from the combined presence of two or more disabilities with great repercussions for communication, education, mobility, living skills, and learning” (Knoors & Vervloed, 2003, p. 82). These issues are more complex than when considering any disability in isolation.

**Identification and assessment Issues**

Identifying deaf children with an additional disability is made extremely challenging by unique assessment issues. Some additional disabilities, such as vision loss or a physical disability such as cerebral palsy, may involve examining physical
characteristics or the functioning of parts of the body. Other disabilities, such as intellectual disability, a specific learning disorder such as dyslexia, or an autism spectrum disorder, involve complex relationships among language, learning, and social functioning. While diagnosis of any disability can be challenging, this process is confounded by the communication and language issues faced by deaf children (Luckner & Carter, 2001).

Some of the unique challenges inherent to the identification of additional disabilities in deaf students are related to the presence of characteristics or indicators that can cross disability category. For example, autism spectrum disorders are characterized by persistent deficits in social communication and social interaction across multiple contexts (American Psychiatric Association, 2013). These deficits parallel those present in some deaf children including greater impulsivity, poorer emotional regulation, impoverished vocabulary of emotion language, and overall gaps in social-emotional development (Calderon & Greenberg, 2003). If a child has an identified hearing loss and presents with deficits in social communication, a diagnostician is challenged to determine the source of these deficits: Is it the hearing loss or is it a potential autism spectrum disorder? Practitioners working with complex, multiply disabled children face these issues on a regular basis.

Definitions, examples, and the impact of comorbidity for disability categories including intellectual disability, specific learning disorder, autism spectrum disorder, physical disability, and deafblindness are presented below.

Deafness and intellectual disability

An intellectual disability (ID) is characterized by “significant limitations in both intellectual functioning and in adaptive behavior as expressed in conceptual, social, and
practical adaptive skills” (Schalock, Borthwick-Duffy, Buntinx, Coulter, & Craig, 2010, p. 5) the onset of which occurs during the developmental period (American Psychiatric Association, 2013). The American Psychiatric Association (2013) further defines intellectual functioning as reasoning, problem solving, planning, abstract thinking, judgment, academic learning, and learning from experience. Adaptive functioning is defined as those communication, social participation, and independent daily living skills that support meeting the developmental and sociocultural standards for personal independence and social responsibility (American Psychiatric Association, 2013). Across the literature, the terms intellectual disability and intellectual developmental disorder are observed, though in the past the now strongly disfavored term mental retardation was used.

Diagnosis of ID occurs through the use of clinical assessment and standardized testing of intellectual and adaptive functions (American Psychiatric Association, 2013). Severity can range from mild to profound, and the overall prevalence of intellectual disabilities is estimated between 1-3% in the general population of the United States (Roeleveld, Zielhuis, & Gabreëls, 1997), varying across severity levels and age. The prevalence of ID in the population of deaf and hard-of-hearing children in the United States is much greater, with 8.3% identified (Gallaudet Research Institute, 2011). In addition, 5.3% are identified with a developmental delay (Gallaudet Research Institute, 2011), which implies that an individual is under 5 years of age and clinical severity cannot be reliably assessed (American Psychiatric Association, 2013).

When an individual is identified with both deafness and ID, language and social functioning can be impacted. Given the communication mismatch, the language of
many deaf children is significantly delayed. Some hearing parents of Deaf children may start to learn ASL from the time of their child’s birth. These children are faced with learning a language at the same time their parents are learning it. The parents are unable to model fluent language structures or use. Therefore, a typical spoken or signed language may not be an appropriate mode of communication through which to assess a deaf child for ID. Poor language skills can lead not only to assessment issues but also the serious error of misdiagnosis (Denmark, 1985).

Hearing loss alone does not guarantee acceptance into the Deaf community and culture. Membership is achieved rather than ascribed (Carvill, 2001) with the most foundational aspect being the use of ASL (Schirmer, 2001). For individuals who are deaf and have ID, opportunities to identify and participate in this community and culture are limited (Carvill, 2001). This may in turn affect the social functioning of an individual. Membership in the Deaf community and culture can support self-esteem by promoting group identification (Bat-Chava, 1994). However, deep and meaningful interactions within the Deaf community and culture may be limited for individuals who are deaf and have ID.

**Deafness and specific learning disorder**

Specific learning disorder (SLD) is characterized by persistent difficulties that appear during the school-age years in general academic skills such as word reading, reading comprehension, spelling, written expression, number sense, number facts, calculation, or mathematical reasoning (American Psychiatric Association, 2013). SLD can manifest in a variety of ways, such as dyslexia, dysgraphia, dyscalculia, and language processing disorder among others (Learning Disabilities Association of America, 2016). The issue with SLD is in processing, or the brain’s ability to organize
incoming information (Stewart & Kluwin, 2001). The terms specific learning disorder and learning disability are often used interchangeably.

A key feature of SLD is that the learning difficulties cannot be attributed to ID, hearing loss, vision loss, neurological disorder, psychosocial adversity, lack of language proficiency, or inadequate educational instruction (American Psychiatric Association, 2013). Due to these diagnostic criteria, it can be extremely challenging to diagnose a deaf child with SLD. If the child has not had the opportunity to develop fluent language due to the communication mismatch, general academic skills may be impacted without the addition of SLD. The relevance of processing is of major importance. Deaf children inherently have a perception issue such that incoming information may not be perceived by their sensory systems (i.e. audition) in full. However, this does not necessarily imply a processing issue. For a child with achievement issues, it is critical to determine if those issues stem from the perception issue (hearing loss) or a processing issue (SLD) (Soukup & Feinstein, 2007). Correct identification is critical in order to provide those with a dual diagnosis with appropriate intervention and services.

The prevalence of SLD ranges from 5%-15% among children across different languages and cultures (American Psychiatric Association, 2013). The prevalence among deaf children can be more difficult to determine due in part to the exclusionary diagnostic criteria described above. Without this exclusionary clause, 75% of deaf children could be diagnosed as learning disabled (Morgan & Vernon, 1994). Given that many causes of hearing loss such as premature birth, meningitis, maternal rubella, cytomegalovirus, and genetic syndromes are also associated with SLD (Edwards, 2010), prevalence estimates become even more difficult to determine. The most recent
national survey conducted by the Gallaudet Research Institute (2011) indicates that 8% of deaf and hard-of-hearing children also have a diagnosis of SLD. However, no specific definitions or diagnostic criteria in relation to this survey are provided. Clearly, diagnosis is a complex process.

Similar to other disabilities, the comorbidity of deafness and SLD impacts an individual more complexly than either disability alone. Laughton (1989) proposed a definition specific to deaf individuals with SLD:

Learning disabled, hearing impaired individuals have significant difficulty with acquisition, integration, and use of language and/or nonlinguistic abilities. These disorders are presumed to be caused by the coexisting conditions of central nervous system dysfunction and peripheral sensorineural hearing impairment, and not by either condition exclusively. The condition can vary in its manifestations and degrees of severity and can affect education, communication, self-esteem, socialization, and/or daily living activities throughout life. (p. 74)

The broad impacts of such a definition are echoed in the educational world. There is a critical shortage of teachers with the training and skills to work with multiply identified deaf children (Luckner & Carter, 2001; Soukup & Feinstein, 2007). Additionally, teacher preparation programs often do not take an interdisciplinary approach (Luckner & Carter, 2001), providing only isolated instruction on disabilities rather than the impact of their comorbidity (Soukup & Feinstein, 2007). In a survey, Soukup and Feinstein (2007) found that 50% of teachers did not feel adequately prepared to teach students who were deaf and had SLD. These issues make the education of deaf children with SLD even more challenging. However, Laughton’s (1989) definition highlights the far-reaching impact of this comorbidity on education, communication, self-esteem, socialization, and daily living activities. It is essential that
practitioners working with deaf children with SLD have the tools necessary to provide these children with an appropriate education.

**Deafness and autism spectrum disorder**

Autism spectrum disorder (ASD) is characterized by persistent deficits in social communication and social interaction across multiple contexts, and restricted, repetitive patterns of behavior, interests, or activities that are present in the early developmental period and impair everyday functioning (American Psychiatric Association, 2013). The American Psychiatric Association (2013) identifies social-emotional reciprocity, nonverbal communicative behaviors used for social interaction, and developing, maintaining, and understanding relationships as skills inherent to social communication and social interaction. Likewise, restricted, repetitive patterns of behavior, interests, or activities are described as stereotypic or repetitive motor movements, use of objects, or speech, insistence on sameness, inflexible adherence to routines, highly restricted and fixated interests, and hyper- or hyporeactivity to sensory input (American Psychiatric Association, 2013). ASD can range greatly in severity. Other terms utilized in relation to ASD include autism, autistic disorder, Asperger’s disorder, and pervasive developmental disorder not otherwise specified.

Estimates of the prevalence of ASD have changed dramatically in recent decades. A report from the Centers for Disease Control and Prevention note a rate of 14.6 per 1000, or one in 68 children aged 8 years (Christensen et al., 2016). The authors note differences across gender, with ASD more prevalent in boys (23.6 per 1000) than girls (5.5 per 1000), and ethnicity, with ASD more prevalent in non-Hispanic white children (15.5 per 1000) than non-Hispanic black children (13.2 per 1000) or Hispanic children (10.1 per 1000). The overall prevalence rate has been steadily
increasing from one in 150 in 2000 to one in 68 in 2010 (Centers for Disease Control and Prevention, 2016). Several theories have been proposed to explain these increases. These include an underestimation of ASD in the past, early diagnosis, changing diagnostic criteria, and the success of national efforts to educate the public about the early signs of ASD (Duchan & Patel, 2012). No single theory has been shown to individually explain the increase in prevalence of ASD.

Determining the prevalence of ASD in deaf children is complicated by the fact that many characteristics of ASD are also present in deaf children (Szymanski & Brice, 2008), such as deficits in social communication and social-emotional development (Calderon & Greenberg, 2003). The most recent national survey conducted by the Gallaudet Research Institute (2011) indicates that 1.7% of deaf children surveyed are also diagnosed with ASD, which equates to one in 57 children. This number is slightly higher than that national rate of one in 68 children. Though this rate does not include every deaf child in the United States, Gallaudet University’s Office of Research Support and International Affairs has been collecting educationally relevant information on deaf students since 1968 (Gallaudet University, 2015) and represents a respected source of demographic information.

A notable difference between hearing and deaf children with ASD is the average age of identification. Deaf children with ASD are identified later than hearing children with ASD (Jure, Rapin, & Tuchman, 1991; Roper, Arnold, & Monteiro, 2003). Mandell, Novak, and Zubritsky (2005) noted that the average age of identification was 3.1 years for hearing children with autistic disorder, 3.9 years for pervasive developmental disorder not otherwise specified, and 7.2 years for Asperger’s disorder. While many
factors impacted age of identification, such as socioeconomic status, ethnicity, and environment (e.g. rural v. urban), hearing loss was associated with a 0.8 year, or 10-month increase in age of diagnosis. This implies that deaf children with ASD are diagnosed with ASD later than their hearing peers. This may be due to the challenge of distinguishing the characteristics of the two conditions, a lack of resources for parents and educators, a lack of diagnostic tools developed specifically for this population, or a combination of these factors (Szymanski & Brice, 2008). There may also be a problem with diagnostic overshadowing in which one condition masks the presence of another, such as hearing loss masking ASD or vice versa (Szymanski, Brice, Lam, & Hotto, 2012). This older age of identification has a great impact on access to intervention and appropriate educational services.

There are a number of relevant factors when a child presents with comorbid deafness and ASD. As with other deaf children, a mode of communication must be selected to promote interaction and learning in children who are deaf and have ASD. Sign language has been used successfully with autistic children for over 40 years, though the signs themselves are often simplified and do not always reflect fluent use of ASL (Szymanski & Brice, 2008). A foundational requirement for using ASL is sustained eye contact, which is commonly a challenge for children with ASD (American Psychiatric Association, 2013; Morton, 2008; Szymanski & Brice, 2008). Language development may therefore be impacted for a student who presents with both hearing loss and ASD.

There are a limited number of programs nationwide that specialize in the education of deaf students with ASD. Explanations that have been proposed include the
lack of appropriate assessment resources, a shortage of curriculum materials and methods, and the scarcity of well-prepared educators (Bruce, DiNatale, & Ford, 2008; Luckner & Carter, 2001; Szymanski, Brice, Lam, & Hotto, 2012). Typically, teacher preparation programs focus on deafness or on ASD, but not on both. For a child whose primary disability is believed to be deafness with ASD as a secondary disability, educational placement would likely be in a school for the deaf. While this placement would provide visual language in the form of ASL, professionals there may not have any specific training on working with students with ASD. On the other side of the coin, if ASD is considered the primary disability with deafness as the secondary, placement may be in a program designed for children with ASD. While these programs can be very successful for hearing children with ASD, professionals may not have the training to work with deaf students and may not provide students with fluent language models in either the staff or peers.

Potential solutions to these challenges are as multifaceted as the issues themselves. For example, altering the content of teacher preparation programs to include more in-depth information about children with multiple handicaps (D'Zamko & Hampton, 1985), training in how to work as a member of an interdisciplinary team (Luckner & Carter, 2001), and providing targeted professional development (Miller, 2000) may address these challenges. The Joint Standards Committee of the National Council on Education of the Deaf and the Council for Exceptional Children (CEC) (1996) provided “66 statements specific to the education of students who are deaf or hard of hearing and is an expansion of the 107 CEC Common Core Knowledge and Skills Statements” (p. 220) that allow for the determination of readiness of deaf educational
professionals and preparation programs. While these recommendations are not specifically targeted to deaf students with ASD, they nonetheless provide actionable steps to address the gap in knowledge and skills in the education of children dually diagnosed with deafness and ASD.

**Deafness and physical disability**

Physical disabilities range in etiology and severity. Some disorders with physical attributes, such as developmental coordination disorder, stereotypic movement disorder, and tic disorders, are included in the *Diagnostic and Statistical Manual of Mental Disorders, 5th Edition* (DSM-V) (American Psychiatric Association, 2013). Other disorders that affect physical movement are neurologically based, such as cerebral palsy, muscular dystrophy, degenerative disorders, and traumatic brain injury (TBI), and are excluded from the DSM-V. Whatever the etiology, the interaction of physical disabilities with deafness leads to unique student characteristics in language and learning.

The American Psychiatric Association (2013) describes the characteristics of neurodevelopmental motor disorders by providing specific diagnostic criteria. These include lack of coordinated motor skills that interferes with daily living (developmental coordination disorder), repetitive, driven, and purposeless motor behavior that interferes with daily living and may be self-injurious (stereotypic movement disorder), or sudden, rapid, recurrent, nonrhythmic motor movement or vocalization (tic disorder).

Neurological conditions can also affect movement. The most common of these in childhood is cerebral palsy, which impacts the ability to move and maintain balance and posture (National Institutes of Health, 2016a). Physical symptoms are also seen in neurodegenerative disorders (e.g. issues with balance and movement), muscular
dystrophy (e.g. muscle weakness and muscle loss), and TBI (e.g. dizziness, weakness or numbness in the arms and legs) (National Institutes of Health, 2016b, 2016c, 2016d). As with other disabilities, the exact manifestation of a physical disability varies across individuals. Severity, age of onset, characteristics, and comorbidity with other disabilities can range greatly.

With so many disorders including a physical correlate, it is difficult to determine an overall prevalence rate in the general population. Within the deaf population, the Gallaudet Research Institute (2011) utilizes the term orthopedic impairment but does not provide specific diagnostic criteria. Nationwide, 4.4% of deaf students are identified as having an orthopedic impairment while 0.3% are identified as having a TBI, though there is no indication of the presence or severity of a physical component to these injuries (Gallaudet Research Institute, 2011).

Research on the comorbidity of deafness and physical disabilities is far sparser than that of deafness and ID, SLD, or ASD. Often, physical disabilities are present in individuals who are severely multiply involved, such that cognitive, motor, social, and sensory development are all impacted. Significant research has been performed on individuals labeled as severely handicapped, multi handicapped, and profoundly disabled among other terms. However, it is difficult to locate research that examines deaf individuals with physical disabilities and no involvement of the cognitive or social systems. In many cases, an overarching genetic, developmental, or physical condition may lead to physical disabilities along with cognitive and social challenges. For example, a TBI can lead to loss of coordination, and weakness and numbness in the legs and arms. Apart from these physical correlates, TBI can also lead to slurred
speech, seizures, trouble with memory or thinking, and increased confusion (National Institute of Neurological Disorders and Stroke, 2012). Physical disabilities interact with deafness (and other conditions) in complex ways.

Physical disabilities can impact a deaf student’s communication, learning, and access to their environment. If a student has impaired movement, the ability to use a signed language clearly will be affected. The movement of the body is an integral part of ASL, used to express pronouns and achieve perspective shift (Wilbur, 2003). For a Deaf student with a physical disability, the challenge of fluent movement in the trunk, shoulders, arms, and fingers can impact the ability to fluently express thoughts, feelings, and ideas. This can be extended to learning as well. The complex relationship between language and learning for Deaf students has been demonstrated. For Deaf students with physical disabilities, these issues persist.

Finally, the severity of the physical disability may impede the student’s opportunity to interact with and access the environment. While the Americans with Disabilities Act of 1990 sets minimum requirements for access to facilities (Department of Justice, 2010), there are many legal exceptions that limit an individual’s access to the environment.

Deaf students with physical disabilities face many unique challenges. While a physical disability may appear along with other cognitive and social deficits, this is not always the case. It is critical to examine the impact of these disabilities for all deaf students with motor involvement.

**Deafblindness**

Of all comorbid conditions, deafblindness is the best documented both in the research literature and in popular culture. Terms including deaf/blind, deaf-blind,
deafblind, and dual sensory disabled are often utilized to emphasize the unique and complex attributes of this dual sensory loss as far more than deafness plus blindness (Knoors & Vervloed, 2003). Federally, the Individuals with Disabilities Education Act defines deaf-blindness as “concomitant hearing and visual impairments, the combination of which causes such severe communication and other developmental and educational needs that they cannot be accommodated in special education programs solely for children with deafness or children with blindness” (U. S. Department of Education, 2004). This combined sensory loss does not indicate that a person is necessarily both profoundly deaf and completely blind. Each sensory loss can occur across a range of severity. However, the term deafblind is used as an umbrella to include those with mild to severe dual sensory loss in order to emphasize their unique living circumstances (Van Dijk, Nelson, Postma, & Van Dijk, 2010). Some deafblind individuals may present with a severe sensory loss in hearing or vision and a milder loss in the other sense. Despite its low incidence, there is great variability in the deafblind population.

The National Child Count of Children and Youth who are Deaf-Blind is a running registry of deafblind children and youth, representing a collaboration between The National Consortium on Deaf-Blindness (NCDB) and every state and territory in the United States (NCDB, 2016). The 2015 count identified 9574 deafblind children and youth from birth through age 21. Of this total, 8470 had additional disabilities, representing 88% of the total deafblind population. Categories of additional disability included orthopedic physical impairments, cognitive impairments, behavioral disorders, complex health care needs, speech language impairments, and other impairments.
These trends are consistent with additional annual reporting (Killoran, 2007). In contrast, the Gallaudet Research Institute’s Annual Survey (2011) identified 1827 deaf youth as having low vision, legal blindness, or Usher syndrome. These numbers show great discrepancy. The National Child Count derives its information from a collaboration between the NCDB and each state or multi-state deaf-blind project (NCDB, 2016). The Annual Survey derives its information primarily from school programs designed to serve deaf and hard-of-hearing youth (Gallaudet Research Institute, 2011). Given the complex nature of deafblindness and the high likelihood of concomitant disabilities, the Gallaudet Annual Survey may be underestimating the number of deafblind children and youth in the United States. In any case, this disability is marked by both its low incidence and high likelihood of additional disabilities.

Hearing and sight are known as distance senses. The auditory system can receive and process auditory input from a relative distance while the visual system does the same thing for visual input; there is no need to be physically close to the input. This differs from touch, taste, and balance, which are known as close senses, and smell, which combines close and distance information. When both distance senses are impacted, a child faces challenges in communication, learning, mobility, and socialization.

Deafblind individuals communicate in a variety of ways. These may include spoken language, signed language, tactile sign language, deafblind fingerspelling, haptics, and finger Braille, among others (Hersh, 2013). Each method has benefits and challenges, and the choice of method may depend on the deafblind individual’s preferences, the communication partner, and other factors. Barriers to communication
and misunderstandings are common for deafblind people. These may in turn lead to frustration, vulnerability, social isolation, and a reduction in functional independence (Hersh, 2013). In addition, deafblind children are at risk for developing limited anticipation skills, curiosity, exploratory play, self-initiated communication, and emotional bonds, as well as increased learned helplessness and self-stimulation (Knoors & Vervloed, 2003).

No matter the mode of communication, a linguistic challenge for deafblind children is the development of symbolic representation. This refers to the understanding that objects have names (Van Dijk, Nelson, Postma, & Van Dijk, 2010). A well-known example is Helen Keller’s blossoming understanding that W-A-T-E-R fingerspelled into her hand referred to something – that is, water being expelled from a pump. Many deafblind children, even those without additional disabilities, struggle to develop symbolic representation. Petroff (1999) found that 50% of a sample of 97 deafblind youth used nonsymbolic communication. This may be impacted by the age of onset and severity of the sensory losses. When both distance senses are compromised, only close senses can be used to manipulate and understand the world.

The education of deafblind children has received considerable research. A well-known approach to instruction, the van Dijk approach, was developed in the 1960’s and is still utilized today. This approach emphasizes the development of attachment bonds between child and caregiver through child-guided activities, direct physical contact and co-movement, imitation, establishment of joint attention, and use of concrete objects of reference to build sequencing knowledge (Van Dijk, Nelson, Postma, & Van Dijk, 2010). Many educational programs for deafblind students also include various assistive
technologies and orientation and mobility training to promote access to information and interaction with the environment (Hersh, 2013).

The education of individuals who are deafblind is an issue that is far more complex than the sum of deaf education and blind education. While there has been considerable research on the compound impact of dual sensory impairment, this has not always translated to meaningful instructional approaches or curricula for the deafblind population.

This section described the characteristics and prevalence of deafness and additional disabilities including intellectual disability, specific learning disorder, autism spectrum disorder, physical disabilities, and deafblindness. The impact of comorbidity on communication, learning, and social-emotional development was explored. The presence of additional special needs plays a major role in the various linguistic and educational approaches utilized with deaf students.

**Educating Deaf Students**

Defining what constitutes an appropriate education for deaf students has sparked considerable debate over many decades. While an in-depth description of this debate is beyond the scope of this paper, it is critical to note that a major divide exists between those promoting placement in a mainstream setting with typically developing hearing peers and those promoting substantially separated placement with other signing Deaf peers. Both are deserving of consideration and every placement decision should be made on an individual basis according to the educational team’s view of what is best for each deaf child. Trends in educational placement are described below, followed by an in-depth examination of best practices for those Deaf learners who are bilingual and utilizing ASL as a primary mode of communication and learning.
Educational Settings for Deaf Students

National influences such as Public Law 94-142’s guarantee of a free, appropriate public education for all children (Lang, 2003) and the improvement of amplification technology such as the cochlear implant (Blamey, 2003) have impacted the educational settings for deaf children.

As shown in Table 2-1 (Gallaudet Research Institute, 2011; Karchmer & Mitchell, 2003; Schildroth, 1988), the demographics regarding student characteristics and school placement have changed over time. The percentage of deaf students being educated in regular education settings alongside their peers has risen from 24.4% in 1986 to 31.7% in 2001 and 57.1% in 2010. Likewise, the percentage of students being educated in special school settings (e.g. state schools, residential schools, special schools) away from the general education classroom dropped from 54% in 1986 to 24.7% in 2001 and 24.3% in 2011. Upward trends can also be observed in the percentage of deaf students within each type of setting who have additional disabilities. In regular education settings, the percentage rose from 20.3% to 29.3% from 1986 to 2001, and in special school settings the percentage rose from 29.9% to 47.7% in the same time frame. These data are impacted by changes in diagnostic criteria and assessment practices for various disabilities.

These data indicate that while deaf children are overall more likely to be educated in the general education classroom today than they were two decades ago, those with additional disabilities are more likely to be educated in a special school setting.
Best Practices for Deaf Bilingual Learners

As described, Deaf bilinguals display both similarities to and differences from hearing bilinguals. Therefore, established best practices for this population will necessarily include approaches for hearing bilingual learners as well as those specific to Deaf bilinguals. Bailes (2001) provides several best practices for Deaf bilingual learners (BP-DBL) through six principles for successfully educating Deaf bilinguals, as shown in Table 1-1.

Below, a discussion of best practices for Deaf bilingual learners is framed by Bailes’ (2001) principles.

Principle 1: Provision of language models in ASL and English

Providing Deaf children with fluent language models in ASL and written and spoken English supports their language and literacy development (Bailes, 2001). Generally, language models should provide input that is comprehensible within meaningful exchanges (Baker, 2006). This means that language instruction should be tailored to a child’s current level of performance and occur in authentic contexts. Specific to Deaf bilinguals, ASL and English should be clearly separated according to the purpose of communication (Knight & Swanwick, 2002), such as the use of ASL for social exchanges with peers and the use of written English to compose a letter. Strategies such as sandwiching, chaining and fingerspelling should be used to associate ASL fingerspelling with words written in English (Padden & Ramsey, 1998) in order to promote literacy development.

Principle 2: ASL as the first and natural language for Deaf children

Recognizing ASL as a natural and accessible first language for Deaf children is a primary part of the bilingual language philosophy for Deaf learners (Bailes, 2001;
Strong, 1995). A primary goal of bilingual education of the Deaf is to promote a positive sense of self and identity (Pribanic, 2006) through the provision of ASL as an accessible first language. Integrating ASL and Deaf culture into students’ lives also supports Freeman and Freeman’s (1998) principles for effective language learning for English as a second language learners by supporting the first language and culture of the student.

**Principle 3: World knowledge as a prerequisite for written English literacy**

Hearing students build world knowledge through their interactions in English at home and bring this substantial knowledge to the task of literacy development (Muter, Hulme, Snowling, & Stevenson, 2004). Many Deaf students do not have this advantage due to the communication mismatch at home (Hamers, 1998). With a dearth of world knowledge, Deaf students are at a disadvantage when it comes to developing English literacy. World knowledge can be promoted by deploying meaningful and powerful instruction (Freeman & Freeman, 1998), such as reading and signing aloud, sharing news, and capitalizing on teachable moments (Bailes, 2001).

**Principle 4: Promoting metalinguistic awareness and knowledge in ASL and English**

Metalinguistic awareness is the ability to think and discuss characteristics and structures of language (Bialystok, 1991). For Deaf bilinguals, metalinguistic awareness can be fostered by encouraging critical analysis of ASL and English (Knight & Swanwick, 2002). For example, students can use ASL to discuss and analyze challenging English grammatical structures. Traditional English literacy activities such as the writing process can be deployed in ASL by videotaping ASL productions (Horn-Marsh & Horn-Marsh, 2009) and using them for classroom discussion and learning.
Principle 5: Valuing approximations in both ASL and English

Deaf children, like hearing children, make language and literacy errors during natural stages in their development. For example, invented spellings of hearing children often rely heavily on graphophonic cues, such as writing skool for school. Errors made by Deaf children often rely on positional graphemic rules and visual similarity, such as writing sahool for school (Padden, 1998). Practitioners working with Deaf children must be aware of error patterns specific to this population.

Principle 6: Involvement of parents in the literacy lives of deaf children

Finally, Bailes (2001) emphasizes the role of parents in encouraging positive literacy outcomes for their Deaf children. Even if a parent is new to ASL, they can support their child’s literacy development by promoting both languages in their child’s environment (Hamers, 1998). One beneficial practice parents can establish is reading with their Deaf child on a regular basis. Schleper (1997) provides fifteen principles for reading to Deaf children based on the behavior of Deaf parents when reading to their Deaf children. For example, parents can adjust sign placement to fit the story and connect concepts in the story to the real world (Schleper, 1997). Parents can support the successful education of their Deaf child by being active members of the literacy development process.

Principles in practice

The six principles described above provide an overview of BP-DBL. An overall theme of these principles is access to language across all settings. For many Deaf children, this may imply the ready accessibility of ASL, spoken English, and written English. A practitioner developing a digital media tool based on BP-DBL would thereby include all modes. For example, a still image of a multimedia version of the popular
childen’s book, *Brown Bear, Brown Bear, What Do You See?* (Martin & Carle, 1967) that includes the text, story illustration, ASL text interpretation, and spoken English narration is provided in Figure 2-3.

This example follows BP-DBL through the use of accessible language modes. However, it is critical to be mindful that Deaf children with additional special needs form a unique population with complex educational and linguistic needs. This multimedia tool may not be appropriate for those learners.

**Learning from Multimedia**

Digital multimedia is a daily part of 21st century life. Children of all abilities are regularly exposed to a variety of multimedia for many different purposes, such as learning and entertainment. From an educational standpoint, it is critical to define multimedia and explore how it can be beneficial for Deaf learners. In addition, a robust discussion regarding current theories of multimedia learning will contribute to this review’s exploration of the question: How do the students in this population learn?

**Defining Multimedia**

Though it goes by many names, such as hypermedia and new media, multimedia can be defined in relatively straightforward terms. Mayer (2014b) defines multimedia as the presentation of words (e.g. spoken or printed text), and pictures (e.g. illustrations, photos, animation or video). It is this combination of elements that underlies multimedia. A picture with a written word, a video with voiceover narration, or an animation with a description are all examples of multimedia according to Mayer’s (2014b) definition. The value of multimedia is in its functional capability to enable particular methods of teaching and learning (Moreno, 2006), many of which are well suited to Deaf learners.
The Potential of Multimedia for Deaf Learners

There is great potential for Deaf learners to take advantage of the characteristics of multimedia to address their unique language and learning needs. As a visual–spatial language with no written form, ASL presents a unique instructional problem. How can a teacher provide materials, independent work, or homework to a student in ASL? This was not possible until the widespread accessibility of multimedia. Without a written form, ASL materials could not be sent home for independent use by students, and most students did not have access to ASL-fluent individuals in their home (Karchmer & Mitchell, 2003). With the technological advances of the last several decades, Deaf students have a vast number of opportunities for ASL enrichment. Tools like Facebook, YouTube, Skype, Glide, video blogs, iMovie, mobile applications, and user-friendly video production software provide Deaf students the opportunity to view and create authentic ASL materials. Additionally, teachers can use these tools to create assignments and homework in ASL that students can access inside and outside of school.

Many empirical studies have examined the implementation of media-based learning tools with deaf students. Multimedia-based tools have shown a significant impact on deaf children’s comprehension (Gentry, Chinn, & Moulton, 2004; Mich, Pianta, & Mana, 2013; Wang & Paul, 2011), time spent in reading activities (Golos & Moses, 2013; Mueller & Hurtig, 2010), vocabulary (Golos & Moses, 2013; Wang & Paul, 2011), writing (Strassman & O’Dell, 2012), and richness of the instructional environment, motivation, interest, and engagement (Wang & Paul, 2011). However, these empirical studies often purposively excluded Deaf children with additional special
needs. This may be due to the challenge of including such an extremely diverse population within the confines of an experimental or quasi-experimental study.

In order to address the question, How do the students in this population learn?, it is important to explore the cognitive elements of multimedia learning within the general population. A strong theoretical foundation can help researchers and practitioners determine how the cognitive structures of Deaf learners and those with additional special needs affect media-based learning.

**Cognitive Foundations of Learning through Multimedia**

The cognitive foundations of learning through multimedia relate to how the human brain takes in information, makes sense of that information, adds to existing knowledge, and creates new knowledge. In the following sections, these cognitive foundations are explored through the concepts of working memory, dual coding theory, cognitive load theory, and the cognitive theory of multimedia learning.

**Working memory**

Working memory deals with how the cognitive system processes stimuli from the environment and transfers that information into long-term storage (Baddeley, 1986). This theory is highly supported empirically and proposes that working memory, where information is processed before moving to long-term storage, has a limited capacity (Miller, 1956). The working memory can hold and process only a limited number of items at one time (Baddeley 1986).

One key feature of the working memory model proposed by Baddeley and Hitch (1974) is its contribution to our understanding of cognitive architecture. These researchers propose that working memory had a primary processor called a central
executive and two subsystems: a verbal system called the phonological loop and a visual system called the visuospatial sketchpad.

The phonological loop is responsible for maintaining and rehearsing verbal information (Wiley, Sanchez, & Jaeger, 2014). This element of working memory plays an important role in vocabulary and language development and learning to read (Baddeley, 1986). The visuospatial sketchpad is responsible for setting up, holding, and manipulating visuospatial images (Wiley, Sanchez, & Jaeger, 2014). Researchers have examined a number of visuospatial skills controlled by this subsystem such as using mental imagery, mental image rotation, and scanning with the mind’s eye (Baddeley, 1990). It is considered a multifaceted system that supports images gained through the perceptual system (i.e., vision) as well as the imagined images generated through mental manipulation (Baddeley, 1990).

The phonological loop and visuospatial sketchpad subsystems work together to process and hold incoming verbal and visual stimuli (e.g., pictures, words, or text). The primary processor, called the central executive, then integrates those elements. The central executive, a controlling attentional system (Baddeley 1990), is involved in coordinating the performance of separate tasks and contributes to selective attention, retrieval from long-term memory, and taking over when either subsystem is overloaded (Wiley, Sanchez, & Jaeger, 2014). One of the primary roles of the central executive is to integrate visual and verbal information into our existing cognitive structures such as established schema.

More recent research (Baddeley, 2000; Henry, 2010) has contributed a new component of working memory: the episodic buffer. Similar to the other subsystems, the
episodic buffer is controlled by the central executive and has a limited capacity (Baddeley, 2000; Henry 2010). However, it differs in that the primary role is integrating information from the different subsystems of working memory to create a unified memory, also known as an episode (Henry, 2010). This is achieved through binding information from the phonological loop, visuospatial sketchpad, and relevant long-term knowledge into a coherent whole (Henry, 2010). Therefore, the episodic buffer serves as an interface that uses a common multidimensional code. This addition has fundamentally changed the working memory model through its emphasis on coordination and the use of a multimodal code (Baddeley, 2000).

Working memory research in special populations has examined what happens when a learner, such as a deaf child, does not have or utilize a phonological loop. Working memory has been a very fruitful area of research in deaf education over the last several decades (Marschark, Lang, & Albertini, 2002). Deaf learners use different encoding strategies than hearing learners. For example, a working memory model for the deaf may include subsystems for articulatory, visual, and sign encoding (Chalifoux, 1991) as well as kinesthetic representations including fingerspelling, sign movement, and lip movement (Conrad, 1970). The challenges in developing an empirically testable working memory model for the deaf relate back to the diversity of the deaf community. The heterogeneity in communication modality, age of onset of deafness, access to spoken language, and other characteristics complicate the development of an experimental sample. It has been suggested that deaf learners can be divided into articulatory and nonarticulatory encoders (Conrad, 1970), though even advanced deaf articulatory encoders may need to supplement with other forms of encoding (Conrad,
1972). Other research has suggested that encoding in working memory for deaf individuals is impacted by modality of the stimulus and early exposure to either spoken or signed language (Hamilton & Holzman, 1989).

Research has shown that deaf learners' working memory is limited when compared with hearing learners. Bellugi, Klima, and Siple (1975) showed that the working memory span for hearing participants was 5.9 items, while the span for deaf participants was 4.9 items. Rudner and Rönnberg (2008) reported the span as 5 ± 1 items for signs and 7 ± 2 items for speech-encoded information. Researchers have theorized that because ASL takes longer to produce than spoken English, Deaf learners have less time for working memory rehearsal than hearing learners (Bellugi, Klima, & Siple, 1975; Rudner & Rönnberg, 2008).

These results have important implications. Deaf individuals do show working memory strengths such as free recall, visuospatial recall, imagery, dual encoding, phonological encoding, and rehearsal, but also many weaknesses such as sequential recall, processing speed, attention, and memory load (Hamilton, 2011). Design of multimedia materials must consider the working memory capacity, functioning, strengths, and weaknesses of Deaf students.

**Dual coding theory**

Dual coding theory (DCT) examines how incoming information is coded in our cognitive systems. DCT is closely related to the working memory model and was first proposed by Paivio in 1971. This theory proposes that we have two distinct coding channels: a verbal linguistic system and a nonverbal image-processing system (Clark & Paivio, 1991). The verbal system contains visual, auditory, articulatory, and modality-specific verbal codes and is generally processed sequentially for spoken languages.
The nonverbal code includes images for shapes, environmental sounds, actions, and sensations related to emotions and nonlinguistic objects and can encode information simultaneously (Clark & Paivio, 1991; Paivio, 2007).

Distinct similarities between DCT and the working memory model in the deployment of multi-channel cognitive systems are apparent. DCT is particularly interesting considering its application to deaf learners. What happens if a learner does not have a channel through the ears or via spoken English? As a visual language, is ASL encoded in the linguistic verbal channel or the nonverbal visual channel? These questions have not been theoretically addressed in the academic literature.

Research has explored the impact of DCT on cognitive structures in hearing bilinguals. The similarities between hearing and deaf bilingual learners warrant an examination of these studies.

Paivio & Desrochers (1980) propose that bilingual hearing learners have a verbal code for each language and a common visual code. For example, an English and French bilingual would have an English verbal code, a French verbal code, and a common visual code. The activation of a code in the first verbal system supports the activation of the parallel code in the second verbal system, but the systems can function independently (Paivio & Desrochers, 1980). The bilingual DCT has been supported empirically on tasks of recall and translation (Paivio & Lambert, 1981) and vocabulary and comprehension (Plass, Chun, Mayer, & Leutner, 1998).

Despite the promising evidence for DCT in the population of hearing bilingual learners, these results should not be generalized to Deaf bilinguals without further empirical inquiry. The language modalities between these populations are
fundamentally different and critically impacted by the coding processes indicated by DCT. Specific empirical investigations that extend DCT into the bilingual Deaf population are recommended.

**Cognitive load theory**

As described, working memory has a limited capacity. What happens when a learner goes over that capacity? That question has driven the development of cognitive load theory, which examines how a limited working memory deals with complex input. This theory has extensive implications for teaching and learning.

Cognitive load theory incorporates the limited capacity of the working memory model (Baddeley, 1986) and the two codes implied by DCT (Clark & Paivio, 1991; Paivio, 2007). Instructionally, cognitive load theory examines how designers can develop materials that take advantage of the dual codes in order to stay within working memory's capacity for processing (Van Merriënboer & Ayres, 2005). This thereby reduces the resources that must be dedicated to cognitively process that material.

Cognitive load theory posits three types of cognitive load: intrinsic, extraneous, and germane (Paas, Renkl, & Sweller, 2003; Van Merriënboer & Ayres, 2005). Intrinsic cognitive load is determined by the material that is being learned (Brünken, Plass, & Leutner, 2003; Paas, Renkl, & Sweller, 2003). Element interactivity refers to the number of elements that require integration in order for the material to be understood and can range from low to high. The specific level of element interactivity of a given instructional material is dependent on the learner using that material (Paas, Renkl, & Sweller, 2003; Van Merriënboer, Kirshner, & Kester, 2003). The level of element interactivity and therefore the intrinsic cognitive load that is demanded by instructional material is based
on the learner’s established schema and understanding of the topic (Van Merriënboer & Ayres, 2005).

Cognitive processes that are not directly needed for learning lead to extraneous cognitive load (Paas, Renkl, & Sweller, 2003; Van Merriënboer & Ayres, 2005). Instructional designers can use methods to reduce extraneous cognitive load by designing materials appropriately. Many empirical studies are concerned with methods that reduce extraneous cognitive load, thereby making cognitive resources available for other kinds of processing (Mayer & Moreno, 2003; Van Merriënboer, Kirshner, & Kester, 2003).

Finally, germane cognitive load is required by directly relevant learning tasks such as schema creation and automation (Paas, Renkl, & Sweller, 2003; Van Merriënboer & Ayres, 2005). Germane cognitive load can be influenced by instructional designers and contributes positively to learning (Paas, Renkl, & Sweller, 2003). When extraneous cognitive load is reduced, cognitive resources can be devoted to processing germane load, which enhances learning.

When the sum of the intrinsic, extraneous, and germane cognitive loads exceeds working memory capacity, learning, or transfer to long-term storage, is not possible. Empirical investigations into these cognitive processes, though challenging in their execution (Brünken, Plass, & Leutner, 2003; Paas, Tuovinen, Tabbers, & Van Gerven, 2003), are numerous (Paas, Renkl, & Sweller, 2003).

A significant amount of research on how individual differences affect cognitive load has been performed when looking at second-language learners. These studies can
inform future empirical studies that focus more specifically on cognitive load theory in populations of learners who are deaf or deaf with additional special needs.

Several types of individual differences have been shown to moderate second-language learning outcomes in multimedia learning. The benefit of elements such as animations (Schnotz & Rasch, 2005) and annotations (Wallen, Plass, & Brünken, 2005) are regulated by visual and verbal learning preferences, and spatial and verbal ability (Plass, Chun, Mayer, & Leutner, 1998). The cognitive resources of low ability learners impact their ability to process and build connections between elements embedded in multimedia resources, and should thereby be an important consideration for designers. High verbal abilities increase second-language vocabulary learning when using multimedia resources that use certain supports, such as single annotations, but not for other supports, such as multiple annotations (Plass, Chun, Mayer, & Leutner, 2003). These same researchers found that high spatial abilities had no impact.

Therefore, while individual difference such as ability can moderate some types of multimedia learning, there are certainly instances when they are not relevant. Indeed, some types of multimedia supports actually show stronger negative learning effects for high-ability learners than for low-ability learners (Atkinson & Renkl, 2007). Known as the expertise reversal effect, this principle applies when a multimedia support is used in conjunction with the prior knowledge of a high-ability learner (Kalyuga, 2014). If a learner already understands a concept but still attends to a multimedia support, cognitive resources are spent unnecessarily on that support, which limits available cognitive resources for germane processing and learning.
There are several lessons from these empirical studies that can be applied to the population of interest in this study. As stated, individual differences can play a role in how multimedia materials should be designed based on the various cognitive loads that are demanded by the materials. However, individual differences do not always interact with materials in an obvious way, as illustrated by the expertise reversal effect. Therefore, designers need to consider not only the instructional material that is being developed, but also the cognitive processing demanded by that material for the intended population.

**Cognitive theory of multimedia learning**

According to the cognitive theory of multimedia learning (CTML), cognitive processing is limited in capacity, active, and occurs through dual channels (Mayer, 2014a). These assumptions are clearly related to the working memory model, DCT, and cognitive load theory. The relationship between these theories can be summarized by stating that CTML is highly concerned with how to design multimedia materials that exploit the dual coding channels to reduce cognitive load and thus increase working memory capacity to allow for effective processing and transfer to long-term storage. CTML examines how multimedia—the combination of verbal and visual information—is integrated during learning and seeks to design multimedia in response to the processes and architecture of human cognitive systems (Mayer, 2014a).

Theoretical and empirical studies have led to a set of principles related to CTML. These principles provide researchers with discrete parameters for functionally examining CTML. Some of these principles include multimedia, temporal and spatial contiguity, modality, verbal redundancy, coherence, personalization, guidance, interactivity, and reflection (Moreno, 2006).
In populations with special needs, many multimedia effects proposed by CTML are exacerbated. As described, deaf learners are functioning with working memory limitations (Bellugi, Klima & Siple, 1975; Rudner & Rönnberg, 2008). Designing materials with CTML in mind is critical to ensure that these learners have the cognitive resources to deal with the instructional input.

Similar to working memory models and cognitive load theory, empirical studies on CTML have highlighted the relevance of individual differences. For example, if stimuli are separated by time or space, the split-attention effect implies that attentional resources are divided (Ayres & Sweller, 2014). Despite support for this effect (Moreno & Mayer, 1999), there is also evidence that individual differences may moderate its presence or strength. Elements including spatial ability (Mayer & Sims, 1994), information coordination ability (Yee, Hunt, & Pellegrino, 1991), expertise (Yeung, Jin, & Sweller, 1998), and experience (Mayer & Gallini, 1990; Yeung, Jin, & Sweller, 1998) are relevant factors. These quantifiable individual differences moderate the application of this CTML principle.

In certain special populations such as English as a second language (ESL) learners, CTML’s influence may parallel the general population. The split attention effect was illustrated by Yeung, Jin, and Sweller (1998) when the integration of stimuli enhanced comprehension for low-ability ESL and English-speaking younger learners while reducing comprehension for high-ability ESL and older English-speaking learners. However, considerably more empirical evidence is required in populations of deaf students, bilingual Deaf students, and those who are Deaf with additional special needs.
These cognitive foundations of multimedia learning are presented to provide a framework for understanding how people learn from multimedia. While there has been extensive research in this area, very little of that research has focused on deaf learners, with even less on Deaf learners, and almost nothing on Deaf learners with special needs. Turning scholarly research into actionable educational change takes a significant amount of time. Practitioners await meaningful investigations into the cognitive foundations of multimedia learning in deaf and Deaf with special needs populations. Meanwhile, a national eye has turned to finding ways to modify curriculum that provides powerful educational opportunities for all learners through universal design for learning.

**Universal Design for Learning**

Universal design for learning (UDL) is a framework that gives practitioners recommendations in providing learners with the opportunity to become expert learners. This section reviews the evolution of UDL and its connection to neuroscience research. Then, the each of the nine UDL guidelines is defined and supported with empirical evidence. Finally, a more specific examination of how UDL has been investigated within deaf populations is provided.

**Evolution of UDL**

UDL was born in the early 1980s out of an initial desire to help individuals with disabilities overcome barriers to learning, and later to eliminating those barriers altogether (Meyer, Rose, & Gordon, 2014). This coincided with an increase in personal computing technology in homes and schools. The time was ripe for meaningful investigations into how to level the playing field in education through the creative use of technology and pedagogy. This prompted the founding of CAST – the Center for Applied Special Technologies – in 1984 in greater Boston, Massachusetts. The initial
mission of CAST was to “develop and apply technologies that would expand learning opportunities for individuals with disabilities” (Rose, Meyer, Strangman, & Rappolt, 2002). Over time, the researchers at CAST reshaped and refined their ideas, which grew into the approach now known as UDL. This term was based off of the concept of universal design in architecture, developed by Ron Mace and defined as “designing all products, buildings, and exterior spaces to be usable by all people to the greatest extent possible” (Mace, Hardie, & Place, 1991, p. 1) and “without the need for adaptation or specialized design” (Center for Universal Design, 2008). CAST reimagined this concept and applied it to learning, adapting the name to become universal design for learning.

According to the refined perspective, barriers are created not by learners but by the curriculum. Technologies need not only be used to provide access to those with disabilities through retrofitting, but to transform the nature of the curriculum itself (Rose, Meyer, Strangman, & Rappolt, 2002). Currently, CAST continues to research, publish, and provide professional development in UDL-based curriculum planning, software development, educational policy, teacher preparation and support, and education research (CAST, 2015). UDL has been recognized on a national level by the National Science Foundation and U. S. Department of Education (Rose, 2012) and in the Every Student Succeeds Act signed by President Barack Obama in 2015 (U. S. Department of Education, 2016).

The current working definition of UDL is a framework to improve and optimize educational practice for all people that 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 reduces barriers in instruction, provides appropriate accommodations, supports, and challenges, and maintains
high achievement expectations for all students. (Meyer, Rose, & Gordon, 2014; U. S. Department of Education, 2008)

Notably, this definition does not target specific students, such as those with disabilities or those who are second language learners. Rather, UDL proposes that barriers can be reduced to create a community of expert learners, or those who are purposeful and motivated, resourceful and knowledgeable, and strategic and goal-directed (Meyer, Rose, & Gordon, 2014).

**UDL and Neural Networks**

The UDL framework is based on neuroscience research that explores the role of the brain in learning. This framework is less concerned with what learners know and more focused on what they do to become expert learners. Expert learners successfully utilize three neural networks in their learning: affective, recognition, and strategic. Successful teachers provide curricula that are designed to eliminate barriers to the use of these networks. Educational professionals can foster activation of these neural networks through the implementation of the UDL guidelines (CAST, 2014), which are outlined around these neural networks and key expert learner characteristics.

Expert learners who are purposeful and motivated are utilizing the affective network. This involves the development of skills such as self-regulation, or “the ability to set motivating goals, to sustain effort toward meeting those goals, and to monitor the balance between internal resources and external demands, seeking help or adjusting one’s own expectations and strategies as needed” (Meyer, Rose, & Gordon, 2014, p. 90). This can be promoted by providing multiple means of engagement, including strategies for self-regulation, collaboration with others, and individual choice.
Expert learners who are resourceful and knowledgeable are utilizing the recognition network. This involves taking in information from the environment, noticing patterns, comprehending that information, and integrating it with previously learned knowledge. This can be promoted by providing multiple means of representation, such as options for how information is presented, use of multiple media, and activation of background knowledge. The recognition network can be strongly supported by the affordances of media-based technologies.

Finally, expert learners who are strategic and goal-directed are utilizing the strategic network. These learners use executive function skills such as goal-setting, application of strategies, and progress monitoring. This can be promoted by providing multiple means of action and expression, including options for multiple media, tools, and technologies.

It should be noted that skills used by expert learners do not always fall exclusively into one network. Often, a skill may be utilized in more than one network. For example, a learner who is setting appropriate goals is using their affective network to engage in self-regulation and using their strategic network to apply executive functions.

Figure 2-4 portrays the relationship between key characteristics of expert learners, neural networks, and UDL principles. In the following section, the UDL guidelines will be explored in depth, including empirical support for each principle.

**UDL Guidelines**

The UDL guidelines are provided in Figure 2-5 in visual form. This visual, known as version 3.0, is the current form published by CAST as they continue to research and refine the guidelines (CAST, 2014). The guidelines are “designed to help educators...”
(novice and expert alike) consider the key sources and types of expected learner variability germane to a particular learning goal and to select or design flexible curricula that help all learners progress towards that goal” (Meyer, Rose, & Gordon, 2014, p. 110).

The guidelines are organized in a purposeful and functional way to allow education professionals to implement them in everyday planning and practice. Moving left to right, each column represents one of the three principles of UDL: provide multiple means of engagement, provide multiple means of representation, and provide multiple means of action and expression. Each principle is then divided into three guidelines. The lowest tier guidelines (recruiting interest, perception, physical action) are the most teacher-centered and are primarily concerned with providing access to material through removing unnecessary barriers to learning. The middle tier guidelines (sustaining effort and persistence; language, mathematical expressions, and symbols; expression and communication) highlight specific strategies for building towards high-level expertise and represent teacher and learner scaffolds. The highest tier guidelines (self-regulation, comprehension, executive functions) represent the learner-centered skills of expert learners (Meyer, Rose, & Gordon, 2014).

**Provide multiple means of engagement**

Providing multiple means of engagement uses the affective network to create purposeful, motivated learners. This is important because motivation is essential to learning (Keller, 2010; Merrill, 2002). The engagement principle proposes three guidelines to support the goal of creating expert learners.

**Providing options for recruiting interest.** The guideline at the lowest tier of Figure 2-5 is focused on teacher-centered actions that can increase access to the
material and remove barriers to learning. This is achieved by individual checkpoints that provide options for recruiting interest by optimizing individual choice and autonomy; optimizing relevance, value, and authenticity; and minimizing threats and distractions (CAST, 2014).

Providing choice to students and recruiting interest has been shown to increase positive attitude toward writing and reading (Flowerday, Schraw, & Stevens, 2004), increase intrinsic interest in schoolwork and preference for challenging school activities (Boggiano, Main, & Katz, 1988), increase self-reported effort toward research (Schuh & Farrell, 2006), increase positive attitude toward mathematics and problem-solving skills (Shyu, 2000), reduce undesirable behavior in students with attention-deficit/hyperactivity disorder (Bennett, Zentall, French, & Giorgetti-Borucki, 2006), and reduce environmental stressors (Mechling, 2005). Teachers can support students in making choices and expanding interests in the classroom. Researchers have also provided specific procedures to support teaching choice-making to students with severe disabilities (Shevin & Klein, 2004).

Providing options for sustaining effort and persistence. The middle tier of the engagement principle (Figure 2-5) is the guideline of providing options for sustaining effort and persistence. This level represents teacher and learner scaffolds that build towards expert learning. This is achieved by individual checkpoints of heightening salience of goals and objectives, varying demands and resources to optimize challenge, fostering collaboration and community, and increasing mastery-oriented feedback (CAST, 2014).
Providing options for sustaining effort has been shown to increase intrinsic interest in schoolwork and preference for challenging school activities (Boggiano, Main, & Katz, 1988), increase self-assessment and skill generalization for struggling writers (Schirmer & Bailey, 2000), increase comprehension of scientific concepts and vocabulary (Marino, Coyne, & Dunn, 2010), increase peer collaboration, and enhance idea development and individual expression (Riddle, 1995). Guthrie and Alao (1997) suggest that teachers who want to increase long-term motivation for reading design activities that utilize conceptual themes, real-world interactions, self-direction, interesting texts, social collaboration, self-expression, cognitive strategy instruction, and curricular coherence. Many beneficial impacts of learning collaboratively with peers have been observed, such as positive peer interactions, camaraderie, helpfulness, engagement, confidence, self-esteem, (Reinking & Watkins, 2000), enhanced reasoning, problem solving, and learning strategy use (Alfassi, 2000).

Providing options for self-regulation. The guideline at the highest tier of Figure 2-5 is focused on the learner-centered skill of self-regulation in expert learners. This is achieved by individual checkpoints of promoting expectations and beliefs that optimize motivation, facilitating personal coping skills and strategies, and developing self-assessment and reflection (CAST, 2014).

Providing options for self-regulation has been shown to improve adaptive behavior of individuals with developmental disabilities (Wehmeyer, Yeager, Bolding, Agran, & Hughes, 2003), motivate learning (Madden, 1997), increase use of self-advocacy strategies (Lancaster, Schumaker, & Deshler, 2002), increase successful use of help-seeking behaviors (Aleven, Stahl, Schworm, Fischer, & Wallace, 2003), increase
self-initiative and perseverance in the face of setbacks (Zimmerman & Tsikalas, 2005), and increase appropriate behaviors in children with ASD (Banda, Matuszny, & Turkan, 2007). Researchers have also noted that skills in self-determination can increase problem-solving and study planning skills in students with ID (Palmer, Wehmeyer, Gipson, & Agran, 2004) and support choice making, problem solving, decision making, independence, and exploration of recreational and leisure activities (Price, Wolensky, & Mulligan, 2002).

**Provide multiple means of representation**

Providing multiple means of representation uses the recognition network to create resourceful, knowledgeable learners. The representation principle proposes three guidelines to support the goal of creating expert learners.

**Providing options for perception.** The guideline at the lowest tier of Figure 2-5 is focused on teacher-centered actions that can increase access to the material and remove barriers to learning. This is achieved by individual checkpoints of offering ways of customizing the display of information and offering alternatives for auditory and visual information (CAST, 2014).

This guideline is supported by ample empirical evidence. Providing options for perception can increase access to materials and eliminate barriers to learning for all learners by increasing word identification and reading fluency (Hughes & Wilkins, 2002), and moderating for learner experience (Kalyuga, Chandler, & Sweller, 2000) and learner ability (Koroghlanian & Klein, 2004). Struggling readers have also benefited from the application of this principle by increasing content-area knowledge and improving oral reading fluency and comprehension (Horney & Anderson-Inman, 1999; Oakley, 2003), increasing reading comprehension skills, word identification, processing speed,
memory recall, and learner-reported success (Montali & Lewandowski, 1996), and accessing and using electronic scaffolds (Horney & Anderson-Inman, 1999).

In deaf learners, providing options for perception has led to increased use of descriptive adjectives in writing (Easterbrooks & Stoner, 2006). Increased enjoyment and interest has been shown for deaf readers (Gentry, Chinn, & Moulton, 2005), those with learning disabilities (Dolan, Hall, Banerjee, Chun, & Strangman, 2005), and those who are considered to be struggling (Oakley, 2003). Finally, options for perception can support learners with ASD by attracting and holding attention, reducing anxiety, making abstract concepts more concrete, and increasing expressive communication (Rao & Gagie, 2006).

Providing options for language, mathematical expressions, and symbols. The middle tier of the representation principle (Figure 2-5) is the guideline of providing options for language, mathematical expressions, and symbols. This level represents teacher and learner scaffolds that can build towards expert learning. This is achieved by individual checkpoints of clarifying vocabulary and symbols; clarifying syntax and structure; supporting decoding of text, mathematical notation, and symbols; promoting understanding across languages; and illustrating through multiple media (CAST, 2014).

Many empirical studies have examined the impact of providing learners with options for language, mathematical expressions, and symbols in the presentation of instructional materials. For typical learners, these options have been shown to moderate for learner ability (Hari Narayanan & Hegarty, 2002; Koroghlanian, & Klein, 2004; Mayer & Sims, 1994), increase vocabulary learning (Nikolova, 2002), increase reading achievement in early elementary grades (Boone & Higgins, 1993), and increase
mathematics achievement and positive attitude about cooperative learning (Weiss, Kramarski, & Talis, 2006).

For second language learners, these options have been shown to increase vocabulary learning (Al-Seghayer, 2001; Dubois & Vial, 2000), increase retention of words and story comprehension (Plass, Chun, Mayer, & Leutner, 1998), increase access and use of embedded resources (Chun, 2001; Proctor, Dalton, & Grisham, 2007) and dynamic visual advance organizers that aid in overall comprehension (Chun & Plass, 1996), and moderate for learner differences (Chun, 2001; Plass, Chun, Mayer, & Leutner, 1998; 2003).

For struggling readers, these options have been shown to increase reading comprehension skills, word identification, processing speed, memory recall, and learner-reported success (Montali & Lewandowski, 1996), increase content-area knowledge, improve oral reading fluency and comprehension, increase access and use of electronic scaffolds (Horney & Anderson-Inman, 1999), and increase reading rate, attention to reading, and sustained time in reading while reducing distractibility, stress and fatigue (Elkind, Cohen, & Murray, 1993; Hecker, Burns, Katz, Elkind, & Elkind, 2002). Finally, deaf readers have benefitted from the provision of language options by showing increased enjoyment and interest (Gentry, Chinn, & Moulton, 2005).

**Providing options for comprehension.** The guideline at the top tier of Figure 2-5 is focused on the learner-centered skill of comprehension in expert learners. This is achieved by individual checkpoints of activating or supplying background knowledge; highlighting patterns, critical features, big ideas, and relationships; guiding information
processing, visualization and manipulation; and maximizing transfer and generalization (CAST, 2014).

Empirical evidence shows that comprehension tools such as concept maps or visual navigation options increase positive attitude toward mathematics and problem-solving (Shyu, 2000), improve navigation and essay production (Puntambekar, Stylianou, & Hubscher, 2003), and support problem-solving skills, coordination of cognitive skills, and information processing (Liu & Bera, 2005) in typical learners.

Options for comprehension allow for the moderation of text structure, access, and level of advisement based on prior knowledge (Shin, Schallert, & Savenye, 1994). In learners with disabilities, these comprehension options improve information retention (Higgins, Boone, & Lovitt, 1996) and reading comprehension of content material, as well as increase independence (Blankenship, Ayres, & Langone, 2005).

**Provide multiple means of action and expression**

Providing multiple means of action and expression uses the strategic network to create strategic, goal-directed learners. This principle proposes three guidelines to support the goal of creating expert learners.

**Providing options for physical action.** As with the other principles, the guideline at the lowest tier of Figure 2-5 is focused on teacher-centered actions that can increase access to material and remove barriers to learning. This is achieved by individual checkpoints of varying the methods for response and navigation, and optimizing access to tools and assistive technologies (CAST, 2014).

There is extensive empirical data to support the use of flexible response, navigation, and assistive technology tools to support students’ academic, communication, vocational, and social-emotional development. In the area of literacy,
students have shown increased accuracy in reading scores (Anderson-Inman, Knox-Quinn, & Horney, 1996), vocabulary acquisition, maintenance, and generalization (Kyhl, Alper, & Sinclair, 1999). Students have shown improved word recognition ability (Raskind & Higgins, 1999), attitude toward reading (Wise et al., 1989), and fluency (Van Daal & van der Leij, 1992). Reading comprehension has also been impacted by the use of assistive technologies (Higgins & Raskind, 1995; 2000; Lange, McPhillips, Mulhern, & Wylie, 2006).

Improvements have also been observed in writing (Goldberg, Russell, & Cook, 2003; Higgins & Raskind, 1995; Zhang, 2000) including spelling accuracy (Dalton, Winbury, & Morocco, 1990; Higgins & Raskind, 2000; MacArthur, 1998; Maki, Vauras, & Vainio, 2002; Van Daal & van der Leij, 1992), grammar usage (Zhang, Brooks, Frields, & Redelfs, 1995), error detection and revision (Graham & MacArthur, 1988; Maki, Vauras, & Vainio, 2002; Raskind & Higgins, 1995), organization and structure (Hetzroni & Shrieber, 2004), and legibility (MacArthur, 1998).

Providing options for physical action has also led to greater student satisfaction (Dalton, Winbury, & Morocco, 1990), confidence (Graham & MacArthur, 1988), better attitude (Maki, Vauras, & Vainio, 2002), participation in collaborative learning, engagement, and motivation (Goldberg, Russell, & Cook, 2003). Students learned, applied, generalized and maintained new study strategies (Anderson-Inman, Knox-Quinn, & Szymanski, 1999), improved retention abilities (Higgins, Boone, & Lovitt, 1996), and decreased reliance on prompts (Davies, Stock, & Wehmeyer, 2002b). In mathematics, students demonstrated increased accuracy on multiplication performance (Irish, 2002).
Impact on language and communication has also been shown empirically when students are provided with options for physical action through the use of assistive technology tools. For example, students have displayed an increase in the number and quality of interactions (Glaser, Rieth, & Kinzer, 1999) including initiations of requests (Dicarlo & Banajee, 2000) and conversation participation (Dattilo & Camarata, 1991).

When given options for physical action, students working on transition and life skills increased initiation (Epstein, Willis, Conners, & Johnson, 2001) and independence in completing school tasks (Davies, Stock, & Wehmeyer, 2001; 2002a) and community travel (Lancioni & Bracalente, 1998). They also increased skills in community-based literacy (Mechling & Gast, 2003) and mathematics (Ayres & Langone, 2002), as well as making informed choices regarding their own leisure time (Dattilo, Guerin, & Cory, 2001). Critically for this population, they acquired self-advocacy knowledge and skills (Lancaster, Schumaker, & Deshler, 2002), enhanced their self-determination (Davies, Stock, & Wehmeyer, 2001), and expressed satisfaction (Dattilo, Guerin, & Cory, 2001; Davies, Stock, & Wehmeyer, 2002a; Lancaster, Schumaker, & Deshler, 2002).

Regarding attitude and behavior, students given options for physical action showed improvements in self-efficacy (Ferretti, MacArthur, & Okolo, 2001; Okolo & Ferretti, 1996), persistence (Okolo, 1992), attitude toward cooperative learning, and motivation to learn (Davies, Stock, & Wehmeyer, 2002b; Okolo & Ferretti, 1996; 1998). Increases in appropriate social behaviors (Hutinger, Johanson, & Stoneburner, 1996) and decreases in inappropriate social behaviors (Embregts, 2002; 2003) have also been observed.
This evidence shows both that providing options for physical action is strongly supported empirically and that the implementation draws significant interest from researchers. As the lowest tier of the UDL guidelines, options for physical action are relatively easy to manipulate in a learning environment and within an empirical study. Certain assistive technologies, such as a speech-to-text or navigational assistance, can be systematically included or excluded in learning materials. Their educational benefit has been illustrated within the research literature.

**Providing options for expression and communication.** The middle tier of the action and expression principle (Figure 2-5) is the guideline of providing options for expression and communication. This level represents teacher and learner scaffolds that can build towards expert learners. This is achieved by individual checkpoints of using multiple media for communication, using multiple tools for construction and composition, and building fluencies with graduated levels of support for practice and performance (CAST, 2014). This is of particular relevance when considering the population of Deaf learners who use ASL.

When provided with options for expression and communication, students engaged in reading tasks displayed improved reading vocabulary (Jones et al., 2004) and comprehension (Dalton, Pisha, Eagleton, Coyne, & Deysher, 2002; Ligas, 2002; Reinking, 1988; Solan, Shelley-Tremblay, Ficarra, Silverman, & Larson, 2003; Vollands, Topping, & Evans, 1999). Struggling readers and spellers developed basic literacy skills (Fasting & Lyster, 2005) including word acquisition (Xin & Reith, 2001), text recall (Henao, 2002), and oral reading accuracy (Vollands, Topping, & Evans, 1999). In writing tasks, students displayed greater volume and linguistic complexity in writing
(Vincent, 2001) as well as fewer spelling mistakes, reading errors, and a higher overall quality of organization and structure (Hetzroni & Shrieber, 2004). Deaf learners also displayed an increased use of descriptive adjectives in writing (Easterbrooks & Stoner, 2006).

The provision of options for expression and communication has also been shown to impact learning in mathematics and science. This includes the increased ability to communicate understanding of mathematics concepts (Wilson, 1999), an increase in science concept learning and knowledge (Leu et al., 2005; Liu, 2004), as well as the independent application of literacy strategies to science texts (Reinking & Rickman, 1990).

When given options for expression and communication, students displayed more desirable learning behaviors such as increased time on task (Dalton, Pisha, Eagleton, Coyne, & Deysher, 2002), attention (Solan, Shelley-Tremblay, Ficarra, Silverman, & Larson, 2003), motivation (Kramarski & Feldman, 2000), retention (Higgins, Boone, & Lovitt, 1996), and persistence (Morse, 2003).

**Providing options for executive functions.** The guideline at the top tier of Figure 2-5 is focused on learner-centered executive functions skills in expert learners. This is achieved by individual checkpoints of guiding appropriate goal-setting, supporting planning and strategy development, and enhancing capacity for monitoring progress (CAST, 2014).

Providing options for executive functions has been shown to support learners empirically. For example, strategy instruction positively impacted the acquisition and retention of skills in the essay writing process (Graham, MacArthur, Schwartz, & Page-
Voth, 1992) and led to lasting improvements in story completeness, length, and quality (Lane et al., 2008). Notably, the provision of individualized supports for learners with SLD led to greater quantity and quality (Englert, Manalo, & Zhao, 2004) and organization of writing (Englert, Wu, & Zhao, 2005).

In other content areas, setting goals in mathematics promoted computation skills, motivation, and self-efficacy (Schunk, 1985) while use of strategy instruction supported a deeper understanding of conceptual relationships in science texts (Puntambekar & Goldstein, 2007).

Taken together, these nine guidelines comprise a set of recommendations on how, according to UDL, to create expert learners. The next two sections explore related areas: the use of UDL with deaf learners, and the similarities and differences between UDL and differentiated instruction.

**UDL and Deaf Learners**

The application of the UDL guidelines has led to a wide range of benefits to many types of students across educational, communicative, and social-emotional domains. Empirical studies have also examined elements of the UDL guidelines with deaf learners and outlined benefits to this population. It is noteworthy that the majority of these studies have reported benefits in the development of resourceful, knowledgeable learners by providing multiple means of representation. These studies primarily looked at curricular modifications that involved providing options for perception, and more specifically, offering alternatives for auditory information (Dalton, Schleper, Kennedy, Lutz, & Strangman, 2005; Easterbrooks, 1999; Easterbrooks & Stoner, 2006; Gentry, Chinn, & Moulton, 2005; Jensema, Danturthi, & Burch, 2000; Jensema & El Sharkawy, 2000; Marschark, 2006; Nugent, 1983; Scherer, 2005; Thorn & Thorn, 1996; Vesel,
These studies investigated how offering options for auditory information can impact a learner's ability to represent information and therefore become resourceful and knowledgeable. Several other studies looked at the representation principle by examining the provision of options for language, mathematical expressions, and symbols. For example, Friedmann and Szterman (2006) and Yoshinaga-Itano and Downey (1996) examined how clarifying syntax and structure impacts deaf learners. Mayer and Akamatsu (2003) examined how understanding can be promoted across languages, and Gentry, Chinn, and Moulton (2005) looked at how information can be illustrated through multiple media.

As stated, the UDL guidelines are not exclusive: there can be crossover between the categories. For example, the representation checkpoint of illustrating through multiple media shares many features with the action and expression checkpoint of using multiple media for communication. However, it is also clear from this review of the literature that the majority of empirical investigations within deaf populations have strongly focused on the representation principle. Even with the impact of category crossover, there is a lack of data on the implementation of the engagement, and action and expression principles of UDL. Critically, these investigations into the use of UDL with deaf learners have generally excluded those with additional disabilities. This creates gaps in knowledge regarding the use of all principles of UDL, particularly for deaf students with special needs.

**UDL and Differentiated Instruction**

As described, UDL is a framework for reducing barriers within curriculum in order to create expert learners. A related concept that has also received a great deal of scholarly and popular attention is differentiated instruction (DI). UDL and DI are not
mutually exclusive: there are many similarities between these constructs and the outcomes they seek for students of all abilities. However, there are fundamental differences between UDL and DI as well that are worthy of examination in this review. First, the foundation of DI is described below.

The DI model proposes that the needs of students should inform the varied and adaptable approaches used in instruction. DI is a compilation of many theories and practices (Hall, Strangman, & Meyer, 2011) and is an innovative way of thinking about teaching and learning rather than a single instructional strategy (Subban, 2006). At its core, DI emphasizes students (Stanford & Reeves, 2009) through varied response to students’ readiness, interest, and learning profile (Tomlinson, 2001). This varied response, or differentiation, can occur at the content, process, or product levels. Content differentiation relates to input, and occurs when teachers vary what is taught and how students access that information. Process differentiation involves giving students varied opportunities for sense-making activities that allow them to attain more complex understandings of ideas and information. Finally, product differentiation relates to output, and allows students a range of ways to show what they know, in other words, to represent their knowledge (Tomlinson, 2001). This differentiation is not performed with the goal of providing completely individualized instruction. Rather, DI advises teachers to make proactive, student-centered responses to the varied needs of their learners.

There are many similarities between the DI and UDL constructs. Both seek to challenge the full range of students in the classroom (Hall, Strangman, & Meyer, 2011), see the value of social and collaborative learning (Subban, 2006), and recognize the
diversity of unique (according to DI) or variable (according to UDL) learners (CAST, 2013). Both emphasize the importance of setting clear goals, performing ongoing assessment (CAST, 2013), providing continuous and consistent teacher professional development, and eliciting whole-school support structures and cooperative teamwork (Subban, 2006). DI and UDL are both concerned with providing instruction that meets the needs of diverse learners. However, how each goes about accomplishing that is different.

The primary difference between DI and UDL is related to timing. Figure 2-6 and Figure 2-7 show the relationship between curriculum and instructional approaches across three unique students under both the DI and UDL umbrellas. As shown in Figure 2-6, DI begins with a single curriculum brought to three unique students. A teacher then performs the complex task of differentiating instruction by content, process, and product. This results in three distinct instructional approaches for the students, each framed by the curriculum. In contrast, UDL begins with the students in mind, as shown in Figure 2-7. The variability of learners guides the reduction of the curriculum's barriers through the provision of multiple means of engagement, representation, and action and expression. Similar to DI, this also results in three distinct instructional approaches for the students, each framed by the curriculum. Figure 2-6 and Figure 2-7 aim to clarify that while DI emphasizes responding to individual needs, UDL emphasizes the proactive design of the curriculum (CAST, 2013). In UDL, the curriculum is developed with student variability in mind, while in DI, the curriculum is differentiated based on students' readiness, interest, and learning profile. The goal of each construct is the
provision of instruction that meets the needs of diverse learners. However, the path to reaching that goal differs between DI and UDL.

This section of the literature review has addressed the critical question, How do the students in this population learn? This has involved examining the education of deaf students including settings and best practices, how individuals learn from multimedia, and how barriers to learning can be reduced or eliminated through UDL. A critical gap has been identified in empirical evidence of the foundations of multimedia learning in populations of learners who are Deaf and Deaf with additional special needs. Another gap has been illustrated in the application of the engagement, and action and expression principles of the UDL framework. This study seeks to examine these gaps by providing structured professional development in UDL to teachers at a school for bilingual Deaf students with special needs. Therefore, it is important to explore professional development as a construct and define how it can help address the question, How do practitioners learn in a professional context?

**Professional Development**

Professional development (PD) is an important element through which educational professionals work to improve practice and increase positive student outcomes. In many cases, PD is established and encouraged by school administrators and targeted to teachers and other personnel. Across many settings, PD plays a critical role in influencing a variety of outcomes. In this review, PD is the vehicle through which the question, How do practitioners learn in a professional context? is addressed.

The importance of PD is illustrated by the fact that the continuing development and learning of educational personnel has been noted as “one of the keys to improving the quality of U. S. schools” (Desimone, 2009, p. 181). This may involve improving
student achievement (Desimone, Smith, Hayes, & Frisvold, 2005), ensuring the effectiveness of policies for teachers and teaching practice (Desimone, Smith, & Frisvold, 2007), and educational reform (Garet, Porter, Desimone, Birman, & Yoon, 2001). Given these lofty goals, substantial resources – including federal monies – are devoted to PD every year (Desimone, 2009).

Despite the acknowledged role of PD and the financial support it receives, PD must be designed to meet the needs of teachers, staff, and students in order to be successful. Therefore, it is important to present a definition of PD as well as illustrate those critical features that make PD successful. In addition, PD models relevant to this study will be reviewed, including professional learning communities (PLCs) and the professional teaching and learning cycle (PTLC).

**Defining Professional Development**

As with several other constructs reviewed in this study, a concise and mutually agreed-upon definition of PD does not exist. Teacher learning can occur formally or informally, discretely or continuously, and embedded in or separated from educational contexts (Desimone, 2009). Many teachers may in fact derive great benefit and learning from activities outside of formal PD, such as mentoring relationships. However, it is both important and possible to build a picture of PD by examining critical shared features identified throughout the literature.

Little (1987) defined PD as “any activity that is intended partly or primarily to prepare paid staff members for improved performance in present or future roles in the school districts” (p. 491). This may involve a traditional PD opportunity such as a workshop. A workshop is a structured and scheduled approach to providing PD that typically occurs outside of the classroom and is moderated by a leader with specialized
expertise (Garet, Porter, Desimone, Birman, & Yoon, 2001). Little’s (1987) definition would also include informal activities such as teacher communities that foster growth and development (Desimone, 2009). In addition, reflection on one’s own practice through self-examination can be a powerful teacher learning experience (Putnam & Borko, 2000).

While a single concise definition of PD is difficult to determine, the literature has highlighted features that contribute to a working understanding of what successful PD is and how that definition shapes the way it is investigated.

**Critical Features of Professional Development**

While PD can be defined and structured in a variety of ways, a significant amount of research has focused on determining what features are shared across successful teacher learning opportunities. Five critical features identified in this review include content focus, active learning, coherence, duration, and collective partnership.

**Content focus**

The array of possible topics that can be considered PD is vast. There is evidence, however, that changing teacher practice is most successful when PD is focused on subject matter content, and how children learn (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001) and think (Whitcomb, Borko, & Liston, 2009). This dual focus has positive effects on student achievement outcomes such as conceptual understanding (Kennedy, 1998) and has been shown to increase teacher knowledge and skills and improve teacher practice (Desimone, 2009). Teachers also report a desire to engage with content-focused PD, noting they are “hungry for continuing education that provides novel ways to address content” (Rhine, 1998, p. 27). Wei, Darling-Hammond, Andree, Richardson, and Orphanos (2009) noted that the most
useful forms of PD focus on concrete activities such as teaching, observation, and assessment, including elements such as “how to elicit and interpret students’ ideas, examine student work, and use what they learn about students’ ideas and work to inform their instructional decisions and actions” (Whitcomb, Borko, & Liston, 2009, p. 209). These reported benefits of content-focused PD were developed through the examination of a variety of sources including case-study data, correlational analyses, quasi-experimental studies, longitudinal studies, meta-analyses, and experimental designs (Desimone, 2009).

**Active learning**

Effective PD involves active learning, which means being actively involved in meaningful discussion, planning, and practice (Garet, Porter, Desimone, Birman, & Yoon, 2001). Some examples of active learning activities for teachers include observation, both of and by expert teachers in the classroom (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001), interactive feedback and discussion (Desimone, 2009), and exploring curriculum and teaching materials for inclusion in classroom practice (Garet, Porter, Desimone, Birman, & Yoon, 2001).

Another example of an active learning activity for teachers is examining students’ work. By engaging in this activity, teachers can learn to design lessons at an appropriate level of complexity, as well as identify students’ areas of struggle. This may in turn inform teachers’ understanding of students’ reasoning and cognitive strategies (Garet, Porter, Desimone, Birman, & Yoon, 2001).

**Coherence**

Coherence is defined as “the extent to which teacher learning is consistent with teachers’ knowledge and beliefs” (Desimone, 2009, p. 184). This implies that PD
content and form must be contextualized in order to be effective. Authenticity is emphasized as an important element for learners (Freeman & Freeman, 1998), and this applies not only to students but also to teachers as learners. Teachers’ own classrooms are an authentic learning environment and provide a powerful context for their learning (Putnam & Borko, 2000). Coherent PD aligned to teachers’ regular practices and performance expectations will be more effective (Garet, Porter, Desimone, Birman, & Yoon, 2001). Examples of coherent PD include keeping records of classroom practice, which can facilitate teacher change by giving teachers the opportunity to “examine one another’s instructional strategies and student learning, and to discuss ideas for improvement” (Borko, 2004, p. 7). By contextualizing PD within the classroom environment, teachers are more likely to make authentic and sustained changes (Garet, Porter, Desimone, Birman, & Yoon, 2001).

**Duration**

While there is no single unit of time that is considered appropriate, the literature suggests that PD must be sustained over time in order to be effective (Garet, Porter, Desimone, Birman, & Yoon, 2001). While quantifications of this concept differ from context to context, some researchers (Desimone, 2009) suggest that PD activities include a minimum of 20 contact hours. This includes the span of time (e.g. over the course of a full school year) and length of time (e.g. several uninterrupted hours). Increasing the duration of PD encourages “in-depth discussion of content, student conceptions and misconceptions, and pedagogical strategies,” and allows teachers “to try out new practices in the classroom and obtain feedback on their teaching” (Garet, Porter, Desimone, Birman, & Yoon, 2001, pp. 921-922). This in turn leads to greater intellectual and pedagogical change (Desimone, 2009).
Collective partnerships

A final critical feature of effective PD is the inclusion of collective partnerships. Collective partnerships are established through PD participation by individuals from the same school, grade, or department (Desimone, 2009). By participating in collective partnerships, teachers can engage in discussion, improve their understandings, and increase their capacity to grow (Ball, 1996). Discussions within collective partnerships can be important contributors to teacher success. When facing a challenging issue, whether it be related to curriculum choices, classroom management, or instructional strategies, collective partnerships allow teachers to encourage one another and share possible solutions (Garet, Porter, Desimone, Birman, & Yoon, 2001). In addition, PD intended for collective partnerships has a number of advantages for designers. Participants may share materials, resources, requirements, and experiences (Garet, Porter, Desimone, Birman, & Yoon, 2001) that are unique to their educational context. Some teachers may even share the same students. Collective partnerships are one way to promote sustained changes in practice (Garet, Porter, Desimone, Birman, & Yoon, 2001) and powerful teacher learning (Desimone, 2009). Collective partnerships may also impact changes on an organizational level by contributing to school reform (Borko, 2004).

Professional Learning Communities

One model that incorporates the critical features of effective PD is the professional learning community (PLC). A PLC is an environment for educators that fosters mutual cooperation, emotional support, and personal growth as they work together to achieve what they cannot accomplish alone (DuFour & Eaker, 1998). Stoll, Bolam, McMahon, Wallace, and Thomas (2006) define a PLC as “a group of people
sharing and critically interrogating their practice in an ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way” (p. 223) while Hord (1997) notes that teachers and administrators “continuously seek and share learning, and act on their learning” (p. 1). Beyond teacher sharing, Seashore, Anderson and Riedel (2003) emphasize the establishment of a “school-wide culture that makes collaboration expected, inclusive, genuine, ongoing, and focused on critically examining practice to improve student outcomes” (p. 3). While these definitions vary, they share the view that PLCs are a powerful way to enact authentic and meaningful change. The ultimate purpose of a PLC is to provide benefits to students (Hord, 1997; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006).

One particular component of a PLC is deserving of an in-depth investigation: community. This review has provided background on the critical features of effective professional learning in PD, but PLCs place this in the context of a community. This is relevant given the specific affordances of learning within a community.

Learning in a community is different than learning individually. Communities emphasize the development of mutually supportive relationships, shared norms and values (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006), and shared professional culture (Garet, Porter, Desimone, Birman, & Yoon, 2001). This is a parallel to Westheimer's (1999) five common features of a community: shared beliefs, interaction and participation, interdependence, concern for individual and minority views, and meaningful relationships.

Establishing teacher communities that encourage collaboration to reinvent practice and share professional growth (Little, 1999) can be difficult and time-consuming
(Borko, 2004). However, Whitcomb, Borko, and Liston (2009) note that teachers in such a community are "more likely to take risks and engage in challenging discussions that push them to deepen understanding and attempt new practices that will reach more learners" (p. 210). There are many elements involved in forming an effective learning community. These include the development of a group identity and norms for interaction, the formulation of a sense of communal responsibility for the regulation of norms and behavior, and the willingness of community members to assume responsibility for colleagues’ growth and development (Grossman, Wineburg, & Woolworth, 2001).

**Benefits of PLCs**

Given their alignment with the critical features of effective PD, PLCs are an ideal model for increasing the success of teacher learning. The benefits of a well-established and run PLC include teacher learning, instructional improvement, (Andrews & Lewis, 2007; Desimone, 2009), self-inquiry and reflection (Whitcomb, Borko & Liston, 2009), student achievement gains, and reduction in feelings of isolation (Hord & Sommers, 2008; Louis & Marks, 1998). Organizational gains are noted as well. Stoll, Bolam, McMahon, Wallace, and Thomas (2006) identified the potential of PLCs to develop capacity, defined as “a complex blend of motivation, skill, positive learning, organizational conditions and culture, and infrastructure of support” (p. 221), to enact educational reform and promote student learning. Other benefits of PLCs identified in the literature include increased classroom motivation, work satisfaction, and collective responsibility for student learning (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). The benefits of effective PLCs are well illustrated in the literature.
Characteristics of PLCs

In the same way that critical features of effective PD have been illuminated by the literature, successful PLCs also display a set of common characteristics. DuFour and Eaker (1998) identified six characteristics of the PLC model: shared mission, vision, and values; collective inquiry; collaborative teams; action orientation and experimentation; continuous improvement; and results orientation. As described below, other researchers have corroborated many of these features and proposed several others.

While DuFour and Eaker (1998) use the phrase “shared mission, vision, and values” (p. 5), Stoll, Bolam, McMahon, Wallace, and Thomas (2006) use the phrase “shared values and vision” (p. 226) and Hord and Sommers (2008) identify “shared beliefs, values and vision” (p. 8) as an important characteristic of PLCs. Taken together, the primary elements of this characteristic include a consistent focus on student and staff learning, shared decision making, and "a collective commitment to guiding principles that articulate what the people in the school believe and what they seek to create" (DuFour & Eaker, 1998, p. 25) throughout all levels of leadership in the school.

In parallel to DuFour and Eaker’s (1998) collective inquiry, Stoll, Bolam, McMahon, Wallace, and Thomas (2006) identify “reflective professional inquiry” (p. 226) while Hord and Sommers (2008) use the phrase “collective learning and its application” (p. 12). While slight differences exist, the primary elements of this characteristic are an endless desire for improving practice through shared dialogue and the search for new ideas and methods. This may take the form of reflective dialogue, observation and analysis of practice, joint planning and curriculum development, and mutual problem solving (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). Collective inquiry “enables
team members to develop new skills and capabilities, which in turn lead to new experiences and awareness” (DuFour & Eaker, 1998, p. 26).

DuFour and Eaker (1998) identify collaborative teams as an important characteristic of PLCs. Stoll, Bolam, McMahon, Wallace, and Thomas (2006) describe collaboration, while Hord and Sommers’ (2008) “collective learning and its application” (p. 12) also relates back to collaboration in teams. The role and benefit of collaboration, community, and community building has already been described in this review. DuFour and Eaker’s (1998) use of the term also refers to the structure of a PLC in that a school using the PLC model is made up of collaborative teams. These are often referred to as collaborative learning teams.

Collaborative learning in teams has many reported benefits including increased teacher confidence, enthusiasm, commitment, willingness to try new things, and enhanced student motivation and performance (Cordingley, Bell, Rundell, & Evans, 2003). Supporting effective collaboration on a team may involve providing participants the freedom and flexibility to identify their own focus, support from peers rather than supervisors, and resources for professional growth (Cordingley, Bell, Rundell, & Evans, 2003). Establishing respect and trust between collaborative learning team members, administrators, and other key stakeholders is an essential part of effective collaboration within a PLC (Whitcomb, Borko, & Liston, 2009).

Another characteristic of PLCs identified by DuFour and Eaker (1998) is an action orientation and experimentation. This involves a willingness to take action and try new strategies and methods. In a strong PLC, a teacher action that does not produce intended results is not considered a failure. Rather, it is a critical part of the learning
process. Related to this characteristic is Stoll, Bolam, McMahon, Wallace, and Thomas’ (2006) idea of collective responsibility, in which commitment is sustained by accountability to one’s peers. An action orientation demands participation and collective responsibility to authentic change.

DuFour and Eaker (1998) identify continuous improvement as a key characteristic of an effective PLC. These authors highlight a consistent dedication to the use of innovation and experimentation as opportunities for improvement. While the term “continuous improvement” is unique to DuFour and Eaker's (1998) set of characteristics, Bolam et al. (2005) note that PLCs are “fluid, rather than fixed, entities, perennially evolving with accumulating collective experience” (p. 9). From this perspective, a PLC is never done; there is always the opportunity to identify an area for improvement.

The final characteristic identified by DuFour and Eaker (1998) is a results orientation. This relates back to the first characteristic of a shared mission and vision such that individuals in a PLC work collaboratively to achieve results consistent with the vision they share. A results orientation also implies that there must be assessment of the activities within a PLC.

Several characteristics have been identified outside of DuFour and Eaker’s (1998) six key components. For example, Hord and Sommers (2008) note the importance of supportive conditions. Many of these relate to the need to provide the time, space, and resources for PLCs to occur. Members must feel a sense of mutual trust, respect, and support (Bolam et al., 2005; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006).
In addition, Hord and Sommers (2008) identify shared and supportive leadership as a key characteristic of PLCs. This method of leadership, rather than a supervisory approach, is critical and therefore deserving of more in-depth examination.

**Leadership**

Establishing an effective PLC relies on more than staff participation within a specific structure. Successful leadership is an integral component of a PLC. Particularly when moving to a PLC model for the first time, significant individual and organizational change is required. This type of change depends on establishing a supportive culture of reform (Knapp, 1997). An effective leader can promote this by establishing trust, respect for every individual, and open and critical communication (Borko, 2004) between administration, teachers, staff, and stakeholders (Stoll, Bolam, McMahon, Wallace, & Thomas, 2006). Leadership in a PLC is exemplified by four critical roles defined by Stoll, Bolam, McMahon, Wallace, and Thomas (2006): creating a learning culture, ensuring learning at all levels, providing enquiry-minded leadership, and maintaining the human side of leadership. These authors note that these roles are influential in ensuring individual and organizational readiness for change, fostering and sustaining effective learning, facilitating growth, promoting reflective enquiry and evaluation, and using emotional intelligence effectively. McLaughlin and Talbert (2001) state that

> principals set conditions for teacher community by the ways in which they manage school resources, relate to teachers and students, support or inhibit social interaction and leadership in the faculty, respond to the broader policy context, and bring resources into the school. (p. 98)

As illustrated, leadership within a PLC is a critical way to ensure that effective PD practices can be established that lead to authentic change and pedagogical development.
Professional Teaching and Learning Cycle

In a PLC, teachers and staff work collaboratively to examine practice and achieve stated goals. One approach to accomplishing this is through the professional teaching and learning cycle (PTLC). The PTLC, developed by the Southwest Educational Development Library (SEDL), is a “vehicle for teacher collaboration and sharing, and the process improves alignment of curriculum, instruction, and assessment” (SEDL, 2008, p. 1). As a six-step job-embedded cycle, the PTLC provides structure to a collaborative learning team that reflects the ideal characteristics of a PLC, including collective inquiry, action orientation and experimentation, and continuous improvement (DuFour & Eaker, 1998).

Tobia (2007) notes that the PTLC was developed to give teachers an opportunity to collaborate on standards-based instructional methods. For example, teachers struggling to teach a specific mathematical skill outlined in a learning standard would move through the PTLC to gain a better understanding of the standard and how it could be addressed. While collaboration on standards-based instructional methods is outside the scope of this study, the PTLC still provides a structure that can benefit individuals participating in PD within the context of a PLC.

The six steps of the PTLC are Study, Select, Plan, Implement, Analyze, and Adjust (SEDL, 2008). During the Study stage, individuals work in collaborative teams to critically examine and discuss learning expectations and practice. At the Select stage, collaborative teams perform research, determine learning goals, select instructional strategies, and locate resources for enhancing learning. During the Plan stage, teams develop lessons incorporating the selected strategies and resources. During the Implement stage, lessons and self-reflection are carried out. At the Analyze stage,
collaborative teams reconvene to determine the success of the selected strategies and materials in meeting the learning goals. Finally, during the Adjust stage, collaborative teams reflect on the overall process and determine alternative strategies or modifications to the lesson that are more likely to promote student learning. The use of a cycle allows for frequent, repeated analysis and revision.

As described, leadership is a critical component to an effective PLC model. This extends to the facilitation of the PTLC model as well. A facilitator can support the PTLC by communicating clear expectations, building the capacity of those who need support, and monitoring and reviewing the implementation and impact (SEDL, 2008). Engaging in these leadership tasks aligns with several of the critical leadership roles defined by Stoll, Bolam, McMahon, Wallace, and Thomas (2006), including creating a learning culture, ensuring learning at all levels, and providing enquiry-minded leadership.

This section of the literature review explored the question, How do practitioners learn in a professional context? This has involved the examination of elements of teacher learning such as the definition and critical features of PD, PLCs, the PTLC, and the roles of community and leadership.

**Conceptual Framework**

The conceptual framework guiding this study was developed to show the relationship between the problem of practice, foundational research, and research questions. It brings together the concepts reviewed here, such as the exploration of the questions, Who are the students in this population? How do the students in this population learn? and How do practitioners learn in a professional context? I reframed that information into a conceptual framework that guided the study moving forward.
Figure 2-8 displays the conceptual framework in a visual form. The overarching problem of practice is described in the orange horizontal bar while the research questions are posed in the purple bar. As shown by the green bar, teachers will move from left to right through one iteration of the PTLC by participating in PD activities shown in the red bar. An in-depth description of how this conceptual framework informs methodology is described in Chapter 3.

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<tr>
<th>Table 2-1. Educational settings for deaf students</th>
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<td>In regular education settings</td>
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<td>In special school settings</td>
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<td>With additional disabilities in regular education settings</td>
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<td>With additional disabilities in special school settings</td>
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Figure 2-1. Visual organization of literature review
Figure 2-2. Comparing Deaf and hearing bilinguals (Baker, 2006; Bialystok, 1991; Grosjean, 1998, 2008; Grosjean & Li, 2013; Hamers, 1998; Muter, Hulme, Snowling, & Stevenson, 2004; Padden, 1998)

### Expert Learners

- Are eager for new learning and are motivated by the mastery of learning itself
- Are goal-directed in their learning
- Know how to set challenging learning goals for themselves
- Know how to sustain the effort and resilience that reaching those goals will require
- Monitor and regulate emotional reactions that would be impediments or distractions to their successful learning

### Resourceful and Knowledgeable Learners

- Bring considerable prior knowledge to new learning
- Activate that prior knowledge to identify, organize, prioritize, and assimilate new information
- Recognize the tools and resources that would help them find, structure, and remember new information
- Know how to transform new information into meaningful and useable knowledge

### Strategic and Goal-Directed Learners

- Formulate plans for learning
- Devise effective strategies and tactics to optimize learning
- Organize resources and tools to facilitate learning
- Monitor their progress
- Recognize their own strengths and weaknesses as learners
- Abandon plans and strategies that are ineffective

### Neural Networks

**Affective**
- The *why* of learning

**Recognition**
- The *what* of learning

**Strategic**
- The *how* of learning

**Neural Networks**

- Monitor the internal and external environment to set priorities, to motivate, and to engage learning and behavior

- Sense and perceive information in the environment and transform it into usable knowledge

- Plan, organize, and initiate purposeful actions in the environment

### UDL Principles

**Provide Multiple Means of Engagement**
- Stimulate interest and motivation for learning

**Provide Multiple Means of Representation**
- Present information and content in different ways

**Provide Multiple Means of Action and Expression**
- Differentiate the ways that students can express what they know

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Figure 2-4. Key concepts in UDL including characteristics of expert learners, neural networks, and UDL principles (Meyer, Rose, & Gordon, 2014)
Figure 2-5. UDL guidelines (CAST, 2014)
Differentiated Instruction

Curriculum

Student

Student

Student

Differentiation by
• Content
• Process
• Product

Approach

Approach

Approach

Figure 2-6. Key relationships in differentiated instruction across three unique students

Universal Design for Learning

Curriculum

Student

Student

Student

Barrier reduction through provision of multiple means of
• Engagement
• Representation
• Action & Expression

Approach

Approach

Approach

Figure 2-7. Key relationships in UDL across three unique students
Figure 2-8. Conceptual framework illustrating relationship between problem of practice, research questions, and foundational theoretical research (CAST, 2014; SEDL, 2008)
CHAPTER 3
METHODOLOGY

The goal of this chapter is to describe the methodological approaches that guided this single instrumental case study. This includes the purpose and context of the study, research questions, research design, professional development, data collection and instrumentation, data analysis strategies, rigor, researcher bias, and limitations.

Purpose Statement

The purpose of this study was to determine how teachers used universal design for learning (UDL) to develop digital media materials for Deaf students who had special needs and how features of professional development (PD) supported or hindered teacher learning.

Research Questions

This study asked three related questions. The primary question asked: How does PD in UDL influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs?

In order to address the primary question, two sub-questions were posed. The first sub-question focused on the application of UDL to the digital media design process within this population. Sub-question one asked:

1. How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program?

The second sub-question focused on the features of PD and teacher learning. Sub-question two asked:

2. What features of the PD did participants feel supported or hindered their learning during the PTLC?
The goal of asking these questions was to determine how UDL can be used to develop digital media materials for Deaf students who have special needs and how teachers felt the features of PD supported or hindered teacher learning during the PTLC.

**Context**

This section explores the context in which this study took place, including the student and faculty populations at the educational setting.

This study took place at The Communication School (all identifying information was changed to protect confidentiality). The Communication School had two school programs: the School for Deaf Children (SDC) and the School for Communication (SFC). Both of these programs sought to provide communication-rich instructional and therapeutic programming to children with developmental and communication challenges. However, students at SDC, who were generally identified with a hearing loss, required programming specific to Deaf children, while students at SFC did not.

While teachers from both the SDC and SFC programs attended the PD program, data was only collected from teachers who worked in the SDC program. SDC served students from birth to age 22 with multiple disabilities. At the time of implementation, over 90% of SDC students were identified with hearing loss along with one or more additional disabilities, such as deafness and cerebral palsy, deafness and autism spectrum disorder, or deafness and developmental delay. SDC abode by the bilingual language and learning philosophy for Deaf children, such that American Sign Language (ASL) and English were available and accessible to students throughout the school environment. However, given the complex range of educational profiles, educational programming was necessarily modified to meet the needs of the students at SDC.
Students were placed at SDC if their educational team determined that the school district in which the student resided did not have an appropriate placement for that child within the district. Students therefore were geographically in addition to educationally, linguistically, and medically diverse. SDC provided a wide range of related services for students including speech and language, occupational, and physical therapy, behavior analysis, ASL/English interpreting, vision, counseling, nursing, and adaptive curriculum. All students participated in weekly adaptive physical education, music, and art classes. The needs of the students were such that all required year-round educational and therapeutic services. SDC was therefore open year-round, with several weeks off at the beginning and end of each summer as well as mid-year vacations that aligned with area public schools.

At the time of implementation, there were 10 classrooms at SDC. As shown in Table 3-1, this included three preschool-level, four elementary-level, and four upper-level classrooms. Classrooms ranged in size from three to five students. Students were grouped into classrooms based on their educational, language, developmental, and therapeutic needs in addition to their age and grade. Each SDC preschool classroom included not only SDC students, but also one to two same-age typically developing peers who served as language and learning models. Along with the students and teacher, each classroom had at least one paraprofessional. SDC strove to have at least one native ASL signer in each classroom, meaning either a Deaf person who grew up with ASL as a first language or a hearing individual who learned ASL from their Deaf parents. In cases where a native signer was not assigned to a classroom, SDC’s administration worked to ensure that language models included hearing individuals who
had achieved high fluency in ASL as a second language. These classroom demographics are provided to give the reader a basic sense of the classroom populations at SDC.

**Research Design**

The purpose of this study was to determine how teachers used UDL to develop digital media materials for Deaf students who had special needs and how features of PD supported or hindered teacher learning. In order to address this purpose, this study utilized the qualitative research paradigm, which has a rich and robust history in educational research (Bogdan & Biklen, 2010; Creswell, 2013).

This project aligned with many key characteristics of qualitative research including the use of a natural setting, the researcher as a key instrument, multiple sources of data, inductive and deductive data analysis, participants’ meaning, reflexivity, and a holistic account (Creswell, 2014), as described below.

SDC was a natural setting where both the researcher and teacher participants learned, collaborated, and taught on a daily basis. This allowed for face-to-face interaction within this natural setting. Related to this is the concept of the researcher as an instrument in the study. A key characteristic of qualitative approaches is that the researcher collects data herself, often through the use of instruments designed specifically for the case study. In this project, I, as the researcher, was employed at SDC and was a key instrument through the development of study instruments, design and implementation of PD, and collection and analysis of data. As described, the use of multiple sources of data is another key characteristic of a qualitative approach. In this study, research journal, document, survey, interview, artifact, and rubric were utilized. A qualitative researcher also engages in inductive data analysis (e.g. identifying patterns,
categories, and themes) and deductive data analysis (e.g. data checking). Both of these data analysis methods were utilized in this study, as described later in this chapter.

Another key characteristic of qualitative designs is the focus on finding participants’ meanings, rather than the meanings determined by the researcher or found in the literature (Creswell, 2014). This study involved teacher participants across all stages of the PTLC and utilized the PLC as a collaborative and active form of PD. This supported the continued connection to participants’ meanings.

Reflexivity is a key characteristic that involves the researcher defining and exploring her role in the setting and study. This may involve an exploration of how “personal background, culture, and experiences hold potential for shaping their interpretations” (Creswell, 2014, p. 186). This is exemplified through an exploration of my role and potential biases in this chapter, and through their influence on the study’s results and implications in the following chapters.

Finally, a qualitative researcher presents a holistic account of the issue of study, in this case, the exploration of the influence of PD in UDL on the digital media design process of teachers working with bilingual Deaf students with special needs. Creswell (2014) reports that a holistic account may involve “reporting multiple perspectives, identifying the many factors involved in a situation, and generally sketching the larger picture that emerges” (p. 186). The design of this study involved a group of teacher participants, allowing for multiple perspectives to be reported. In addition, the project provides rich details regarding the implementation of and teachers’ response to the PD, and the characteristics of the digital media designs produced during the study.
As described, this project exemplified many of the key characteristics of qualitative research in general. More specifically, this study utilized a particular approach to qualitative research: the single instrumental case study. Each element of this design is described below.

An instrumental case study provides insight into an issue, phenomenon, or situation, or helps to refine a theory (Baxter & Jack, 2008). This is accomplished when “the researcher focuses on an issue or concern, and then selects one bounded case to illustrate this issue” (Creswell, 2013, p. 99) by describing the case within specific parameters, such as time, place, activity, definition, and context (Baxter & Jack, 2008; Creswell, 2013). In this case, the single bounded case selected as the unit of analysis was the group of SDC teachers participating in the PD.

The use of a single bounded case design is appropriate under a variety of circumstances including a critical, unusual, common, revelatory, or longitudinal case (Yin, 2014). In this study, the rationale for the single-case design was nested in the critical case composed of teacher participants at SDC. A single critical case can “represent a significant contribution to knowledge and theory building by confirming, challenging, or extending the theory” (Yin, 2014, p. 51). As described in the literature review, UDL has been examined in traditional Deaf populations. However, the majority of these studies examined the provision of multiple means of representation to develop resourceful, knowledgeable learners. There is a lack of data on the implementation of UDL guidelines with bilingual Deaf students with special needs, as well as those from the engagement, and action and expression principles of UDL. This implies that the
critical case of teacher participants, as curriculum designers, may confirm, challenge, or extend the theory (Yin, 2014), which justified this study in its use of a single case.

This section provided a rationale for the use of a qualitative single instrumental case study. This research design was appropriate given the purpose of the study and my role as the researcher.

**Professional Teaching and Learning Cycle**

The PTLC (SEDL, 2008) guided the design of the PD activities in this study. Teacher participants engaged in the six PTLC stages: Study, Select, Plan, Implement, Analyze, and Adjust. In this section, the reader is provided with a brief description of each stage. Later in this chapter, details are provided regarding the design of PD activities and materials as well as the data sources and instrumentation utilized during each stage.

**Overview of the PTLC Stages**

Before engaging in the PTLC, I provided teachers with an overview of the purpose and timeline of the study (Appendix A). This also provided a forum to seek written, informed consent from participants (Appendix B). Teachers had the opportunity to participate in the PD activities without consenting. This supported the ethical provision of the intervention even if teachers did not select to be involved in the data collection and analysis phases of the study. Teachers from SDC and SFC were involved in the PD. However, only consenting SDC teachers were included in data collection.

Following this introduction, the teacher participants moved through the PTLC. The Study stage introduced UDL through a collaborative, small-group training. The Select stage involved the identification of learning goals and UDL guidelines of focus in teacher participants’ lesson and digital media materials. During the Plan stage, the
participants designed, created, and reflected on the design of their lesson and digital media materials. During the Implement stage, the lessons and digital media designs were utilized with SDC students, and teacher participants engaged in a reflection about student response. During the Analyze stage, the small group reconvened to examine the role of UDL in their design process. Finally, during the Adjust stage, participants examined the role of the PTLC in their understanding and use of UDL in the design process. These six stages – Study, Select, Plan, Implement, Analyze, and Adjust – represent one iteration of the PTLC.

Data Collection

The data collected during the PTLC involved a variety of sources and instruments illustrative of the case study approach, including research journal, document, survey, interview, artifact and rubric. These sources were chosen based on the affordances of each to provide particular information related to the research questions. Later in this section, a description of the activities and materials for each PTLC stage is followed by a rationale for each data source and description of the development of each instrument used at that stage.

Though data was collected at each stage of the PTLC, the data sources varied across the stages. The conceptual framework for this study was modified to incorporate these methodological approaches. The modified visual expands on the problem of practice, research questions, PTLC, and PD activities provided in Chapter 2. In addition to these elements, the expanded framework includes PD materials, data sources, and instrumentation (Figure 3-1). The vertical alignment within the visual shows how different data sources and instrumentation were utilized at different stages to address the research questions.
To maintain organization across data types, a filing system was utilized. A numbered folder was set up for each teacher participant containing all training materials and instruments that were needed during the PD. This allowed for organized data collection during and following the PTLC and supported data analysis.

**Delivery of the Professional Development**

The delivery of the PD occurred in a collaborative, small group manner. This approach was selected to align with several of the critical features of successful PD reviewed in Chapter 2. For example, PD is more successful when it is content focused, promotes active learning, coherent, and includes collective partnerships (Borko, 2004; Desimone, 2009; Freeman & Freeman, 1998; Garet, Porter, Desimone, Birman, & Yoon, 2001; Whitcomb, Borko, & Liston, 2009). The PD described in this section exemplified these features. It was focused on subject matter content (UDL) that examined how students learn and think. Active participant engagement was elicited during the training activities described below. The PD was coherent in that it was contextualized to the everyday experiences of working with SDC’s diverse population. Finally, teacher participants engaged in collective partnerships through PD activities such as discussion, collaboration on digital media designs, and provision of authentic feedback to peers. An exploration of how the PD exemplified these critical features of PD is explored in later chapters.

All PD trainings in this study occurred during established training sessions within SDC’s schedule. The majority of these were during daily meetings that occurred for 45 minutes before students arrived in the morning. One session occurred on a dedicated PD day, implying that teachers and staff were present but students were not. This provided an extended and more flexible block of time.
The initial goal was to move through the PTLC over a two-month period by meeting for PD trainings once weekly in addition to the PD day. However, following the overview, timeline, and consent session, some changes occurred in SDC’s schedule. The administration team requested that the training proceed on a daily basis over the course of approximately one week. This allowed for the completion of the Study, Select, and Plan stages. This was followed by a break while the teachers engaged in the Implement stage before reconvening for the Analyze and Adjust stages. The PTLC was therefore completed within the span of four weeks. This was followed by individual interviews with teacher participants.

**PTLC Study Stage**

During the Study stage of the PTLC, participants engaged in a structured training (Appendix C) that provided foundational information about UDL and actionable recommendations regarding UDL implementation. This section provides information regarding the activities and materials of the PD as well as the data sources and instrumentation collected during the Study stage.

**Activities and materials**

Given the schedule changes requested by SDC’s administration, the Study stage of the PTLC occurred over two days. The first was a 45-minute morning meeting time. The second was during a PD day during which teachers met for a longer block of time.

The content of the Study stage training was delivered to teacher participants via a PowerPoint presentation developed through two primary sources: the research literature and the Center for Applied Special Technology (CAST).

UDL was developed at CAST to reduce barriers in order to create a community of expert learners, or those who are purposeful, motivated, resourceful, knowledgeable,
strategic, and goal-directed (Meyer, Rose, & Gordon, 2014). Empirical evidence supporting the implementation of UDL, reviewed in the previous chapter, provided the foundation for the exploration of UDL at SDC.

In order to learn more about UDL, I attended a multiday UDL institute at CAST. Many resources including information, visuals, and examples, were gathered at the UDL institute and incorporated into the training. Feedback on all training materials was also provided through peer review by CAST employees, as described later in this chapter.

The content areas explored in the Study stage materials include the history and definition of UDL, core concepts of UDL, neural networks and UDL, and UDL guidelines. The design of each of these areas within the training is described below.

**History and definition of UDL.** The first section of the training provided an overview of the development of UDL. This included a brief history of CAST, the current federal initiatives incorporating UDL, the relationship between universal design and UDL, and the differences between equality, equity, differentiated instruction, and UDL.

**Core concepts of UDL.** The second section of the training introduced the three core concepts of UDL: goals, variability, and context (Meyer, Rose, & Gordon, 2014). Instruction designed according to principles of UDL should have clear goals with embedded and flexible means. This implies that teachers and learners know what the learning goal is and what the various options are to reach that goal. The core concept of variability proposes that the idea of an average learner is a myth and educators need to expect variability and design with options. This core concept is supported empirically by neuroscience research (Meyer, Rose, & Gordon, 2014). The final core concept of UDL is that context, or environment, matters. Educators should focus on changing the
environment by reducing barriers to meet the needs of a student, rather than focusing on changing the student to meet the structure of the environment. These three core concepts of UDL – goals, variability, and context – were critical to the introduction to UDL through the Study stage materials.

**Neural networks and UDL.** The next section in the PD was an overview of how UDL incorporates the role of the brain in learning. Three neural networks – affective, recognition, and strategic – were reviewed. Engaging the affective network creates purposeful and motivated learners by stimulating interest in learning. Utilization of the recognition network creates resourceful and knowledgeable learners by presenting content in different ways. Finally, engaging the strategic network creates strategic and goal-directed learners by differentiating the ways that students can express what they know (Meyer, Rose, & Gordon, 2014). One goal of UDL-based instruction is to engage all the neural networks to create expert learners through the provision of multiple means of engagement, representation, and action and expression. Reviewing these neural networks provided the teacher participants a bridge to the problem-solving framework of the UDL guidelines.

**UDL guidelines.** A significant amount of the training at the Study stage focused on the UDL guidelines. The guidelines and related terminology, such as principles, goals, guidelines, and checkpoints, were introduced, along with the structure of the guidelines. For example, the checkpoints at the lowest tier of the visual (Figure 2-5) represent the access level and are highly teacher-guided. The checkpoints at the middle tier are scaffolded and guided by both the teacher and learner. The checkpoints at the highest tier display expert learning and are guided by the learner (Meyer, Rose, &
Gordon, 2014). The terminology and structure of the UDL guidelines were given ample review in the Study stage training to ensure that all participants had an opportunity to develop a common understanding of these concepts in order to engage in successful collaborative discussions later in the PTLC.

Next, teacher participants were given an in-depth look at each principle: engagement, representation, and action and expression. Each principle was introduced by a reflective question and response with specific examples. The engagement principle explored the relationship between emotions and learning. The representation principle examined what multiple representations look like. Finally, the action and expression principle explored how effective visuals support students in becoming strategic learners. After the introduction to the principles, each of the nine guidelines and related checkpoints were introduced by providing specific examples of how these can be exemplified in practice.

The content of the Study stage materials sought to provide teacher participants with a foundational understanding of UDL concepts and concrete examples of implementation. Given the nature of this study, a solid understanding of these guidelines was critical.

**Data sources and instrumentation**

The Study stage of the PTLC involved a single data source – the research journal – in which I recorded reflections, thoughts, and emerging ideas. A robust journal can make significant contributions to the research process such as articulating procedures, establishing goals, pursing ideas, structuring thoughts, describing progress, addressing anxiety, dealing with negative feedback, and exploring a variety of formats for writing (Borg, 2001). A research journal can also contribute to the research product
by providing a forum for evaluating progress, motivating the researcher, and
documenting the researcher’s evolving thought process (Borg, 2001). Additionally,
reflections should include a robust discussion of potential biases and challenges
(Creswell, 2013) that emerge during the study. This was critical given my dual role as
the researcher and a Curriculum Coordinator in the setting.

The research journal utilized in this study was recorded digitally. Entries were
written directly after study procedures, such as PD trainings or interviews, to allow me to
record the maximum amount of detail. Each entry was guided topically by the Research
Journal Guide (Appendix D). This document included the following prompts: date,
description of research activity, participants’ knowledge, participants’ collaboration,
participants’ design process, participants’ teaching practice, research process, and
other. These scaffolds were not intended to limit my reflections. Rather, they focused
each entry on the research questions and research processes.

PTLC Select and Plan Stages

The next two stages of the PTLC, Select and Plan, were completed in
conjunction with one another. First, this involved identifying learning goals and UDL
checkpoints, including those that were already established in the learning environment
and those being targeted by the teacher in a lesson plan incorporating digital media.
Then, teachers designed and created those materials and digital media. This section
provides information regarding the activities and materials of the PD as well as the data
sources and instrumentation collected during the Select and Plan stages.

Activities and materials

The Select and Plan stages took place over two morning training periods. The
materials were developed and delivered in a similar manner to that described in the
Study stage. However, rather than focusing primarily on providing foundational information, the Select and Plan stages emphasized collaboration between teachers through small group discussion and reflection.

These stages were guided by a set of training visuals (Appendix E). These visuals provided a brief review of the schedule and UDL guidelines. Then, teachers were introduced to the UDL Lesson Planner (Appendix F). This document, utilized by all teachers, included basic lesson information such as the title of the lesson, subject area, unit plan, and grade(s) of the students. Teachers were then guided to identify the learning goals of the lesson, the activities that would address these goals, and any barriers to learning that they sought to reduce or eliminate. Next, teacher participants noted those UDL checkpoints that were already established in the learning environment and those that were targeted in the lesson. They were also prompted to explain the reasoning behind those choices.

The training visuals used during the Select and Plan stages provided teachers with a completed UDL Lesson Planner as an example. Following this, they completed the UDL Lesson Planner collaboratively or individually, based on their preference as a learner. Throughout all stages, I was available to the teachers to answer questions, clarify any misconceptions, and provide support.

Once their lesson and materials were planned, teachers brought their designs to life. They were encouraged to use a digital media component that supported the learning goals identified in the UDL Lesson Planner, such as a presentation, e-book, video, or other medium. These artifacts were collected digitally to support analysis at a later stage in the PTLC.
Data sources and instrumentation

The Select and Plan stages involved two data sources: the research journal and a document. The format for the research journal was identical to that used in the Study stage, including the use of the Research Journal Guide instrument.

The document created by teacher participants at the Select and Plan stages was the UDL Lesson Planner. As described, this document provided teachers with a common template to develop their ideas and explore the implementation of UDL. The document sought information in line with the core concepts of UDL, such as clear learning goals and the context of learning (Meyer, Rose, & Gordon, 2014). This was illustrated through prompts in the UDL Lesson Planner for learning goals, barriers to learning, and established and targeted UDL checkpoints. In this way, teachers concentrated on successfully integrating a small number of UDL guidelines into their designs rather than becoming overwhelmed. Teachers were also prompted to provide a rationale for their choices.

PTLC Implement Stage

This section provides information regarding the activities and materials as well as the data sources and instrumentation collected during the Implement stage.

Activities and materials

The Implement stage was the only stage in the PTLC that did not involve group meetings. Rather, teachers took this time to teach their UDL-based lessons and implement their UDL-based digital media materials. This occurred in their regular classrooms over a period of two-and-a-half weeks. Teachers had the flexibility to implement their lesson at any time during this span of time and to incorporate repetition as needed.
During this stage, teacher participants reflected on their students’ responses to the UDL-based lessons and materials through use of a survey. At the end of the Select and Plan stages, teachers were provided with instruction on how to complete the Student Use Survey (Appendix G). This provided an opportunity to explore students’ motivation, knowledge, independence, and educational success. The development of this instrument is described below.

**Data sources and instrumentation**

The Implement stage involved two data sources: the research journal and a survey. The format for the research journal was identical to that used in previous stages, including the use of the Research Journal Guide instrument.

During this stage, two-and-a-half weeks were provided during which teachers taught their UDL-based lessons, used their UDL-based digital media designs, and reflected on those designs. At SDC, students were often provided with multiple opportunities to engage with instructional materials. This implied that teachers may have utilized the single digital media design they created during the Plan stage on several occasions.

Teachers were asked to complete the Student Use Survey immediately after implementation with students, necessitating its brevity. The Student Use Survey focused on student response to the UDL-based lesson and digital media materials. The survey provided teachers an opportunity to gauge student motivation, knowledge, independence, and educational success. These constructs were selected to align with the goals for each UDL principle. The goal of the engagement principle is to create purposeful, motivated learners, while the representation principle strives to create resourceful, knowledgeable learners. Finally, the goal of the action and expression
The principle is to create strategic, goal-directed learners. Together, these UDL guidelines aim to create expert learners (Meyer, Rose, & Gordon, 2014). Therefore, the Student Use Survey examined three constructs that relate to the three principles: motivation, knowledge, and independence. Additionally, the survey examined educational success as a reflection of the creation of expert learners. The selection of these constructs for inclusion in the Student Use Survey was supported by the literature upon which this study was built.

After rating the presence of these constructs, teachers were prompted to describe the observations that led to these conclusions. Teachers were also given the opportunity to note their overall view on the digital media material as well as ways they would make changes. In this way, the Student Use Survey aligned with the purpose of questionnaires, which should collect information on attitudes, perceptions, or facts (Harlacher, 2016).

Given the population of students at SDC, obtaining reliable measures of success of a given digital media product directly from the students themselves would be challenging. With such a wide range of abilities, success would be measured in vastly different ways. One student may be expected to write a five-sentence paragraph, while another is focused on object tracking or identification. Therefore, success of the digital media designs was determined by the use of the Student Use Survey.

The use of a survey allowed for the collection of information on observations, attitudes, and perceptions across all teacher participants. The design of the survey followed Harlacher’s (2016) five-step process for questionnaire development. Open-ended questions were included because they are highly flexible and allowed teachers to
use their own words (Harlacher, 2016). Open-ended responses were included in the analysis through coding, as described later in this chapter.

**PTLC Analyze and Adjust Stages**

The final two stages of the PTLC, Analyze and Adjust, were also completed in conjunction. This involved reconvening after implementation to reflect and examine the role of UDL in the design process through small- and whole-group discussion. Teachers also examined how the features of PD supported or hindered their learning during the PTLC.

This section provides information regarding the activities and materials as well as the data sources and instrumentation collected during the Analyze and Adjust stages.

**Activities and materials**

The Analyze and Adjust stages took place during one morning PD session. This meeting was heavily collaborative and participant-guided. A PowerPoint (Appendix H) was utilized as a visual to guide the session.

This meeting began with a brief review of the UDL guidelines in order to address any questions or confusion that emerged during the Implement stage. Then, I provided some information about the submitted UDL Lesson Planner documents, such as an overview of the topics selected. I also presented a compiled visual highlighting the UDL checkpoints that were identified as already established in the environment and compared it to a visual highlighting those checkpoints that were targeted in the UDL-based lessons. Quotes from the UDL Lesson Planner were also shared that illustrated the barriers to learning that teachers were trying to reduce or eliminate, as well as the reasons why specific UDL checkpoints were targeted.
Following this, the teacher participants broke into small groups to participate in two reflections. The first set of questions was provided to prompt discussion regarding how the teachers’ experiences in the PD influenced their design process, implementation, and future use of UDL. The second set of questions was provided to prompt discussion regarding how the teachers’ experiences in the PD influenced their knowledge, design process, collaboration, teaching practice, and overall view of the PTLC. Between the two reflections, the whole group reconvened and each small group was provided the opportunity to share any meaningful discussion with the group as a whole.

The constructs included during these reflections were selected with purpose. This study’s literature review revealed that PD is noted as “one of the keys to improving the quality of U. S. schools” (Desimone, 2009, p. 181) through ensuring the effectiveness of teaching practice (Desimone, Smith, & Frisvold, 2007). Similarly, changing teacher practice is most successful when PD is focused on subject matter content (i.e. knowledge), and how children learn (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001) and think (Whitcomb, Borko, & Liston, 2009), reflected in the design process. Collaboration was included because effective PD involves active learning, which means being actively involved in meaningful discussion, planning, and practice (Garet, Porter, Desimone, Birman, & Yoon, 2001, p. 925) in order to improve understanding and increase the capacity to grow (Ball, 1996), relating to implementation and future use. As illustrated, the concepts included during the Analyze and Adjust stages were selected based on relevant information reflected in the current literature.
Data sources and instrumentation

The Analyze and Adjust stages involved a single data source: the research journal. The format for the research journal was identical to that used in previous stages, including the use of the Research Journal Guide instrument.

Post-PTLC

When all six stages of the PTLC were completed, I engaged in several activities relevant to this study. This involved the analysis of documents and artifacts developed during the study, and individual interviews with teacher participants.

This section provides information regarding the activities and materials as well as the data sources and instrumentation collected during the post-PTLC stage.

Activities and materials

The post-PTLC stage involved my analysis of the UDL Lesson Planners and digital media artifacts. This was accomplished through the use of the Document Rubric (Appendix I). This rubric gave me the opportunity to examine each set of UDL-based lessons and materials for the presence and strength of the UDL checkpoints established and targeted by the teacher participants. It also allowed me to make note of any observable checkpoints that were not reflected in the UDL Lesson Planner. The development of the Document Rubric is described in the following section.

Individual interviews with teachers were scheduled at mutually convenient times during the week following the conclusion of the PTLC. This allowed teachers to have completed an entire cycle before reflection. With permission, interviews that occurred in spoken English were audio recorded. All recordings were then transcribed into written English. Sections of the audio that were unclear were brought back to teachers to ensure accuracy in the transcriptions. The single interview that occurred in ASL was
video recorded with permission and transcribed into written English. Sections of the video that were unclear were brought back to the teacher to ensure accuracy in the transcriptions. Additionally, sections of the transcription for the interview that occurred in ASL were checked for translation quality by a licensed ASL interpreter employed at SDC. All interviews occurred in quiet, private spaces within the school and were guided by a set of questions on an interview guide. The development of the Interview Guide (Appendix J) is described in the next section.

Teacher demographic information was collected during interview and confirmed using a survey. The five-question survey (Appendix K) gathered information including the teacher’s name (changed for confidentiality), age, total years teaching, years teaching at SDC, Massachusetts teaching license, and background with UDL. The name, age, and years teaching questions were open response. The response options for Massachusetts teaching license, for which teachers could select all applicable responses, included I am not a licensed educator, I have a license in Deaf/hard-of-hearing, I have a license in special education, and other with a write-in option. The response options for background with UDL, for which teachers could select one response, included

- I had no background with UDL. I had never heard of UDL before.
- I had heard the term "UDL" or "universal design for learning," but I didn't really know what it was.
- I had a little experience with UDL.
- I had a lot of experience with UDL.
- I was already an expert with UDL.
Teacher demographic information in response to this survey and discussed during interview is presented in the next chapter.

**Data sources and instrumentation**

Data sources collected after the completion of the PTLC included a research journal, rubric, and interview. The format for the research journal was identical to that used in previous stages, including the use of the Research Journal Guide instrument.

During the PTLC, teacher participants designed a UDL-based lesson that included a digital media artifact, such as a PowerPoint, video, or e-book. The UDL Lesson Planner guided teacher participants in identifying components including goals, barriers, and established and targeted UDL checkpoints. During the post-PTLC phase, I utilized the Document Rubric (Appendix I) to analyze the presence and strength of UDL checkpoints in each document and artifact. The use of a rubric was a consistent method of assessment across each document and artifact in the study (Rochford & Borchert, 2011).

The first page of the Document Rubric contained basic information about the document, such as the participant code, title of the lesson, subject area, and targeted UDL checkpoints. These were transferred directly from the UDL Lesson Planner. The first page of the rubric also introduced the levels of performance 0 through 3. The level of performance was rated on a scale of four to push me into a positively- or negatively-leaning response, rather than allowing for neutral responses. In addition, each level was defined based on absolute performance, rather than being defined relative to other levels. This involved avoiding comparative and evaluative language (Rochford & Borchert, 2011). These levels of performance were expanded through narrative description that could be accessed during use.
The second page of the Document Rubric provided space for my analysis. Each UDL checkpoint was listed and noted as identified as already established by the teacher, targeted by the teacher, or observed by the researcher. This allowed me to explore those checkpoints that the teachers noted as already established or targeted as well as those that I observed in their designs that may not have been noted on the UDL Lesson Planner. For each UDL checkpoint, the level of performance was noted and I provided comments. Both the UDL Lesson Planner and any related digital media artifacts were analyzed to complete the Document Rubric.

Another data source employed during the post-PTLC phase was interview. Interviewing provides access to people’s stories and a deep understanding of their perspectives and the meaning taken from an experience (Patton, 2002). I sought to engage in individual interviews with all teacher participants. Of the ten consenting SDC teacher participants, seven attended at least five of the PD sessions and were therefore sought for interview. Three teacher participants missed two or more PD sessions and were therefore excluded from the interviews. I felt that these teacher participants hadn’t had an opportunity to develop a foundation in UDL strong enough to successfully design, implement, and reflect on the process. Therefore, seven individual interviews were completed.

Individual interviews supported the examination of the UDL-based design process as well as specific design decisions, such as why teachers targeted certain UDL checkpoints. During all interviews, teachers were provided with a copy of their UDL Lesson Planner as well as visual that reflected their use of the UDL guidelines stated in their UDL Lesson Planner. This visual highlighted those checkpoints identified as
already established in yellow and highlighted targeted checkpoints in pink. Interview also provided an opportunity to more deeply explore students’ responses to the digital media designs. Finally, teacher participants were asked to reflect on the features of PD including the PTLC as a structure for PD.

These interviews followed the general interview guide approach by establishing the issues that would be explored before the interview occurred. These issues were outlined in the Interview Guide (Appendix J) to serve as a “basic checklist during the interview to make sure that all relevant topics are covered” (Patton, 2002, p. 342). These questions were intended to be guiding rather than limiting; the interview still maintained a conversational style and followed spontaneous topics. However, a guided interview has the advantage of using time wisely while still being comprehensive and systematic (Patton, 2002).

The questions in the Interview Guide represented six types of questions outlined by Patton (2002): experience/behavior, opinion/value, feeling, knowledge, sensory, and background. Patton (2002) recommends researchers consider the time dimension of questions such that all six types of questions are considered for inclusion referencing the past, present and future. This creates a question matrix that allows researchers to ensure that a variety of questions are being asked. The development of the Interview Guide used in this study utilized the question matrix approach. Rather than focus on the time dimensions of past, present and future, I realigned these to the study constructs of design process, implementation, and future use. In this way, the questions targeted the issues and timing critical to this study.
As described, a range of activities and materials were implemented across the stages of the PTLC. Data sources and instrumentation also varied, including a research journal, document, survey, artifact, rubric, and interview. These activities, materials, and data sources were selected, and instruments designed based on the research literature in order to provide teacher participants with multiple opportunities to share their experiences, perspectives, and thoughts. This contributed to the rigor of the study, which is examined later in this chapter.

**Data Analysis**

The analysis of this case study’s data utilized specific techniques that continually referenced the theoretical foundation upon which the study was based. To reorient the reader, this study involved the provision of structured, collaborative PD on the use of UDL in a particular context and with a specific population. The theories born of these concepts guided the development of the research questions, review of the literature, and research design. In addition, the instruments were designed to collect specific types of data that would inform the research questions built on the foundation of these theories. The use of theories can help to “organize the entire analysis, pointing to relevant contextual conditions to be described as well as explanations to be examined” (Yin, 2014, p. 136).

Creswell (2013) represents data analysis as a spiral, such that the researcher moves “in analytic circles rather than using a fixed linear approach” (p. 182). Data analysis techniques may be revisited and utilized on multiple occasions as information is revealed in the analysis. The major data analysis technique that was used throughout this study was coding. Saldaña (2016) defines a code as “a word or short phrase that symbolically assigns a summative, salient, essence-capturing, and/or evocative attribute
for a portion of language-based or visual data” (p. 4). Codes were created, reconstructed, and reconfigured in search of patterns, categories, and themes. The use of meticulous coding allowed for the qualitative interpretation of the data through the identification of patterns and relationship between categories (Creswell, 2013). Coding was a critical element of this case study. Charmaz (2014) states that coding “generates the bones of your analysis … integration will assemble those bones into a working skeleton” (p. 113).

Organization and management of data was prioritized throughout the study. Any hard-copy documents, rubrics, or surveys from the data collection phase were digitized for analysis. Digital files were maintained on a password-protected cloud-based system. The qualitative analysis software NVivo was utilized to support data organization and analysis at all stages in the study as described below.

The initial step in the data analysis spiral was first cycle coding. During this process, I utilized several first cycle coding methods including attribute, descriptive, and in vivo coding. Saldaña (2016) recommends these basic coding methods as a generic approach to data and analysis. These methods were appropriate given the goals of the study and my level of experience with deep qualitative inquiry. As recommended by Saldaña (2016), attribute coding was used for all data as a management technique, while descriptive coding was used for all data as a detailed inventory of their contents. Finally, in vivo coding was used to attune myself to participants’ perspective and action. Sample codes for each of these methods is provided in Table 3-2. I strove to maintain an open mind and code liberally. For example, codes such as student motivation and student engagement were both utilized during first cycle coding. During later coding
cycles, these codes were examined and combined. Initial first cycle coding of all qualitative data was performed in the NVivo software environment.

Moving through the data analysis spiral, second cycle coding reorganized and reanalyzed data from the first cycle coding. The goal of second cycle coding was to “develop a sense of categorical, thematic, conceptual, and/or theoretical organization from your array of first cycle codes” (Saldaña, 2016, p. 233). Major themes, categories, and concepts were identified through pattern coding, leading to metacodes (Saldaña, 2016). As I approached second cycle coding, I did not feel that the NVivo software allowed me to visualize my data in a way that appealed to me as a thinker. I used NVivo to export data for individual codes. Then I labeled each piece of data with the initial code I had assigned it and left space for notes below (Figure 3-2). These were printed on different colored paper based on the pattern codes I had developed and cut into strips. In this way, I was able to physically spread out my data in front of me and manually manipulate and group items in a way that I do not feel that NVivo would have allowed, given my experience. The second cycle codes were then recorded in the notes section on each individual strip of paper and reentered into NVivo. Sample patterns codes are provided in Table 3-2.

Throughout all coding cycles, it was critical to develop analytic memos. Analytic memos provide an opportunity for a researcher to reflect on coding processes and choices (Saldaña, 2016). The relationship between the researcher, data, and analytic memos is reflected in Clark’s (2005) assertion that “memos are sites of conversation with ourselves about our data” (p. 202). After the first and second coding cycles, I used PowerPoint to create visuals for my codes and emerging themes and record my analytic
memos. As I played with the data, I found new ways of organizing the information. For each iteration, I added a slide to this analysis PowerPoint and dated the work I completed. In this way, I had a running visual record of my emerging thoughts and memos about why I made certain coding choices. This method was invaluable to me throughout the analysis process.

The data analysis methods described in this section were nested in the data analysis spiral. In this way, the approaches were utilized and revisited to direct and hone the responses to the study’s research questions.

Rigor

In this case study, specific strategies that support the credibility and dependability of the research process were utilized to establish rigor. Credibility of a qualitative study relies on the use of rigorous methods, the credibility of the researcher, and a belief in the value of qualitative inquiry (Patton, 2002).

This study used six of Creswell’s (2013) recommended validation strategies: prolonged engagement, clarifying researcher bias, triangulation, peer review, member checking, and rich description.

Prolonged engagement in the field involves building trust with participants, learning the culture, and deciding what is salient to study (Creswell, 2013). While there is no set frame of time to quantify the term prolonged, the data collection in this study took place over several weeks. This involved regular meetings as teachers progressed through the PTLC. After learning about UDL, teachers were provided with the opportunity to select relevant UDL guidelines and design a digital media artifact as well as collaborate with their peers during this process. Then, they implemented the designs with their students and reflected on that process before reconvening with other
participants and analyzing this process. This was followed by the opportunity to participate in an interview. The four-week PTLC was intensive, collaborative, and supportive. While four weeks is a relatively limited amount of engagement in the field, I had over ten years of experience at SDC to establish professional, trusting relationships with staff and to learn and participate in the school culture. In seeking a professional practice doctorate, I explored salient questions for study for several years. These contributed to the credibility of the study.

As a result of my prolonged employment at the research setting, it was critical to clarify researcher bias as a method of validation. This involved explorations of experiences, biases, prejudices, and orientations (Creswell, 2013) that could have impacted the study. A robust discussion of researcher bias, provided in the next section, contributed to my credibility and therefore the overall rigor of the study.

Another validation strategy used in this study was triangulation of data. As stated, this study collected data from a variety of sources including document, artifact, rubric, interview, survey, and research journal. The use of these sources provided corroborating evidence to illuminate emerging themes (Creswell, 2013). Triangulation of data sources also revealed inconsistencies, which provided me with the opportunity to “study and understand when and why these differences appear” (Patton, 2002, p. 560).

The rigor of this study was also supported by peer review. The PD materials described in this chapter were peer reviewed by individuals external to the study. The role of the peer reviewer includes asking “hard questions about methods, meanings, and interpretations” (Creswell, 2013, p. 251). During the UDL institute, I developed supportive professional relationships with several CAST staff members who were
experts in UDL and UDL implementation. The PD materials were given to the CAST staff members digitally and their comments, suggestions, and reflections were discussed in a face-to-face meeting at the CAST office. In this way, individuals external to the study contributed to the rigor by providing peer review of the materials used to instruct the teacher participants on the foundational concepts of UDL.

While peer review is a validation strategy that involves an external individual, internal checks were completed through member checking. In member checking, the researcher “solicits participants' views of the credibility of the findings and interpretations” (Creswell, 2013, p. 252) and is a type of analytical triangulation (Patton, 2002). Member checking is critical in establishing credibility. To engage in member checking, the researcher took “data analyses, interpretations, and conclusions back to the participants so that they can judge the accuracy and credibility of the account” (Creswell, 2013, p. 252). The comments, ideas, and reflections were recorded and utilized to guide the researcher along the data analysis spiral.

Rich, thick description is a validation strategy that is related to the transferability of data (Creswell, 2013). Thick descriptions provide “abundant, interconnected details” (Stake, 2010, p. 49) and may involve direct quotes and descriptions of the participants, setting, movement, and activities (Creswell, 2013). Rich, thick description is provided in the next chapter regarding the participants, context, and findings, and many direct quotes from participants are provided.

The validation strategies described in this section include prolonged engagement, clarifying researcher bias, triangulation, peer review, member checking, and rich description. These strategies contribute to the rigorous design of this single
instrumental case study. Inherent to rigor is an exploration of researcher bias, provided in the next section.

Researcher Bias

It is impossible to avoid all bias in a research design. Yin (2014) notes that qualitative researchers, heavily involved in the data collection and analysis process, are particularly prone to the impact of bias. This is because their understandings of the issues and context may “undesirably sway them toward supportive evidence and away from contrary evidence” (p. 76).

One strategy to acknowledge and reduce bias is to examine one’s openness to contrary evidence. Case study data in its entirety will not fit neatly into predetermined categories and support singular conclusions. One of the benefits of case study is its naturalistic setting, which is therefore real, authentic, messy, and unpredictable. Ignoring contrary evidence to make one’s conclusions more sleek and presentable is an avoidable problem. Yin (2014) states that “the quest for contrary findings can produce documentable rebuttals” (p. 76) that can reduce bias. This can be accomplished through several strategies, such as member checking and repeated coding cycles. These strategies were utilized throughout the study and illustrated in the results and implications chapters. Contrary evidence was illuminated through repeated coding cycles, checked by members, and presented in the narrative.

Another strategy to reduce bias is to strive for reflexivity in writing. This involves acknowledging that one’s writing is positioned based on culture, society, gender, experiences, values, perspectives, and other factors (Creswell, 2013). Deeply and clearly describing and reflecting on these elements can increase reflexivity in the research report. Gilgun (2005) describes writing as “co-constructions, representations of
interactive processes between researchers and researched” (p. 258). I strove for reflexivity in these co-constructions by describing past experiences with the issues of the study – including application of UDL prior to this study and past PD opportunities at SDC – and exploring how these experiences shaped the interpretations within the study.

By actively and unceasingly engaging in strategies such as locating contrary evidence and striving for reflexivity, I sought to acknowledge and reduce researcher bias within this study.

**Methodological Limitations**

This study contained several methodological limitations related to the research design as well as my role as the researcher.

General limitations of all qualitative and case study approaches influenced this study. As a bounded case that represented a very specific population and context, the opportunities for generalizability are limited. However, many qualitative researchers are not particularly focused on generalizability (Creswell, 2013). This study utilized rich description of the case to provide adequate information regarding the population of students and teachers at SDC. This will support readers in determining the generalizability of the results to their population.

My role as the researcher was also considered as a limitation. I have over ten years of employment experience in a variety of roles at SDC. While in many ways this was a benefit that supported a deep knowledge of the setting and rich description, it was also a limitation. As described in the previous section, researcher bias was inevitable and strategies had to be consciously and continuously employed in order to reduce the impact of bias.
Any research design and researcher role will have an impact on a study. In this study, the qualitative single instrumental case study was selected by a researcher with extensive experience at the research setting on the basis of the affordances of the design to address the research questions. However, it was critical to acknowledge and discuss all limitations and consider how they impacted the results of the study.

**Summary**

This section described and justified the methodology of this study. This included the purpose and context of the study, research design, PTLC process, PD design, data sources and instrumentation, and data analysis. In addition, information regarding the rigor of the study, researcher bias, and limitations was provided.
Table 3-1. SDC classroom demographics, 2016-2017 school year

<table>
<thead>
<tr>
<th>Level</th>
<th>Total students</th>
<th>Student age range</th>
<th>Student grade range</th>
<th>Total staff</th>
<th>Native signing staff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preschool</td>
<td>5</td>
<td>3-4</td>
<td>PreK</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Preschool</td>
<td>5</td>
<td>3-4</td>
<td>PreK</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Preschool</td>
<td>4</td>
<td>3-5</td>
<td>PreK</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Elementary</td>
<td>4</td>
<td>5-8</td>
<td>K-3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Elementary</td>
<td>4</td>
<td>7-11</td>
<td>1-5</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Elementary</td>
<td>5</td>
<td>9-10</td>
<td>2-4</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Elementary</td>
<td>5</td>
<td>8-11</td>
<td>3-5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Upper</td>
<td>5</td>
<td>11-16</td>
<td>5-10</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Upper</td>
<td>5</td>
<td>13-16</td>
<td>6-10</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Upper</td>
<td>3</td>
<td>17-20</td>
<td>10-12+</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 3-2. Coding methods (Saldaña, 2016)

<table>
<thead>
<tr>
<th>Coding Method</th>
<th>Description</th>
<th>Examples from this analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>First cycle: Attribute</td>
<td>Basic descriptive information used as a management technique</td>
<td>SDC experience, teaching experience, UDL background, SDC use of UDL, student diversity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>student socialization, families, teacher collaboration, teacher planning, PD suggestions, multimedia, design process, structure of UDL guidelines</td>
</tr>
<tr>
<td>First cycle: Descriptive</td>
<td>Basic topic of a passage that gives an inventory of its contents</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>student socialization, families, teacher collaboration, teacher planning, PD suggestions, multimedia, design process, structure of UDL guidelines</td>
</tr>
<tr>
<td>First cycle: In vivo</td>
<td>Direct use of participants’ own language to attune to participant perspective and action</td>
<td>It was more work, but at the same time, it made the lesson more interesting for me and also for the kids.</td>
</tr>
<tr>
<td>Second cycle: Pattern</td>
<td>For the categorization of coded data into a smaller number of categories or meta codes</td>
<td>teacher beliefs, feelings of isolation, design process, duration, active learning, high expectations</td>
</tr>
</tbody>
</table>
Figure 3-1. Expanded conceptual framework including methodology (CAST, 2014; SEDL, 2008)
Figure 3-2. Example of paper-based second cycle pattern coding approach. Photo courtesy of author.
CHAPTER 4
RESULTS

This chapter presents the results of this analysis through structured examination of the research questions. This study asked one primary research question: How does professional development (PD) in universal design for learning (UDL) influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs? In order to address the primary question, two sub-questions were posed. The first sub-question focused on the application of UDL to the digital media design process within this population, while the second sub-question focused on the features of the PD and teaching learning. These questions asked:

1. How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program?

2. What features of the PD did participants feel supported or hindered their learning during the professional teaching and learning cycle (PTLC)?

The goal of asking these questions was to determine how teachers can use UDL to develop digital media materials for Deaf students who have special needs and how the features of PD supported or hindered teacher learning during the PTLC.

First, teacher participation in the PTLC PD sessions is described. This is followed by the results of the analysis for sub-question one, sub-question two, and the primary question. This chapter concludes with a presentation of the limitations related to the results of the study.

Participation in the Study

The PTLC PD sessions were attended by teachers from both programs at The Communication School: the School for Deaf Children (SDC) and the School for Communication (SFC). However, participation in data collection was only sought for
SDC teachers, given their role in the education of bilingual Deaf students with special needs. Therefore, there was a maximum of 21 teachers (10 SDC, 11 SFC) along with several administrators present during the PTLC PD sessions. Attendance during the PTLC PD sessions varied across different meetings, as displayed in Table 4-1. While 10 SDC teachers consented to participation in the study, a complete set of data was not obtained from all 10 teachers. Six teachers submitted individual documents (UDL Lesson Planner, digital media artifact, one or more Student Use Survey) and participated in interview. Two teachers collaborated on their documents and therefore submitted a single set of documents. However, only one of those collaborating teachers was responsive to my request for interview. This resulted in seven sets of documents and seven individual interviews. Two teacher participants did not submit any documents and were therefore not considered for interview. Data collected from teacher participants is reflected in Table 4-2.

The following section provides a description of these eight participating teachers. This includes their name (changed to maintain confidentiality), gender, age, total years teaching, years teaching at SDC, student grade range, education, Massachusetts educator license, reported background with UDL, and topics for their UDL-based lesson and digital media design. This information is summarized in Table 4-3.

Preschool

During the 2016-2017 school year, there were three preschool classrooms at SDC. All three teachers at this level submitted documents, and two participated in interviews.

Hannah was a 35-year-old female. She had 13 years of teaching experience including 10 years in the public school setting and 3 years at The Communication
School. Her public school teaching roles included special education inclusion and co-teaching in English, science, and math across various elementary, middle, and high school environments. At The Communication School, she taught one year in the SFC program and one year in a mixed class with SDC and SFC students. The 2016-2017 school year was her first teaching fully in the SDC program. All three years at The Communication School involved preschool- or early elementary-aged students. Hannah held a Massachusetts educator license in special education and during the time of the study was pursuing a master’s degree in special education. She indicated that she received an introduction to UDL in one of her graduate classes, but “the UDL was kind of a secondary piece, it wasn’t like a major focus. So I still can learn some more about it!” (Interview 1, April 7, 2017). On the demographic survey, Hannah indicated that she had a little experience with UDL. For her UDL-based lesson, Hannah focused on two-dimensional shape identification using tangrams. Her digital media artifact was series of web-based videos that used music and animation to review shapes and their names. Hannah did not create these videos.

Ella was a 30-year old female who started working at SDC immediately after graduate school. She had degrees in speech pathology, sign language interpreting, and Deaf education. At the time of the study, Ella did not hold a Massachusetts educator license. She had 4 years of teaching experience, all at SDC. Three of those years were in SDC elementary classrooms and one was in an SDC preschool classroom. When asked about her background with UDL, Ella indicated that she “had never heard of it. But I’ve also been out of grad school for four years” (Interview 3, April 11, 2017). For her UDL-based lesson, Ella collaborated with Eliza to focus on the life cycle of a plant,
which they studied in the context of a larger unit on animal habitats. Their digital media artifact was a teacher-created PowerPoint about grasslands that used written English, pictures, and images of ASL signs to walk students through the steps of planting grass seed.

The final SDC preschool classroom was taught by Eliza. Eliza was a 33-year-old female with a variety of experiences at The Communication School. She worked for 3 years as a paraprofessional in the SFC program before becoming a teacher in the SDC program. The 2016-2017 school year was her first year as a teacher. She had a master’s degree in special education: severe disabilities and held a Massachusetts educator license in special education. Eliza and Ella worked collaboratively on their UDL Lesson Planner and digital media artifact. However, Eliza was not responsive to my request for an interview and therefore did not participate in that component of the study.

Elementary

During the 2016-2017 school year, SDC had four elementary level classrooms. Though all four teachers consented to participation in the study, only three submitted documents and participated in interviews. Those three teachers are described below.

Isla was a 25-year-old female who had 3 years of experience at SDC. She worked as a paraprofessional during her first year at SDC before moving into the role of elementary teacher. Her background was in psychology but she had a Massachusetts educator license in instructional technology and a master’s degree in assistive technology. Isla indicated that she was already an expert with UDL, in large part due to her graduate program, because “it was just all UDL. So that’s just been my mindset for the past… since I started my grad program and finished it” (Interview 2, April 11, 2017). For her UDL-based lesson, Isla’s elementary SDC students collaborated with a
classroom of SFC post-high school transition students. These two classes learned
about germs in their environment, swabbed for bacteria, and used microscopes to view
germs that had grown in petri dishes. Isla’s digital media artifact was a teacher-
created PowerPoint that reviewed basic concepts about germs and the process of
swabbing for germs to grow in a petri dish, and prepared students to view the germs
under a microscope. This PowerPoint incorporated written English, pictures, and
images of ASL signs.

Molly was a 32-year-old female with 9 years of teaching experience, all at SDC. She
had a degree in special education and a master’s degree in reading. Her
Massachusetts educator license was in special education, and she had taught
preschool through middle school aged students at SDC. Molly indicated that even
though she was aware that “Isla is doing this for her master's” (Interview 6, April 12,
2017), she had no background in UDL. For her UDL-based lesson, Molly focused on a
cooking activity in which students made a banana yogurt parfait and then reviewed the
recipe. She created two digital media artifacts to support this lesson. First, she created
a heavily animated PowerPoint that displayed the materials, ingredients, and process
for making the recipe. Second, she created three levels of a digital recipe review based
on the needs of her students. The goal was to make this recipe and review available
and accessible for students to do at home with their families.

The final elementary teacher participant was Corey, a 30-year-old female. She
had 3 years of teaching experience, all in SDC elementary classrooms. Corey had 5
years of experience as a teaching assistant at a school for students with multiple
sensory impairments. She had a degree in Deaf studies and a master's in Deaf
education and held a Massachusetts educator license in Deaf and hard-of-hearing.
Corey indicated that she had no background in UDL and that it was “brand new. I had not heard of it at all” (Interview 4, April 12, 2017). For her UDL-based lesson, Corey focused on the creation of science lab reports following the use of a microscope. Her digital media artifacts were a single-slide PowerPoint that reviewed the targeted vocabulary for the lesson and templates for written and picture-based lab reports.

**Upper**

During the 2016-2017 school year, SDC had three upper level classrooms: one middle school, one middle/high school, and one high school/transition classroom. Though all three teachers consented to participate in the study, only the middle school and high school/transition teachers submitted documents and participated in interviews. Those two teachers are described below.

Tina was the most experienced teacher who participated in this study. Tina was a 60-year-old female with 36 years of teaching experience, 33 of which were at SDC. She began as a counselor and worked as a supervisor in SDC’s residential dormitory, which was no longer operational at the time of the study, before transitioning to the teacher role. She noted that she had been a first-hand observer of the many changes at The Communication School, particularly in how language philosophies, such as the use of manual codes of English such as Signing Exact English-II (SEE-II) and the bilingual approach, have changed over the years. Tina said, “I’ve seen a lot of changes in education while I have been here. First, things were total communication, then SEE-II, and now we’re bilingual” (Interview 5, April 12, 2017). Tina had a degree in elementary special education and a master’s in counseling. She held Massachusetts educator licenses in both special education and in school counseling for the Deaf. Tina indicated
that she had heard the term UDL but she did not really know what it was. For her UDL-based lesson with her middle school students, Tina focused on animal adaptations. She used three digital media artifacts in her design. She developed one PowerPoint herself and downloaded a second PowerPoint from a teacher website. Both of these artifacts incorporated written English and pictures. The third digital media artifact was a closed-captioned video about animal adaptations from a children’s science website. Tina did not create this video.

The final teacher who participated in this study – and the only male – was Sean. Sean was a 26-year-old teacher with three years of teaching experience, all in the SDC middle and upper schools. During the time of the study, Sean was working in a high school/transition classroom, indicating that some of his students were in their post-high school years. SDC student generally stayed until they turned 22 years of age, focusing on those transitional and/or vocational skills relevant to their future endeavors. Sean had a degree in Deaf studies and a master’s in Deaf education, with a Massachusetts educator license in Deaf and hard-of-hearing. On the demographic survey, Sean indicated that he had heard the term UDL but did not really know what it was. For his UDL-based lesson, Sean focused on encouraging students to perform independent research on a community outing they wished to take with their class. His digital media artifact was a FlipChart, similar to a PowerPoint, about community outings and the research process.

As stated, this study asked a primary research question and two sub-questions. The sub-questions each addressed an element of the primary question; sub-question one focused on the use of the UDL guidelines in the design process while sub-question
two focused on the features of the PD and teacher learning. The results of the study are presented by first examining the sub-questions, then exploring how that information can be integrated to address the primary question. All teacher and student names used in this study have been changed to maintain confidentiality.

**Sub-Question One**

Sub-question one asked, How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program? This focused on teachers’ use of UDL as a framework of design to plan, create, implement, and reflect on a lesson plan that incorporated digital media. Data sources addressing this question were created and collected across several stages of the PTLC, as shown in Figure 3-1, and reviewed below.

During the first stage of the PTLC (Study), UDL was introduced and reviewed using a structured presentation (Appendix C). During the Select stage, teachers identified learning goals using the UDL Lesson Planner (Appendix F). They also used this document to identify any UDL checkpoints that were already established in their learning environment as a part of their regular practice. This implied that while they did not specifically focus on a particular checkpoint, it was observable as part of their typical routine. Teachers also used the UDL Lesson Planner to identify those checkpoints they wished to specifically target for inclusion in the lesson. During the Plan stage, teachers designed their lesson activities and created their digital media, both of which were also reflected on the UDL Lesson Planner. During the Implement stage, teachers implemented their lessons and digital media in their classrooms, noting students’ responses on the Student Use Survey (Appendix G). Teachers came back together
During the Analyze stage to examine the role of the UDL guidelines in their design process. During the Adjust stage they examined the role of the features of PD and the PTLC on their learning. After the PTLC was completed, I used the Document Rubric (Appendix I) to rate the presence and strength of the UDL checkpoints in the teachers’ designs. Finally, teachers were invited to participate in individual interviews that were guided by the Interview Guide (Appendix J). During these interviews, each teacher had a number of documents available for review and reflection, including their UDL Lesson Planner, Student Use Survey and a visual that highlighted their established and targeted UDL checkpoints.

There were seven total designs in the study on a range of content area topics (Table 4-3). During the Select and Plan stages of the PTLC, teachers used the UDL Lesson Planner to identify UDL checkpoints that were already established in their learning environment as a part of their regular practice, as well as those that they were targeting within the lesson. The Document Rubric allowed me to examine the presence and strength of those teacher-identified checkpoints, and note any checkpoints that I observed as a researcher that had not been identified by the teacher. I rated each of the teacher-identified and researcher-observed checkpoints on a scale of zero to three as a measure of its strength within the design. A rating of zero indicated that the checkpoint was not observed or present in the design despite having been identified by the teacher. A rating of one indicated that there was some evidence of the UDL checkpoint in the design but it was only observable in parts of the design or in limited contexts. A rating of two indicated that there was significant evidence of the UDL checkpoint in the design and it was observable in most parts of the design and in most contexts, but there
remained some opportunities for increasing the application of the checkpoint. Finally, a rating of three indicated that there was ample evidence of the UDL checkpoint across all aspects of the design.

Checkpoints with ratings of one, two, or three were included in the analysis because these three levels of performance indicated some, significant, or ample evidence of the checkpoint within the designs. Given that some teachers learned about UDL for the first time during the PTLC, I felt that it was important to include all observed checkpoints, even those that were observed only weakly. Given their inexperience with UDL, some teachers may not have had the experience to strongly implement a UDL checkpoint. However, their decision to target that checkpoint was still worth exploring as a part of their design process. Therefore, UDL checkpoints with ratings of one, two, or three were included in the analysis.

For the purpose of this analysis, any checkpoint with a rating of zero was removed from the analysis. This decision was made because this rating indicated that there was no evidence of this UDL checkpoint in the design. This occurred in four instances across all seven designs. In three designs, teachers identified the lowest tier engagement checkpoint, “minimize threats and distractions” as already established in their learning environment without providing evidence within the UDL Lesson Planner of how this checkpoint was present. In one design, a teacher identified the lowest tier representation checkpoint, “offer ways of customizing the display of information” without evidence to support this. These four instances involved checkpoints that were identified by teachers as already established in their environment; the teachers were not targeting these checkpoints. There was enough evidence of the checkpoints targeted for
inclusion to rate each as one, two, or three on the Document Rubric. However, the lack of evidence for the presence of the checkpoints rated zero indicated that the teachers did not illustrate how they already established the checkpoints within their learning environment. Given that one of the checkpoints was rated zero across three designs, teachers may need more support in either understanding or illustrating this within their designs.

This led to a list of all the teacher-identified and researcher-observed checkpoints within the UDL Lesson Planner for each design. By tallying the total number of designs in which a checkpoint was identified by teachers or observed by the researcher, I was able to determine the frequency with which each checkpoint was used. Given that there were seven total designs in this study, there were seven opportunities to identify or observe each checkpoint across the designs; the maximum frequency for each individual checkpoint was seven. The frequency count for each checkpoint, provided in Figure 4-1, was used to guide the thematic discussions. During interviews, teachers reflected on the utilization of the UDL guidelines on their design process, designs, and digital media artifacts, and these data also contributed to thematic analysis.

Three themes emerged from the data. These themes were:

1. Teachers utilized the three UDL principles to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program.

2. Teachers utilized the three tiers of the UDL guidelines to make decisions when designing digital media materials for this population.

3. Teachers utilized individual UDL guidelines to make design decisions when designing digital media materials for this population.

Each theme illustrated how the UDL guidelines were utilized in a different way to explore the data. Theme one involved looking at the three principles without
consideration of the three tiers. In other words, the three tiers were collapsed into one category for each the engagement, representation, and action and expression principles. Theme two involved looking at the three tiers without consideration of the three principles. In other words, the three principles were collapsed into one category for each the lowest, middle, and highest tiers. Theme three examined each of the nine UDL guidelines individually to identify patterns of use. Both principles and tiers were considered.

Each theme is explored in the following sections.

**Theme One: Teachers Utilized the Three UDL Principles to Make Design Decisions**

The first theme revealed in the data was that teachers utilized the three UDL principles to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program. Theme one involved looking at the three principles without consideration of the three tiers. In other words, the three tiers were collapsed into one category for each the engagement, representation, and action and expression principles. The total frequency was added for each principle, or column, in Figure 4-1. This number was divided by the total number of design opportunities for that principle, which was determined by multiplying the number of checkpoints by seven designs. These data showed that checkpoints from the representation principle were identified or observed most frequently, followed closely by those from action and expression, and engagement. This is displayed graphically in Figure 4-2.

The representation principle has 12 total checkpoints. Across seven designs, this led to 84 total opportunities to identify or observe representation checkpoints (Figure 4-
Checkpoints from the representation principle were identified or observed 49 times, indicating that they occurred in 58% of design opportunities (Figure 4-2).

The action and expression principle has eight total checkpoints. Across seven designs, this led to 56 total opportunities to identify or observe action and expression checkpoints (Figure 4-1). Checkpoints from the action and expression principle were identified or observed 28 times, indicating that they occurred in 50% of design opportunities (Figure 4-2).

The engagement principle has ten total checkpoints. Across seven designs, this led to 70 total opportunities to identify or observe engagement checkpoints (Figure 4-1). Checkpoints from the engagement principle were identified or observed 31 times, indicating that they occurred in 44% of design opportunities (Figure 4-2).

While checkpoints from the representation principle were identified or observed most frequently, those from action and expression, and engagement were consistently used across designs as well. Interviews with teachers revealed ways in which they utilized the three UDL principles to make design decisions. Teachers’ utilization of the UDL principles was informed by their grounding in the field of Deaf education and the learning needs of their students.

Molly provided evidence that her grounding and experience as a teacher of Deaf students with special needs impacted her utilization of the three principles. She noted that her typical teaching style defaulted to “mostly representation, and action and expression, because you’re thinking about, ‘How can I get language out of them?’” (Interview 6, April 12, 2017). The representation principle focuses on the perception, provision, and comprehension of information, language, and symbols. Molly’s statement
is supported by the frequency data in Figure 4-2, which showed that checkpoints from the representation principle were identified or observed most frequently. As described in this chapter’s literature review, language development is a critical element in the development of Deaf children. This is reflected in Molly’s view of her approach to the UDL principles.

Ella noted that the goals of the three principles in meeting the needs of her students guided her decision-making during the design process. For example, she described the type of lessons she generally tries to plan for her busy preschool students as “hands-on, engaging, and interactive” (Interview 3, April 11, 2017). This supports her students in becoming motivated (a goal of the engagement principle), and goal-directed (a goal of the action and expression principle). This was exemplified in the lesson that she and Eliza developed collaboratively on the life cycle of a plant. While planting grass seeds, Ella reflected that one of our students has sensory defensiveness. So given the choice, she would not touch the dirt. But giving her that outlet of, ‘Here, use a cup to scoop it instead,’ she was given that choice and she made the decision on her own, ‘Yes, I want to be a part of the activity, I’m going to use a cup, I’m going to scoop the soil, the dirt, and be a part of the activity.’ (Interview 3, April 11, 2017)

This example shows mindful decision making regarding the utilization of the UDL principles based on the learning needs of her students. Ella targeted the engagement principle by providing options for recruiting interest. She optimized the student’s individual choice to participate in the activity and reduced the threat of feeling forced to touch the dirt when the student was defensive to that sensation. The lesson also showed evidence of the action and expression principle when Ella provided options for physical action. The access to a cup as a tool to scoop dirt gave the student an option
for physical action that allowed her to be a full participant and experience all of the learning, social, and linguistic impacts of the activity with her peers.

With such a heavy emphasis on the engagement of her busy preschool students, Ella reflected that oftentimes “some of the representation aspects kind of get lost in the excitement of the hands-on activities and the language learning. So to be reminded to supply that information that they might not have already had was helpful for me” (Interview 3, April 11, 2017). Ella reflected on her teaching practice in this general way and recognized an area – representation – that she often overlooked. This showed that Ella utilized the UDL principles to guide her decision-making process within this design and within her teaching practice.

The evidence provided supports the first theme: teachers utilized the three UDL principles to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program. Teachers’ utilization of the UDL principles was informed by their grounding in the field of Deaf education and the language and learning needs of their students.

**Theme Two: Teachers Utilized the Three Tiers of the UDL Guidelines to Make Design Decisions**

The second theme revealed in the data was that teachers utilized the three tiers of the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program. The lowest tier guidelines are primarily teacher-centered and concerned with providing access to material through removing unnecessary barriers to learning. The middle tier guidelines highlight specific strategies for building toward high-level expertise and represent
teacher and learner scaffolds. The highest tier guidelines represent the learner-centered skills of expert learners (Meyer, Rose, & Gordon, 2014).

Theme two involved looking at the three tiers without consideration of the three principles. In other words, the three principles were collapsed into one category for each the lowest, middle, and highest tiers. The total frequency was added for each tier, or row, in Figure 4-1. This number was divided by the total number of design opportunities for that tier, which was determined by multiplying the number of checkpoints by seven designs. In this study, checkpoints from the lowest tier were identified or observed more than those from middle tier, which were in turn identified or observed more than those for the highest tier. This is presented graphically in Figure 4-3.

The lowest tier has eight total checkpoints. Across seven designs, this led to 56 total opportunities to identify or observe checkpoints from the lowest tier (Figure 4-1). Checkpoints from the lowest tier were identified or observed 38 times, indicating that they occurred in 68% of design opportunities (Figure 4-3).

The middle tier has 12 total checkpoints. Across seven designs, this led to 84 total opportunities to identify or observe checkpoints from the middle tier (Figure 4-1). Checkpoints from the middle tier were identified or observed 46 times, indicating that they occurred in 55% of design opportunities (Figure 4-3).

The highest tier has 10 total checkpoints. Across seven designs, this led to 70 total opportunities to identify or observe checkpoints from the highest tier (Figure 4-1). Checkpoints from the highest tier were identified or observed 24 times, indicating that they occurred in 34% of design opportunities (Figure 4-3).
These data showed that checkpoints from the lowest tier were utilized more than those from middle tier, which were in turn utilized more than those from the highest tier. Evidence from teachers revealed ways in which they utilized the three tiers of the UDL guidelines to make design decisions. Teachers’ utilization of the three tiers of the UDL guidelines encouraged them to push into higher tiers, helped them reflect on their teaching practice, and helped them recognize the benefits of targeting the lowest tier when creating designs based on the nature of the students and goals of the lesson.

Evidence from the UDL Lesson Planner showed that teachers used the three tiers of the UDL guidelines to push into higher tiers. Figure 4-4 displays those checkpoints, highlighted in yellow, that were identified as already established in at least one design. This implied that while a teacher may not have been specifically targeting that checkpoint, it was still present in the learning environment as part of the regular practice. Eight lowest tier, seven middle tier, and three highest tier checkpoints were identified as already established in at least one design. This can be compared to Figure 4-5, which displays those checkpoints, highlighted in pink, that were targeted in at least one design. This implied that these were the checkpoints that teachers were specifically targeting in their designs. Five lowest tier, eight middle tier, and five highest tier checkpoints were targeted in at least one design. This shows that teachers sought to make a change from their established practice (reflected in the already established checkpoints in Figure 4-4) in their designs for implementation (reflected in the targeted checkpoints in Figure 4-5). Teachers pushed themselves into higher tiers when they determined which checkpoints they wanted to target in their designs.
Teachers reflected that the tiered structure of the UDL guidelines impacted their thinking by encouraging them to create designs that pushed into higher tiers, thereby reducing scaffolding, and increasing learner control. Ella, Tina, and Corey reflected how the tiered structure impacted their general design process. Ella noted that

if you’re at the bottom tier or second tier every day, ‘Oh maybe let’s throw in something from the third tier, and here is where we can do it.’ It’s nice to have this actual chart to see and to be given those, ‘Here is how you can do it.’ (Interview 3, April 11, 2017)

Tina had a similar reaction. She stated that the UDL guideline visual “helps us focus on bringing the kids up. Instead of becoming stuck or stagnant at one level, you can try to push them up” (Interview 5, April 12, 2017). This was reflected in Tina’s animal adaptations lesson. She identified five checkpoints as already established in her environment, all of which came from the lowest tier. This indicates that while she was not specifically targeting those checkpoints, they were present in the learning environment based on her regular teaching practice. Tina targeted five checkpoints from the middle tier and one from the lowest tier. This shows that she mindfully pushed herself – and her students – into higher-level skills reflected in the UDL guidelines.

For example, Tina targeted a middle tier engagement checkpoint: foster collaboration and community. During a group discussion about the possible adaptations of the animals displayed in her PowerPoint, Tina sought to transfer ownership to the students rather than control the conversation herself.

They’re all individually on different levels, but they can collaborate together. How to make that happen more often? And to build on their strengths and minimize my control. I can control it, but not too closely. Trust, faith in the learner, all that. (Interview 5, April 12, 2017)
This shows that Tina used what she had learned in the PD about the tiered structure of the UDL guidelines to design a lesson that would push her students to take greater control of their learning.

Corey also reflected on those UDL checkpoints that she identified as already present in the learning environment as part of her regular teaching practice, as well as those she targeted in her lesson. Corey felt that “once the ones that we already do fell into place, it seemed more… It just became obvious that we should be pushing them up a little bit” (Interview 4, April 12, 2017). This was reflected in Corey’s microscope lab report lesson. She identified six checkpoints as already established in her environment, all of which came from the lowest tier. She targeted four checkpoints from the middle tier.

For example, Corey targeted a middle tier action and engagement checkpoint: use multiple tools for construction and composition. After viewing a variety of leaves under the microscope, students were given the option to complete their lab report in written English and/or pictures, or a spoken English or ASL video. She described how her students responded to these options for expression and communication. She noted that Rhea broke out of her comfort zone and chose to create a PowerPoint, and “was so happy with her choice” (Interview 4, April 12, 2017). She also described Annie as especially noteworthy, noting that she “loves having a choice and then she just kind of takes it from there. She’s really motivated by this topic in general. She loves the plants, she loves the microscopes. Just having that freedom to pick, she dove in” (Interview 4, April 12, 2017). Corey reflected that Brian, whom she described as more comfortable with spoken English than ASL, initially chose to do an ASL video. However, he changed
midstream to a spoken English video when he “saw his own limitations as we were going through the process, and quickly was like, ‘Yeah, I think that this is better for me’” (Interview 4, April 12, 2017).

Corey’s utilization of the three tiers of the UDL guidelines helped her elementary students find unique ways to express and communicate their knowledge. During her interview, Corey shared that she had carried this concept into other areas of teaching as well. While studying European explorers in social studies, students wrote a letter home from the perspective of an explorer. “They were kind of given multiple avenues for expressing a letter to mom and dad – however you want to do this! Do you want to write it? Do you want to do pictures? Do you want to type it?” (Interview 4, April 12, 2017). Corey applied what she learned during the PTLC about the three tiers of the UDL guidelines to the creation of a design that provided her students with specific strategies that increased their control while maintaining their success.

There was also evidence that the three tiers of the UDL guidelines helped teachers reflect on their practice and identify areas for improvement. During all interviews, teachers were provided with a visual that reflected their use of the UDL guidelines stated in their UDL Lesson Planner. This visual highlighted those checkpoints identified as already established in yellow and highlighted targeted checkpoints in pink. When provided with this visual for her design (Figure 4-6), Ella explained how the three tiers helped her reflected on her practice. All established and targeted checkpoints in her design came from the lowest and middle tiers. While emphasizing the linguistic diversity of her students, she reflected that she needed to challenge the higher-level students as much as those with more emerging skills.
The kids are so young and their language is… a lot of them vary. Some of them have higher language, some of them have lower. So after looking at this and seeing that we didn’t really target these areas, it kind of makes me think, ‘Oh shoot.’ The kids who have that higher language, we should have been pulling them up by asking them some of the questions or giving them something from the top tier. (Interview 3, April 11, 2017)

She also stated that having the highest tier checkpoints available in the UDL guideline visual was “beneficial to actually see written down on paper to remind me to kind of prompt for that knowledge” (Interview 3, April 11, 2017). This shows that she was able to utilize the three tiers of the UDL guidelines to self-reflect on her own practice and identify areas of need.

While Tina, Corey, and Ella described the value of pushing into the higher tiers, Isla – who had the strongest UDL background of all the participants – took a different approach. She purposely targeted three checkpoints from the lowest tier and one from the middle tier. She sought to set students up for success based on the nature of her activity and the inherent challenges it posed to her and her students.

Isla’s lesson involved a unique collaboration with an SFC teacher I will call Nicole. Nicole taught a classroom of SFC post-high school transition students. These students did not use ASL as a primary mode of communication, but instead used a mix of various alternative and augmentative communication (AAC) eye and head switch-controlled devices, such as a Tobii. In addition, several of Nicole’s students had extremely low vision and required tactile materials. Isla’s SDC early elementary students, all of whom were Deaf, used a variety of communication approaches including ASL, spoken English, and AAC devices.

Even with these entirely unique student groups, Isla and Nicole decided to collaborate on a lesson examining germs under the microscope. Nicole’s class had
completed a unit on germs earlier in the year and joined Isla’s class to share their experiences, act as peer models, and provide everyone with an opportunity to interact in unique ways. Isla focused on a lowest tier action and expression checkpoint because

I wanted to have the varied methods of response, especially because I knew that Nicole’s students had such variety in their communication. And my students – we were pretty different in a lot of ways! But it worked out really well because we could see how a switch was used to access yes/no questions with the Tobii. (Interview 2, April 11, 2017)

Beyond the use of switches and yes/no questions, the varied methods of response also supported one of Nicole’s students at a higher level. Isla reflected that this student showed unexpected interest and engagement in the lesson.

I could also ask some critical thinking questions for one of her students, and he was able to respond. He was actually really willing to, and they were a bit shocked! I think it was nice that he was so interested and engaged in that. (Interview 2, April 11, 2017)

Isla’s experiences with her students and background in UDL guided her to target checkpoints from the lowest tier. This shows that pushing into the higher tiers is not always the appropriate approach to take. With her focus on lower-level checkpoints, Isla was able to engage students across a range of ages and abilities and have a very successful lesson.

Another example of the benefit of targeting checkpoints from the lowest tier came in Isla’s reflection on adapting materials. In order to provide options for perception as part of the representation principle, she offered alternatives for visual information, as shown in Figure 4-7. This was geared particularly for a student from Nicole’s class who had low vision and needed tactile materials. Isla described the adaptation process and the benefits to both Nicole’s student and her own class.

I decided that because it’s in a petri dish, I flipped it over so you could get the flat on the bottom, and on the outside I did hot glue on where the
spores were. Bigger dots of hot glue where there were bigger spores and all that stuff. It was all tactile so she could feel it. All my other students loved it, too, which was cool, because I was like, ‘This is really geared towards the student who has significantly low vision and is blind, but all the other students thought it was really cool.’ (Interview 2, April 11, 2017)

By providing options for perception, she engaged students across a range of skills.

These examples show that while some teachers focused heavily on pushing into the higher tiers, there were also benefits to targeting the lowest tiers when creating designs.

The evidence provided supports the second theme: teachers utilized the three tiers of the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program. Teachers’ utilization of the three tiers of the UDL guidelines was illustrated by striving to push into higher tiers, reflecting on their own practice, and thoughtfully targeting lower tiers based on the nature of the students and goals of the lesson.

**Theme Three: Teachers Utilized Individual UDL Guidelines to Make Design Decisions**

The third theme illustrates how teachers looked beyond the structure of the principles and tiers and utilized individual UDL guidelines to make design decisions. This theme examined each of the nine UDL guidelines individually to identify patterns of use: both principles and tiers were considered. The data for all nine guidelines are displayed in Figure 4-8.

The percentage of each guideline’s identification or observation in designs was calculated by dividing the frequency of use of each individual guideline by the number of total opportunities across all designs. These data revealed several patterns that were compared to themes one and two. Theme one examined how teachers generally utilized the three principles, without exploring the role of the three tiers. Theme two
examined how teachers generally utilized the three tiers, without exploring the role of the three principles. Theme three explored how teachers made design decisions when considering both axes of the UDL guideline visual: the three principles and the three tiers.

**Examining the utilization of individual principles at each tier level**

Data from theme one showed that overall, checkpoints from the representation principle were identified or observed most frequently, followed closely by those from action and expression, and engagement. These data looked at all three tiers simultaneously. Based on theme one, one might expect that each individual tier would follow the same pattern. However, this pattern was not always repeated when looking at each tier individually.

The general pattern from theme one only holds true for the highest tier. This is because the representation guideline (provide options for comprehension) was observed most frequently, followed by the action and expression (provide options for executive functions) and engagement (provide options for self-regulation). However, the spread between the three principals at the highest tier (19-54%) was greater than it was when considering all three tiers as performed for theme one (44-58%). Therefore, there were differences when looking at the principles from the highest tier individually as compared to the principles as a whole.

When looking at the middle tier, the action and expression guideline (provide options for expression and communication) was used the most frequently, followed by representation (provide options for language, mathematical expressions, and symbols), and then engagement (provide options for sustaining effort and persistence). Therefore,
when looking at the middle tier individually, teachers’ most frequently used principle was different than when looking at the principles as a whole.

At the lowest tier, the representation guideline (provide options for perception) was used the most, followed by engagement (provide options for recruiting interest), and then action and expression (provide options for physical action). Once again, the pattern revealed in theme one does not hold when looking at the lowest tier individually as compared to the principles as a whole.

This shows that while theme one provides relevant general information about how teachers utilize the three UDL principles to make design decisions, that theme cannot be grossly applied to each of the three tiers individually. Examples supporting theme three will illuminate how the characteristics of teachers of Deaf students with special needs influenced design decisions when considering all nine guidelines.

**Examining the utilization of the tier levels for each individual principle**

Data from theme two showed that across all three principles, checkpoints from the lowest tier were identified or observed more than those from middle tier, which were in turn identified or observed more than those for the highest tier. When looking at each principle individually, this pattern holds only for the engagement principle. The lowest tier guideline (provide options for recruiting interest) was observed more than the middle tier (provide options for sustaining effort and persistence), which was in turn observed more than the highest tier (provide options for self-regulation). This is the only principle for which the pattern revealed in theme two holds.

When looking at the representation principle, the lowest tier guideline (provide options for perception) was utilized the most. However, the middle tier guideline (provide options for language, mathematical expressions, and symbols) and highest tier
guideline provide options for comprehension) were utilized by teachers to the same degree. Therefore, when looking at the representation principle, the pattern from theme two does not hold.

The guideline utilized the most for the action and expression principle is the middle tier (provide options for expression and communication), followed closely by the lowest tier guideline (provide options for physical action). The highest tier guideline of the action and expression principle (provide options for executive functions) was utilized the least for that principle. Once again, the pattern from theme two does not hold for this principle.

This shows that while theme two provides relevant general information about how teachers utilize the three tiers of the UDL guidelines to make design decisions, that theme cannot be grossly applied to each of the three principles. Theme three illuminates how the characteristics of teachers of Deaf students with special needs dictate design decisions when considering all nine guidelines individually.

In the following sections, I describe how teachers chose individual UDL guidelines based on their experiences and goals, and avoided those guidelines that were deemed inappropriate for their students’ developmental level or the goals of the lesson. I also provide examples and contexts for those checkpoints that were observed most and least frequently across the teachers’ designs.

**Role of teacher background and experience in the utilization of individual UDL guidelines**

Theme three was supported by teachers’ reflections on the process of using UDL as a framework of design. Teachers’ backgrounds and experiences with Deaf students with special needs impacted the identification and observation of UDL guidelines that
did not follow the patterns revealed in themes one or two. For example, the middle tier of the action and expression principle encourages teachers to provide options for expression and communication. As displayed in Figure 4-8, this middle tier guideline was identified or observed more frequently that the lowest tier guideline for action and expression. As supported by the literature review in this study, Deaf students have unique and specialized needs in language and communication development. Ella encompassed this way of thinking.

We teach in a bilingual classroom. One of our students might understand the concept in English, but is learning sign language and might not know how to represent that language in sign language. To give them both, equal opportunity… That was something that we had actually talked about as a team: remembering to do both. And exposing the kids to both, because it’s so important. (Interview 3, April 11, 2017)

Similarly, Molly reflected that as a teacher of Deaf children “you’re thinking about, ‘How can I get language out of them?’” (Interview 6, April 12, 2017). With language and communication at the forefront of their minds, these teachers mindfully utilized an individual UDL guideline based on their background and experience as teachers of Deaf students.

Other evidence supporting theme three was revealed when two teachers shared the belief that some guidelines were inappropriate for their students’ developmental level or the goals of the lesson. Tina and Corey independently reflected that they specifically avoided checkpoints from the middle tier representation guideline for a similar reason. Tina worked with middle school aged students and focused her lesson on animal adaptations, while Corey’s elementary aged students learned about creating lab reports after using a microscope. Both teachers noted that they avoided representation checkpoints from the “provide options for language, mathematical
expressions, and symbols” guideline. They felt that focusing on those checkpoints would negatively impact the motivation and attention of the Deaf students, particularly when the learning goals were for science content. Tina reflected that she avoided this area “because they struggle, some of them struggle with text. If they see that, they’re going to be turned off. That can impact their attention” (Interview 5, April 12, 2017).

Similarly, Corey reflected that

for what I was doing, I stayed away from syntax and structure. I wanted this to be a successful lesson and those are more stressful and definitely more triggers for Deaf students in general, but then behavioral Deaf students… I didn’t really want to go in that direction for this specific lesson. (Interview 4, April 12, 2017)

This is an example of the complex relationship between language background, literacy development, and motivation in Deaf students. Both Tina and Corey felt that in order to teach a successful science lesson, they had to avoid specific representation checkpoints that could impact attention and cause stress. This shows mindful utilization of the individual UDL guidelines while making design decisions based on the belief that a particular guideline was inappropriate for the students and lesson.

Molly’s reflection on her cooking lesson provided insight into how she, as a teacher of Deaf students with special needs, viewed the importance of both the UDL principles and tiers in her design process. She noted that she most often designed within the lowest and middle tiers of the representation and action and expression principles. This was based on her constant desire to address the language needs of her Deaf students. Therefore, Molly chose to challenge herself by making mindful design decisions using the UDL guidelines.

Most often it’s been in the first and second level and not up on that top tier. So I intentionally picked something that was on the left side, on the
That I was trying to get out of everybody. (Interview 6, April 12, 2017)

Though she also noted that “branching out is challenging” (Interview 6, April 12, 2017), Molly presented with a very robust design and her Document Rubric showed the strongest implementation of UDL checkpoints across all seven teachers despite the fact that UDL was a new concept for her at the beginning of this study.

These examples show that many factors influenced teachers’ use of the UDL guidelines. Their background and experience, such as knowledge of the unique language and learning needs of Deaf students with special needs, impacted the way they utilized individual UDL guidelines in their design process.

**Frequency of individual UDL guideline use**

Frequency of use varied across each UDL guideline. In this section, the most frequently and infrequently used guidelines are explored in more depth. This information can be used as a guide to determine the contexts in which individual UDL guidelines are more or less likely to be utilized in the designs of teachers of Deaf students with special needs.

Individual UDL guidelines were identified or observed in the following order, from highest percentage to lowest: perception (lowest tier of representation); recruiting interest (lowest tier of engagement); expression and communication (middle tier of action and expression); physical action (lowest tier of action and expression); comprehension (highest tier of representation); language, mathematical expressions, and symbols (middle tier of representation); sustaining effort and persistence (middle tier of engagement); executive functions (highest tier of action and expression); and self-regulation (highest tier of engagement). This is displayed visually in Figure 4-9.
Frequently utilized UDL guidelines. The four UDL guidelines that were identified or observed most frequently include all three of the lowest tier guidelines along with one middle tier guideline (Figure 4-9). Providing options for perception (representation) was identified or observed in 71% of design opportunities. Providing options for recruiting interest (engagement) and providing options for expression and communication (action and expression) were both identified or observed in 67% of design opportunities. Finally, providing options for physical action (action and expression) was observed in 64% of design opportunities. The use of any of these four guidelines does not imply a superior design process when compared to designs that did not utilize them. However, their frequent use across the seven designs in this study warranted a deeper analysis in order to reveal the contexts of their use.

The most frequently used guideline – provide options for perception – comes from the lowest tier of the representation guideline. At least one of the three checkpoints in this guideline was identified or observed in six teachers’ designs: Isla, Molly, Sean, Tina, Ella and Eliza, and Corey. Table 4-4 describes how these teachers implemented these checkpoints.

Teachers provided options for perception by incorporating multiple modalities into their lessons and digital media designs. Lessons were conducted in spoken English and ASL, with AAC communication devices included as well. Digital media products reflected written English, images of ASL, pictures, and animations. This is illustrated in Figure 4-10, which shows still images from Isla and Molly’s PowerPoint artifacts. Both of these slides were animated, which cannot be reflected in Figure 4-10. By incorporating
these multiple modalities in their lessons and digital media designs, teachers provided options for perception.

Molly reflected that providing options for perception was a time consuming but beneficial practice. Her PowerPoint was heavily animated to isolate each individual step of creating the banana yogurt parfait recipe. She noted that adding the animation to the PowerPoint “was more time consuming to make, but I don’t think that’s a bad thing. I think that that’s always the challenge, just in general. It’s good teaching principles” (Interview 6, April 12, 2017). She noted benefits to using animations in her Student Use Survey.

Taking the time to make a quality presentation with digital visuals is important, and when I thought about what my goal for the motions was, I never dreamed it would work so well for everyone. It was great. It really highlighted vocabulary that I hope sticks with the students, and at the very least we will make sure to highlight materials, ingredients and directions over and over so that every child can define them. (Student Use Survey, April 12, 2017)

Molly reflected that the use of animations as an option for perception was an important element of her design. The use of videos in ASL is another option for perception that I expected to see in digital media artifacts. However, none of the digital artifacts collected incorporated video-based ASL content. Tina spoke of her desire to both include more ASL videos and analyze videos from the Described and Captioned Media (DCM) Program.

I can see using UDL more for developing more PowerPoints, to include more videos, throwing some YouTube clips in there. And to analyze the movies from DCM more carefully. I wish there were more movies in ASL. To not be depending on words. (Interview 5, April 12, 2017)
She identified time as the greatest barrier to creating or locating ASL-accessible materials for her students. "One thing is, I wish I had more time for everything" (Interview 5, April 12, 2017).

Molly and Tina’s statements, coupled with the evidence from the UDL Lesson Planner and Student Use Survey documents, show that teachers valued providing options for perception for their Deaf students with special needs. They accomplished this by incorporating multiple modalities within their lessons and digital media designs.

Another frequently used guideline – provide options for recruiting interest – comes from the lowest tier of the engagement principle. At least one of the three checkpoints in this guideline was identified or observed in all seven teachers’ designs. Teachers provided options for recruiting interest by maximizing students’ opportunities to make choices within the context of engaging, relevant, and hands-on activities. Table 4-5 describes how teachers implemented these checkpoints.

Hannah reflected that providing hands-on activities was the most successful way to engage her preschool students. On her Student Use Survey, she reflected on the activities she had included in her design and noted that “the hands-on portion was much more engaging and motivating for them” (Student Use Survey, March 21, 2017) when compared to the web-based video she selected.

Sean recruited interest from his high school/transition students by informing them that the class’ next community outing would be selected based on the research done during the lesson. Students had the autonomy to select a community location of interest to them and support their choice through guided research. Sean noted that the structure of his high school/transition classroom was often different than a more traditional
classroom, given the age and goals of his students. A significant amount of time was
devoted to preparing students for their transition to their post-secondary adult lives.

It’s so much discussion, and, ‘What happens if this happens.’ It’s not as,
‘This is the content, and let me teach it to you.’ A lot of the stuff that we do,
I don’t feel like I’m giving them stuff. I feel like I’m pushing them to the way
that I think could benefit them best. (Interview 7, April 12, 2017)

Sean recruited interest by providing appealing choices to his students within the context
of an authentic and relevant activity.

Similarly, Molly shared that she expected her cooking activity would recruit
interest because her students would be able to eat their recipe once it was ready. She
also focused on the value and authenticity of a task that could be repeated at home with
families. As described in the literature review of this study, there is often a
communication modality mismatch between Deaf children and their parents and
families. Opportunities for meaningful language-based interactions can be difficult to
establish, especially as children become older. This modality mismatch means that Deaf
children who arrive home from school often cannot describe their day to their families.
Molly sought to use the lesson and the recipe review as a way to increase the
opportunity for interaction and carryover at home. She described her goal for one
student who was in the early stages of expressive ASL ability.

He’s not going to go home and say, ‘I want to make a banana yogurt
parfait.’ And even if he did and signed that perfectly, beautifully, would that
be understood? And so I want to be able to give him a tool that says, ‘This
is what this is,’ and then turn it over and say, ‘Here is the recipe if you
want to make it together!’ with the hope that the family could be like,
‘Yeah, you want to make this five star recipe!’ (Interview 6, April 12, 2017)

In these examples, Sean and Molly designed lessons that engaged their students
by providing options for recruiting interest. They did this by maximizing students’
opportunities to make choices within the context of engaging, relevant, hands-on activities.

Another frequently used guideline – provide options for expression and communication – comes from the middle tier of the action and expression principle. At least one of the three checkpoints in this guideline was identified or observed in all seven teachers’ designs. Table 4-6 describes how teachers implemented these checkpoints.

Teachers provided options for expression and communication by providing students with multiple modalities for both receptive and expressive communication of ideas. Across designs, teachers utilized spoken and written English, ASL, pictures, images of ASL signs, animations, and video.

Some of the multiple modalities within these designs have already been described in this chapter, such as Isla’s germ PowerPoint shown in Figure 4-10 and the variety of modality choices for Corey’s microscope lab report. In her Student Use Survey, Corey noted positive responses when students were given multiple tools for composition. For example, Rhea “jumped at the chance to make a PowerPoint,” and “picked all images herself – constructed sentences with minimal support” (Student Use Survey, April 6, 2017). This evidence illustrates how Corey provided options for expression and communication in her design.

In her design, Hannah provided options for expression and communication by giving her students multiple tools for construction. Hannah’s preschool students worked on identifying two-dimensional shapes within the context of completing tangram patterns. In the first part of the activity, she provided her students with the opportunity to
explore multiple tangram templates and pattern blocks. In the second part of the activity, she also provided a worksheet on which students recorded how many of each shape they utilized in their pattern. These activities are illustrated in Figure 4-11. Hannah provided her students with multiple means of action and expression by giving them the opportunity to use pattern blocks in different ways as they identified two-dimensional shapes.

These examples illustrate how teachers provided options for expression and communication for their bilingual Deaf students with special needs. They accomplished this by incorporating multiple modalities and tools for composition and construction within their lessons and digital media designs.

The final frequently used guideline that is explored comes from the lowest tier of the action and expression principle: provide options for physical action. At least one of the two checkpoints in this guideline was identified or observed in six teachers’ designs: Isla, Molly, Sean, Tina, Ella and Eliza, and Corey. Table 4-7 describes how teachers implemented these checkpoints.

Teachers provided options for physical action through a variety of lesson materials and activities. Some of these have already been described in this chapter, such as Corey’s options for completing a microscope lab report, and Molly’s use of three levels of digital recipe review. This was also reflected when Ella and Eliza provided students with tools – such as a cup to scoop dirt – in their grass seed lesson. This option for physical action gave a student with sensory defensiveness the opportunity to engage with the materials and lesson. Similarly, in her Student Use Survey, Isla noted that one student “was very engaged with the cotton swabs (swabbing
for bacteria) because he got to wear gloves like a scientist and have a choice of what he wanted to test!” (Student Use Survey, April 10, 2017). Isla observed an increase in this student’s motivation when he was given this option for physical action.

These examples illustrate how teachers provided options for physical action for their Deaf students with special needs. They accomplished this by including a variety of lesson materials and activities within their lessons and digital media designs.

**Infrequently utilized UDL guidelines.** Two UDL guidelines were identified or observed nearly half as often as any of the other guidelines, as shown in Figure 4-9. Both of these guidelines come from the highest tier. Providing options for self-regulation (engagement principle) was identified or observed in 19% of design opportunities and providing options for executive function (action and expression principle) in 24% of design opportunities. It is important to note that it would never be expected for any single design to address all UDL checkpoints. However, the notable lack of consistent use of these two guidelines warranted a deeper analysis. This information is not intended to indicate designs incorporating these infrequently utilized guidelines were superior to those that did not include these guidelines. Rather, these examples can be used as a guide to determine the contexts in which these infrequently utilized guidelines can be implemented.

The self-regulation guideline of the engagement principle contains three checkpoints. These were identified or observed in the designs of Molly, Sean, and Ella and Eliza. Table 4-8 displays how these teachers implemented these checkpoints.

Teachers provided options for self-regulation by setting and maintaining high expectations, incorporating structured opportunities for students to participate in self-
reflection, and incorporating individual strategies for success. Sean illustrated this when he described his perspective on setting expectations for his students.

I think quickly at this school, I saw my expectation of kids always has to be this level <holds hand up high>. I think the minute we don’t get to that, we’re just expecting them to be always that low. (Interview 7, April 12, 2017)

After his community outings lesson, Sean completed his Student Use Survey. He indicated that he observed an increase in independence, stating “students embraced the opportunity to complete research independently” (Student Use Survey, April 6, 2017). Overall, Sean’s design accounted for four of the nine examples of checkpoints from the two infrequently utilized guidelines. He often referred to having high expectations and pushing his students to reach their maximum potential.

As described, Molly sought to challenge herself by targeting a checkpoint from the self-regulation guideline of the engagement principle. This was an area she felt she did not address frequently enough. She provided options for self-regulation by designing three levels of a digital recipe review that students used to self-reflect on the recipe that was cooked (Figure 4-12). Student engagement in self-reflection was the goal of this lesson. Molly noted that she “really wanted to make it more of an analysis afterwards, because I feel like they have a lot of experience there. I’ve been trying to make it as hands-on as possible and individual as possible, in that setting” (Interview 6, April 12, 2017). Molly utilized the individual UDL guidelines to promote self-reflection and provide options for self-regulation.

Ella and Eliza targeted self-regulation by ensuring the consistent use of a positive reinforcement system – their students’ token boards. On her Student Use Survey, Ella reflected that their digital media materials also supported the self-regulation of one of
her preschool students. She noted that by “using an interactive PowerPoint, my student was able to self-regulate and sit appropriately, wait for her turn in order to tap the SmartBoard – feeling of pride in helping her teachers” (Student Use Survey, April 3, 2017).

Teachers of Deaf students with special needs can provide options for self-regulation in a variety of ways, such as setting and maintaining high expectations, incorporating structured opportunities for students to participate in self-reflection, and incorporating individual strategies for success.

The other infrequently utilized guideline comes from the highest tier of the action and expression principle. At least one of the three checkpoints in the executive functions guideline was identified or observed in the designs of Hannah, Molly, Sean, and Ella and Eliza. Table 4-9 shows that teachers provided options for executive functions by guiding students in setting goals, and supporting planning and strategy development.

Two checkpoints from this guideline were observed in Sean’s design. After viewing and discussing the community outings FlipChart, students were guided by a worksheet to complete independent research. This worksheet (Figure 4-13) guided students to set a goal by selecting a community outing they wished to take. The worksheet supported planning by prompting for information such as activities, transportation, past experiences, and logistical concerns. The worksheet supported strategy development by asking how the community outing would help students become independent adults and why the outing would be appropriate for the class. Sean’s
design showed mindful consideration of how he could provide options for executive functions for his Deaf students with special needs.

Ella and Eliza also supported planning and strategy development in their design for their preschool students learning about grasslands. They introduced the students to the hands-on activity – planting grass seed – by using a PowerPoint to review relevant vocabulary and present the steps for the activity. Within this digital media artifact, they supported planning by providing a picture-based list of necessary materials as well as a visual of the six steps to plant the grass seed (Figure 4-14). Both of the visuals in Figure 4-14 were animated such that each material or step appeared one-at-a-time, allowing for more isolated review and emphasis on the process.

The executive functions guideline includes another checkpoint: enhance capacity for progress monitoring. This checkpoint was not identified or observed across any of the seven teachers’ designs – the only one of the 30 checkpoints to have that designation. The implications of this finding will be discussed in the next chapter.

The third theme revealed the importance of approaching digital media design for Deaf students with special needs in context. Teachers’ experiences and backgrounds working with Deaf students, the goals of the lesson, and considerations of the appropriateness of each guideline to meet the needs of the students were relevant in guiding teachers’ designs. Theme three showed that teachers utilized individual UDL guidelines to make design decisions, and illustrated contexts for the most and least frequently utilized guidelines.

**Sub-Question One: Summary**

The data provided for sub-question one illuminate how teachers utilized the UDL guidelines to make decisions when designing digital media materials for students with
special needs in a bilingual Deaf education program. The three themes explored how the three principles, three tiers of support, and nine individual guidelines that make up the structure of the UDL guidelines had an impact on those design decisions.

Data supporting theme one showed that guidelines from the representation principle were identified or observed more than those from action and expression or engagement. Data supporting theme two showed that lowest tier guidelines were identified or observed more than middle tier guidelines, which were in turn identified or observed more than those from the highest tier. Data supporting theme three showed that looking at the nine guidelines individually can reveal patterns different than those in themes one or two. These patterns may be influenced by teachers’ experiences and backgrounds, the goals of the lesson, and the appropriateness of the guidelines to the needs of the students. The third theme also explored the most and least frequently used guidelines and illustrated the contexts in which these guidelines were used by teachers of Deaf students with special needs.

These three themes addressed sub-question one: How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program? The goal of sub-question one was to determine how the UDL guidelines influenced the design process for teachers of this unique student population. The evidence revealed that the structure of the guidelines – including the three principles, three tiers of support, and nine individual guidelines – was essential in guiding teachers in making decisions when designing for this population.
Sub-Question Two

Sub-question two asked, What features of the PD did participants feel supported or hindered their learning during the PTLC? This focused on the features of PD and teacher learning.

In this study, UDL was presented to teachers through a structured PD format: the PTLC. This model of PD, developed by the Southwest Educational Development Library (SEDL), is a “vehicle for teacher collaboration and sharing, and the process improves alignment of curriculum, instruction, and assessment” (SEDL, 2008, p. 1). This six-step cycle is intended to be implemented on a continual basis as a way to give teachers an opportunity to collaborate and improve their practice (Tobia, 2007). This study was designed as a single iteration of the cycle. The six steps of the PTLC teachers progressed through included Study, Select, Plan, Implement, Analyze, and Adjust (SEDL, 2008). The activities involved in each of these stages are described in Chapter 3 and can be viewed visually in Figure 3-1.

It should be noted that seven out of ten teacher participants sat down with me for individual interviews. There were three teachers who consented to participation in the study but attended only three or four of the six PTLC meetings. Additionally, these three teachers did not respond to requests for interview. I did feel some frustration and disappointment at this, but noted that “this is part of the process and I can’t stress about the things that I can’t control” (Research Journal, March 16, 2017). I do question how the perspectives of these three teachers would differ from the seven teachers who did participate in more of the PD sessions as well as the interview. Necessarily, these three teachers’ viewpoints are not strongly reflected in the study because they did not
participate in interviews. Data from these three teachers would impact the results for this sub-question.

The analysis of these data revealed two themes:

1. The presence of critical features of PD was more relevant to teacher learning than the structure of the PTLC.

2. Teacher learning was supported and hindered by the presence of five critical features of PD.

Each theme is explored in the following sections.

**Theme One: The Presence of Critical Features of PD was More Relevant to Teacher Learning than the Structure of the PTLC**

Teachers reflected on their experiences during the PD through various formats. These included small group discussion during the Analyze and Adjust stages of the PTLC and conversation during individual interview. Analysis of these reflections showed that teachers did not share extensively regarding the structure of the PTLC. Rather than speaking to the structure of the PTLC, teachers focused on the various ways the structure of the PD made the experience more or less successful for them. The analysis showed that teachers’ reflections could be categorized by the ways this PD was and was not reflective of Desimone’s (2009) critical features of PD. When teachers were asked during interviews to reflect on their perspective on the PTLC, they frequently described critical features rather than structural elements of the PTLC. Given this study’s use of an interview guide, I was able to compile teachers’ responses to the interview question that focused on the structure of the PTLC. I used these responses to identify the critical features of PD that the teachers referenced in their responses. Teachers’ reflections when asked about the structure of the PTLC and the related critical feature referenced in their response are provided in Figure 4-15.
As shown in Figure 4-15, teachers’ responses to my inquiry about the structure of the PTLC were focused on how the presence of the critical features of PD supported or hindered their learning. Hannah described an active learning strategy that she wished had occurred earlier in the PTLC. Isla was glad to get a refresher on the content of UDL and described the coherence of her view of UDL as a mindset. Molly wished for more examples of the content and needed clarification of how UDL differed from her current practice. Sean expressed that he was glad the PD was shorter than previous experiences. Tina noted that she appreciated the option to engage in active learning strategies either in collective partnerships or individually. Ella emphasized the need for more examples of the content to support her as a learner. Finally, Corey also wished for more specific examples of the content, and reflected positively about an active learning strategy and the contained duration of the PTLC. Theme two will explore the ways that each critical feature was or was not present in the PD, how each could have been strengthened, and how these critical features supported or hindered teacher learning.

These comments illustrate that the teachers found the presence of critical features of PD more relevant to their learning than the structure of the PTLC. The structure of the PTLC was important in that it afforded activities that incorporated these critical features. The nature of the presence of the five critical features of PD is explored in the next theme.

**Theme Two: Teacher Learning was Supported and Hindered by the Presence of Five Critical Features of PD**

As described in the literature review, there are five critical features shared across successful teacher learning opportunities: content focus, coherence, duration, active learning, and collective partnerships. The presence and strength of each of these
features in the PTLC supported and hindered teacher learning in various ways. Each critical feature is explored in the following sections.

**Content focus**

PD that maintains a content focus is concentrated on subject matter content, and how children learn (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001) and think (Whitcomb, Borko, & Liston, 2009). In this study, the presence of this critical feature was valued by the teachers participating in the PTLC. Teachers noted that the content of the PD supported their current practice because it was child-focused.

This PD included an introduction to the core concepts of UDL and the UDL guidelines, an opportunity to design UDL-based lessons and materials, implement them in the classroom, and reflect on their use during the PTLC. The literature review of this study explored the benefits of digital media as a tool to help Deaf children learn and think. In this way, PD on digital media design for Deaf children is content focused. Given the affordances of digital media to address the needs of Deaf students with special needs, many SDC teachers already designed and created digital media as a regular part of their practice. The PD on UDL provided teachers with a different set of parameters to approach this task. When considering her design process, Corey stated that she was

> really trying to target different things, and I don’t usually think beyond Individualized Education Program objectives and what the curriculum outline says. This was a different set of parameters that I was trying to pull from. So I think just in incorporating all of the things, it was a little bit different” (Interview 4, April 12, 2017)

While Corey noted that the UDL-based design process taught during the PTLC was different, the PD’s emphasis – or content focus – on how children learn, supported her regular practices in providing digital media to her Deaf student with special needs.
Tina felt her current practice was not only supported but also enhanced. She noted that using UDL to design her lesson and materials was “more work, but at the same time, it made the lesson more interesting for me and also for the kids” (Interview 5, April 12, 2017). This reflection showed that Tina found value in the content of the PD for its benefits not only to the students but to herself as well. I noted in my research journal that

we may have focused so heavily on how UDL can benefit our students that we didn’t stop to think about how UDL can benefit our teachers! Students aren’t the only ones that fall into a rut in the classroom and become bored with the same-old-same-old. Teachers do as well. I think this will be a very interesting talking point. (Research Journal, April 12, 2017)

Tina’s reflection that using UDL made the lesson more interesting for the students showed that the PD was focused on how students learn and think – a key element of the critical feature of being content focused (Desimone, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001; Whitcomb, Borko, & Liston, 2009).

While these examples illustrate the presence of a content focus in the PTLC, there was also evidence that this critical feature could have been strengthened. Several teachers reflected that the terminology of the UDL guidelines caused them difficulty. For example, Tina stated, “I think I need more experience in interpreting and understanding the terminology in the Guidelines” (Interview 5, April 12, 2017). While reviewing the UDL guidelines during her interview, Molly reflected on some checkpoints that were not clear to her, such as “heighten salience of goals and objectives – that’s a lot of words! I don’t really know what that means!” (Interview 6, April 12, 2017). Tina and Molly’s statements show that the content of the PD could have focused more specifically on UDL terminology.
Along with feeling unsure about some UDL terminology, teachers noted that their understanding would have been supported by a greater variety of concrete examples during the PD. During the Study stage of the PTLC, teachers were provided specific implementation examples for each guideline. In addition, teachers were provided with a completed UDL Lesson Planner during the Select and Plan stages. However, several teachers reflected that these examples were insufficient in meeting their needs. This may have been due to my own familiarity with UDL impacting the number of examples I felt were necessary to support teachers’ comprehension. I reflected in my research journal that “I also need to be more aware that I have been living and breathing UDL for a few months now, and most of these people just got introduced to it last week. Of course they are overwhelmed and confused!” (Research Journal, April 6, 2017). A deeper level of comprehension with the content of the PD would have been supported by more examples. Molly illustrated this when she stated

I think maybe a few more examples of lesson plans would be helpful. I think probably because it was a lot of principles that are examples of good teaching, that I was like, ‘I think I understand this, but I want somebody to tell me that I understand this.’ That would just have been helpful. (Interview 6, April 12, 2017)

Molly’s statement was reflective of the many elements of UDL that were already observed in regular teaching practice at SDC, as shown on the UDL Lesson Planner. Molly struggled to distinguish some of the UDL-based practices from what she referred to as “examples of good teaching.” Similarly, Ella reflected that she was a “learn-by-doing, but from examples” type of learner, and that being “given examples, I think would be very beneficial. How people incorporated media, when they did, what times of day, what equipment they used, did they use pictures, different icons, things like that” (Interview 3, April 11, 2017). These statements show that the content focus – teachers’
understanding of how children think and learn with UDL – could have been strengthened with more concrete examples.

As described, this PD supported teachers’ regular practices and was content focused by exploring different ways that children think and learn. However, more concrete examples were needed to support some teachers’ understanding of the terminology and concepts of UDL. In this way, the presence of the content focus critical feature during the PTLC supported and hindered teacher learning in various ways.

Coherence

Coherence is defined as “the extent to which teacher learning is consistent with teachers’ knowledge and beliefs” (Desimone, 2009, p. 184). This implies that PD content and form must be contextualized to teachers’ knowledge and beliefs in order to be effective. Teachers described ways the PD was coherent with their beliefs, knowledge, performance expectations, and regular practice.

Several teachers illustrated ways the PD provided in the PTLC was consistent with their beliefs. Isla had extensive background in UDL from her graduate program. She repeatedly referred to UDL as a “mindset” and stated that she “personally loved this professional development because I felt like it was really embracing what I believe should be the philosophy of teaching and how we should approach teaching and education for all students” (Interview 2, April 11, 2017). In this way, the PD was coherent with her beliefs as a teacher. However, Isla also reflected that this might not have been the case for all teachers, particularly those who were new to UDL. She reflected that they “might not have really gotten that it was a mindset. I think they were a little more hesitant. Because they saw these guidelines and were like, ‘Oh, this is like a curriculum, this is what I have to do’” (Interview 2, April 11, 2017). This illustrates that
cohesion with teachers’ beliefs may have been mediated by their previous experiences with UDL.

Coherence with teachers’ knowledge was also reflected in this study. For example, Hannah described how the PD helped her understand how some of her knowledge was already reflective of UDL.

It made me a little more mindful of… ‘What do you call this? What’s a label for it?’ As opposed to, ‘I’m just going to plan something and I don’t know what the technical term is for it, but I know it’s going to work.’ It kind of put a label to it, which was nice. I was thinking, ‘Oh man, I didn’t realize that was this,’ when I was looking at it. (Interview 1, April 7, 2017)

In this example, Hannah’s established knowledge – what Molly referred to as “principles that are examples of good teaching” (Interview 6, April 12, 2017) – was coherent with the knowledge provided through the content of the PTLC.

As described, many teachers expressed their desire for more experience with UDL terminology, concrete examples of UDL, and lesson plan development. Had these been provided, the PD may have been more strongly coherent with teachers’ knowledge. Isla provided a suggestion that could have impacted the strength of knowledge coherence in this study.

It would be beneficial to maybe have teachers share a lesson that they were really proud of. What they thought they did well on, how they did it, and what they did. And then maybe talking about, ‘Well that’s really cool!’ And pointing out, ‘That was actually UDL, and that was as well. And you want to know something cool, if you had done this, that would have also been UDL. But this isn’t a wrong lesson. You did great, here are some ways that you could always make it better.’ (Interview 2, April 11, 2017)

Isla’s background with UDL allowed her to see opportunities to improve the PD in ways that could have benefitted teachers through coherence with their knowledge.

Another important factor related to teacher learning was coherence with teachers' performance expectations. Sean expressed that he engaged with this PD
because it was coherent with the performance expectations he set for himself. He stated that the PD did not feel like

something you *have* to do and 'I expect this in all of the lessons,' and all of this stuff. It's like, 'I'm doing this to help you.' You could take as much as you want. And yes, you have to do this lesson, but beyond that, you don't have to feel panicked by it. (Interview 7, April 12, 2017)

Corey illustrated the relevance of coherence with teachers' performance expectations as well. She reflected that she wished for a deeper level of confirmation of her own understanding of the PD content – once again reinforcing the need for more concrete examples – when she stated, "I just want to know where I *am* doing it, and where I *still could* be doing it" (Interview 4, April 12, 2017). Just as Sean set a performance expectation based on the ways the PD could help him, Corey set a high performance expectation of herself to understand and apply the PD in her practice. While the PD was coherent with teachers' performance expectations, this could have been strengthened with more concrete examples.

Finally, coherence with teachers' regular practices supported and hindered teacher learning. Teachers had positive reflections on the PTLC when it aligned with their regular practices, such as their approach to instructional planning and their overall teaching skills. Sean noted that the design process and required time for the UDL-based lesson was not different than his regular practice.

If you guys asked us to make a UDL lesson each time we did it, maybe that would be added time. But even still, my lesson didn’t change. I made my lesson. I thought of the stuff, but I wasn’t focused on that. I focused on what I wanted to do. And then when I went back, I was like, 'Oh, I hit the points.' (Interview 7, April 12, 2017)

Sean embraced this PD because it aligned with his regular practice. His reflection that his lesson did not change based on the UDL process may indicate that he did not
branch out and attempt to incorporate elements of UDL that were not part of his regular practice. Sean reflected that this may be due to the timing of the PD. SDC’s school year runs annually from July through June, and the PD took place in March and April. Therefore, teachers’ regular practices were well established when the PD was implemented. Sean noted that he felt that

> a lot of the stuff is set up. Maybe if we did this again in July, maybe not July, but in the fall, it would be like, ‘Oh, this was helpful because I didn’t think about this whole section.’ But at this point, a lot of it is so established. I don’t know. I’m not going to change. (Interview 7, April 12, 2017)

Discussions of timing do bridge into the critical feature of duration. However, it is important to note that the strength of the PD’s coherence with teachers’ regular practices may have been impacted by the fact that the regular practices were already well established in the context. Sean’s statement that he “felt so genuinely good about all of it” (Interview 7, April 12, 2017) illustrates the positive impact of the PD’s coherence with his regular practice.

Isla’s experience with UDL played a role in how the PD was coherent with her regular practice. As described, Isla frequently referred to UDL as a mindset. She already incorporated UDL as a mindset in her approach to the design process, implying that it was part of her regular practice. Isla reflected that some teachers might not have had sufficient experience to view UDL in this way. “I just think it’s a lot about a mindset, and being comfortable, and they’re not quite there yet, which is ok!” (Interview 2, April 11, 2017). I had a similar reflection after the Study stage of the PTLC, noting “a lot of people seemed to need reassurance that they do indeed already ‘do’ a lot of UDL in their classrooms already” (Research Journal, March 21, 2017). The PD’s coherence with teachers’ regular practices was determined by what those regular practices were.
For Isla, the PD was highly coherent with her view of UDL as a mindset. However, the PD may have been less coherent with the regular practices of teachers without UDL background. This was supported by teacher reflection on the PD process made during the Analyze stage of the PTLC when a teacher noted that at times the PD “felt abstract. How do I make this applicable to a lesson?” (Research Journal, April 6, 2017).

As a critical feature, coherence was observed in different ways with teachers’ beliefs, knowledge, performance expectations, and regular practices. Alignment with these elements supported teacher learning.

**Duration**

The duration of PD refers to the depth and breadth of time over which it is implemented. While there is no single unit of time that is considered appropriate, the literature suggests that PD must be sustained over time in order to be effective (Garet, Porter, Desimone, Birman, & Yoon, 2001).

The PTLC was implemented during six 45-minute meetings and one PD day over a period of four weeks in addition to the lesson implementation teachers did in their classrooms. The individual interviews were performed throughout the week following the completion of the PTLC. As described, there is no specific unit of time that can be considered appropriate for all groups of teachers. Views on the duration of the PD are influenced by other PD opportunities that teachers are involved in within their context. For teachers used to single-day PD, a multi-week training might be considered sustained over a long period of time. For teachers involved in annual PD throughout a full school year or longer, four weeks might be viewed as extremely short.

Teachers at SDC had regular opportunities for a variety of approaches. For example, all SDC staff were involved in weekly 45-minute sign language classes...
throughout the school year targeted to their skill level and the demands of their particular job. Staff also had single 45-minute trainings that reviewed instructional approaches, new resources, or other relevant topics. A discussion on the duration of PD must be framed by the experiences of those individuals who are a part of the context in which it occurred. The elements of the duration critical feature that supported or hindered teacher learning included the logistics, and contained and targeted nature of the PD.

When considering the logistics of the PTLC, several teachers noted that the duration of the PD was short in comparison to other trainings they had experienced. Sean and Tina both expressed positive responses to this short duration, particularly in comparison to longer PD sessions. Sean shared that he was “happy that it wasn’t as long as we’ve had in the past” and that “it felt quick too, in a good way” (Interview 7, April 12, 2017). This positive response contrasted to his negative description of some of SDC’s PD opportunities of longer duration. He reflected that “going back to the 12-week thing – I don’t know – it just gets to me when it’s that long. When it was the last one, I was like, ‘Oh, that was so fast!’ Which was also good” (Interview 7, April 12, 2017). For Sean, the short duration was a positive feature of the PD. This contrasts with Garet, Porter, Desimone, Birman, and Yoon’s (2001) recommendation that PD be sustained over time to be effective. Sean lauded the brevity of the PD compared to other opportunities at SDC. The brevity may have positively influenced his engagement and thereby the PD was more effective for Sean than would be training sustained over a longer period of time. He expanded on his comments to make a recommendation to
SDC regarding the logistics of future PD planning. He reflected particularly on how the Study, Select, and Plan phases of the PTLC occurred on four sequential days.

    That is kind of what I would suggest to the school. Just kind of bang it out. Give us a week. And I guess that week is tough because you have less planning time and stuff, but I don’t know. It didn’t feel that way. (Interview 7, April 12, 2017)

Sean’s comments show that his learning was supported by the duration of the PD – in this case, the short duration.

    The duration of the PTLC may have had a different impact on teacher learning for other teachers. As described, some teachers, such as Tina and Molly, expressed the desire to develop a deeper understanding of the terminology related to UDL. Other teachers, including Molly, Ella, and Corey, expressed that they needed more concrete examples throughout the PTLC. Hannah stated that she would “love to get some more training, maybe in the summer” (Interview 1, April 7, 2017). During the Analyze stage, I noted that “as always, I wish there was more time!” (Research Journal, April 6, 2017) as the PD provider. These statements indicate that the duration was not extensive enough for some individuals. Increasing the duration of the PD may have led to more effective results for some teachers, like Tina, Molly, Ella, and Corey, but not for others, like Sean. The timing within the year was also a logistical concern expressed by Sean. As described, the PTLC took place in March and April during a school year that runs from July through June. The PTLC may have had a different impact on teachers if it took place earlier in the school year before teachers’ routines were, as Sean described, “so established” (Interview 7, April 12, 2017).

    Another element of the duration feature that was observed to influence the effectiveness of the PTLC was that it was contained to an allotted time. This implies that
from the first meeting of the PTLC, teachers were informed exactly how long the cycle would last, what they would do for each step, and when it would end. Additionally, each step of the cycle involved ample devoted time for teachers to engage deeply in the activities for that step. Ella “liked being given that allotted time so that I didn’t have to do it at home, or during my lunch break, or in the morning, secretly” (Interview 3, April 11, 2017). Another teacher reflected during the Analyze stage that “being allotted time at school was beneficial” (Research Journal, April 6, 2017).

Ella also described how the contained nature of the PD supported her as she used the information she learned in the Study stage to complete her UDL Lesson Planner in the Select and Plan stages.

Given time to actually take it in, take a minute to fill it out, have time to ask each other questions or ask you questions, I think was beneficial. Because I don’t think it would have been as successful, if you said, ‘Here you go, you have to do it on your own.’ (Interview 3, April 11, 2017)

Molly had a similar reflection when she stated that she “liked it because I felt like we had time to do it, and not like, ‘Ok now you guys have homework, bye!’” (Interview 6, April 12, 2017). Moving through the PTLC stages in the time allotted for this PD was one way I ensured that teachers had ample time to engage with the content. I was particularly pleased that we completed the Study stage in two PD meetings, implying “this will leave us Monday and Tuesday to do Select/Plan, and leave people with plenty of time to really collaborate, design, and make their materials” (Research Journal, March 17, 2017). For Ella and Molly, the contained duration of the PTLC supported their learning by allowing them to engage with the UDL content.

The final element of the duration feature relevant to teacher learning was the targeted nature of the PD. This implies that the PD had clear, structured objectives for
teachers to develop a specific set of knowledge and skills within a given timeframe. Tina compared this to bilingual education trainings that many SDC staff were involved in for upwards of four years of training. She thought the PTLC was “a similar idea, but I thought this was more structured. It was to the point. We got right to the point. It was like an instant training. Right away, we could do it” (Interview 5, April 12, 2017). Tina’s statement shows that the structured, targeted nature of the PD was an important element of its duration and supported her learning. It allowed her to put the PD into practice right away. This was also observed in a teacher’s reflection during the Analyze stage of the PTLC, when it was stated that the PD allowed “enough time to get deep info on it, and use it in a way that was applicable to classrooms” (Research Journal, April 6, 2017). Sean compared the PTLC to other 12-week PD opportunities he experienced at SDC, noting that the PTLC was helpful rather than required. He said that those longer PD trainings felt “like a class, and it feels like something you have to do, instead of, ‘this is something that is helpful to you’” (Interview 7, April 12, 2017). The targeted objectives and clear timeline of the PTLC were beneficial elements of the duration of the PD for these teachers.

As a critical feature, duration supported and hindered teacher learning in different ways. Some teachers lauded the brevity of the training while others expressed a desire to develop more in-depth knowledge that would demand a longer duration. The contained and targeted nature of the PTLC’s duration also impacted teacher learning.

**Active learning**

PD that includes active learning implies that participants are actively involved in meaningful discussion, planning, and practice (Garet, Porter, Desimone, Birman, & Yoon, 2001, p. 925). During this PD, a variety of active learning activities were included.
Teachers engaged in meaningful discussion, collaboration, planning, and reflection on their practice. Activities elicited participation by asking questions and placing teachers in small groups for discussion. The inclusion of active learning supported and hindered teacher learning in various ways by impacting engagement, comprehension and skills, and teachers’ experiences with others.

Teachers’ engagement with the PD was impacted in different ways by the active learning strategies employed during the PTLC. For example, during the Study stage of the PTLC, teachers were given approximately 30 minutes to complete an activity called Around the World. During this active learning activity, they moved among posted chart papers that elicited the definition, examples, and bottom line take-away message for each of the nine UDL guidelines (Figure 4-16). This allowed teachers to explore, discuss, and refine their ideas as they encountered new terminology and concepts.

Corey reflected that she “liked the activity of getting up in the middle of it and walking around” (Interview 4, April 12, 2017). Molly also liked the Around the World active learning activity but shared that it was more challenging than she expected. She said, “I liked the breakout activity of us writing. But I think that I felt like, ‘Oh yeah, we can totally do that.’ And I got there and we were like, ‘This is harder than I thought!’” (Interview 6, April 12, 2017). When I reflected on this active learning strategy, I noted that I made an “on-the-spot change and instead of moving every three minutes or so, I just had people float between the chart papers as they wanted. This felt much more relaxed and people were really writing a lot on the papers!” and that “I heard a lot of talk about UDL and teacher practice, which of course is a good sign!” (Research Journal, March 17, 2017). This shows that for some teachers, like Corey and Molly, this activity learning strategy
supported their engagement in the PTLC and challenged them to develop a deeper understanding of the content.

Another active learning strategy used at the end of every PTLC meeting was the Whip Around. During this activity, each individual was given the opportunity to share a word or short phrase that encapsulated how they felt about the PD activities that day. The responses to the Whip Around activity are shown in Table 4-10. These responses varied by teacher and day, and provided an overall sense of how the teachers felt about the PD for each stage of the PTLC. For example, after completing the Study stage of the PTLC, I noted “I definitely dumped a lot of information onto the participants today. This was definitely reflected in a few of the Whip Around responses like ‘anxious’ and ‘challenged’” (Research Journal, March 17, 2017). As an active learning strategy, the Whip Around allowed me to take a daily pulse of the project during implementation.

However, Corey, who used the term Wrap Around, had a negative reaction to this active learning strategy.

My least favorite part is Wrap Around. That’s really all I can say. I’m more than willing to say my piece when I want to, but that’s just one of those things that… Now I don’t have any words in my brain, of course! (Interview 4, April 12, 2017)

In this situation, the active learning strategy negatively impacted Corey’s engagement in the PD. This shows that not all active learning strategies will support teacher engagement and learning in a PTLC.

Teachers’ comprehension and skills were also impacted in different ways by the active learning strategies employed during the PTLC. As active learning strategies, discussion and collaboration with others encouraged teachers to think critically and analyze their own practice. Tina described how these activities supported her...
throughout the PD and compared this to a less active approach such as a lecture-based presentation.

I liked that first you explained everything. Then we could discuss in small groups, or be on our own. I liked having that choice because I don’t always feel like I fit in a small group discussion. I like working on my own, having that option. Then we try something, share it with others, discuss, and get some feedback from each other. Sometimes sharing ideas helps. Then you can go back to more of an in-depth discussion. I like that because sometimes when you just sit through a presentation, then it’s over. That’s it. Goodbye, and you leave. (Interview 5, April 12, 2017)

Other teachers echoed Tina’s thoughts during the Analyze stage of the PTLC. I noted “some really nice comments were made about appreciating the time that was provided for people to really plan and design their lessons, rather than just be presented to all the time” (Research Journal, April 6, 2017). This illustrates the value teachers placed on this element of the PD.

Tina engaged in various active learning strategies, such as discussing with others and sharing feedback, when it felt appropriate to her as a learner. She also appreciated having the option to work individually. The option to engage in these active learning strategies helped Tina approach the task of digital media design and be more critical through self-reflection and analysis.

Your presentation also made it meaningful. If you read something, you might think, ‘Oh, that’s a good idea.’ But with yours, it was more, ‘Let’s try this!’ You could analyze your media usage to see if it was really appropriate or not, and what wasn’t successful. It was good because I’ve analyzed that a little bit, but not really taken a hard look at it. So I thought it was good. I was like ‘Oh, wow, this is different!’ (Interview 5, April 12, 2017)

Tina found the critical analysis of her own media usage an effective active learning strategy that supported her learning.
Teachers’ experiences with others during active learning activities also supported and hindered teacher learning. These included collaboration, discussion, and sharing and confirming ideas with others. These are explored in more depth in the following section about collective partnerships.

As a critical feature, the inclusion of active learning strategies supported and hindered teacher learning in different ways. Teachers’ engagement, comprehension and skills, and experiences with others were impacted by the active learning strategies employed during this PD.

**Collective partnerships**

Collective partnerships refer to participation by individuals with similar professional experiences, such as those from the same school, grade, or department (Desimone, 2009). Participation in collective partnerships allows teachers to engage in discussion, improve their understandings, and increase their capacity to grow (Ball, 1996). A variety of types of collective partnerships were utilized in the PTLC.

As described, teachers from both programs at The Communication School attended the PD sessions. While the SFC teachers were not the focus of this study, their role within the activities of the PTLC was relevant. When teachers worked in small groups or paired up for discussion, SFC and SDC teachers often collaborated. Teachers across age/grade ranges were observed to work together as well. For example, I observed during the Select and Plan stages of the PTLC that “there were definitely people working together, so that was good. And a little bit of cross-program collaboration, which is always nice to see!” (Research Journal, March 20, 2017). The make-up, activities, and impact of these collective partnerships were instrumental to teacher learning.
Teachers reflected on how the make-up of the collective partnerships impacted them during the PTLC. Ella and Corey described participating in collective partnerships with teachers from SFC. Ella noted that getting a different perspective from an SFC teacher was beneficial.

It was interesting because during the collaboration time, I sat with one SFC teacher and one SDC teacher. So it was nice to have those different perspectives, definitely. Because SFC doesn't always include the extra language piece, which SDC always does. So I think setting up in groups where you're kind of mixed could be really good, could be really beneficial. (Interview 3, April 11, 2017)

Corey described how a collective partnership between herself, Ella, and an SFC teacher referred to as Fran supported her comprehension of the content particularly during the early stages of the PTLC.

In the beginning, it was Ella, Fran, and I talking. So it’s interesting to have a variety of age ranges and SFC versus SDC conversations, and how they all thought it was being applied. And then, ‘Ok, well I thought it was this.’ So working some of those things out ourselves and then kind of coming up with the big question and asking that, rather than just peppering you with all of those issues" (Interview 4, April 12, 2017).

Corey reflected that a collective partnership that mixed programs and age ranges supported her engagement in the PTLC. However, not all teachers had this type of response to the collective partnerships they experienced during the PTLC.

As illustrated in the previous section, Tina noted that she liked having the option to work individually. She did not always feel like she fit in a small group discussion and she provided a few possible reasons for her discomfort. While her students might be a good match with students from down the hall, Tina did not feel comfortable socially to jump in and collaborate with those teachers. She did collaborate occasionally with a teacher who worked adjacent to her classroom, but Tina did not feel that the students were a good match academically.
It’s possible that my class would be a good match academically with the classes down at the other end of the hall. But I don’t really socialize with them much, so I feel a little awkward jumping in, ‘Do you mind if I join you?’ The class next door to mine, she sometimes joined in, but her class has more cognitive challenges. It didn’t feel like it was a good match. (Interview 5, April 12, 2017)

Tina’s statement contrasts with Ella and Corey’s view. Ella and Corey reflected that the perspectives of collaborators from different programs and age ranges was beneficial, while Tina felt that her students differed too much from the teacher adjacent to her to benefit from a collective partnership.

Sean had a reflection similar to Tina when he described his experience as a high school/transition teacher engaging in discussion with Isla, an elementary teacher. Sean noted that “it’s also tough too, because Isla is talking about these specific students, and I’m like, ‘Oh, this is not at all the same’” (Interview 7, April 12, 2017). He reported feeling isolated by the nature of his students, noting “that’s also what’s challenging about my class, too. I’m kind of on my own” (Interview 7, April 12, 2017). Hannah also reflected that the nature of her preschool students made her feel isolated when it came to collective partnerships.

I have the odd group. There is nobody else who is similar. I have no buddy class in the building. In theory, it’s nice – chatting with other teachers about their units and giving ideas and things. But for myself, I’m kind of in an awkward spot. I don’t have anybody. (Interview 1, April 7, 2017)

These statements show that Tina, Sean, and Hannah had a very different reaction to mixed-group collective partnerships than Ella and Corey. These reflections illustrate how the make-up of collective partnerships can support or hinder teacher learning within a PTLC.

The activities of the collective partnerships were another element relevant to teacher learning. Engaging in meaningful discussion is an important contributor to
teacher success (Ball, 1996; Garet, Porter, Desimone, Birman, & Yoon, 2001), and this was reflected in this PTLC. I observed this during the Analyze and Adjust Stages of the PTLC when I noted “for each of the two reflections today, there was lots of meaningful conversation going on” (Research Journal, April 6, 2017). Several teachers reflected on the value they found in discussing the content with others through collective partnerships. For example, Corey thought “it was helpful to have those conversations while we’re going through the process” (Interview 4, April 12, 2017) of the PTLC. Molly described sharing her UDL Lesson Planner with Isla and Hannah. She said, “they both gave me some feedback on it, so that was helpful” (Interview 6, April 12, 2017). In addition to providing the opportunity to receive feedback from other teachers, participating in the collective partnerships allowed Molly to clarify unclear concepts with others.

It was helpful to say, ‘Go talk with other people,’ so that you could say, ‘Hey, do you get this? This was my idea,’ and ‘Oh, that’s a good idea.’ Or you’re like, ‘Oh, ok, I feel better about it!’ I think that was helpful. (Interview 6, April 12, 2017)

These statements illustrate that the chance to engage in meaningful discussion within collective partnerships was a valuable activity for these teachers. Teachers’ engagement in meaningful discussion was observed during the Study stage of the PTLC when groups of teachers “were actively chatting and I think would have gone on if I hadn’t had to move things forward given the time” (Research Journal, March 16, 2017).

Similarly, Isla and Ella reflected that being given the opportunity for collective partnerships during the PD was both welcomed and beneficial. Isla noted that she really enjoys hearing other peoples’… what they do in their classrooms, and how they do it. Because I don’t get out! I am the teacher of my
classroom, so I often don’t get out to see what other people are doing.
(Interview 2, April 11, 2017)

In this way, the collective partnerships of the PTLC provided Isla with an experience that she did not often have – learning about the daily activities of other classrooms. Ella also noted that having time to work with other teachers made the PD more successful for her. She appreciated being given time to actually take it in. Take a minute to fill it out, have time to ask each other questions or ask you questions, I think was beneficial. Because I don’t think it would have been as successful if you said, ‘Here you go, you have to do it on your own.’ (Interview 3, April 11, 2017)

Isla and Ella’s reflections show that being provided with the time to engage in activities within collective partnerships supported their learning.

Finally, collective partnerships were observed to impact teachers’ participation in the PTLC in various ways. Several teachers reported wanting more time to engage in collective partnerships. Tina said, “I wish there was another way to find time for teachers to collaborate, and not just prep, prep, prep” (Interview 5, April 12, 2017). Ella reflected that if provided more time for collective partnerships, “seeing other people’s lesson plans could be really helpful” (Interview 3, April 11, 2017). These statements are reflective not only of a desire for more opportunities to engage in collective partnerships, but also of the need to extend the duration of the PD to accommodate this.

Several teachers made suggestions about how they envisioned collective partnerships playing a role in future PD at SDC. For example, during the Adjust stage of the PTLC, I noted that one teacher thought it “would be helpful to have morning time to work on and collaborate on unit plans” (Research Journal, April 6, 2017). Shortly after the completion of the PTLC, The Communication School’s administration announced that teachers would be provided with an additional 12 hours of collaborative prep time.
during the first six weeks of school. While teachers shared positive reactions to this change, the full impact of this opportunity has not yet been determined.

Isla recommended bringing SDC and SFC teachers together to increase confidence with implementing UDL.

It would be nice to have some teacher mentorship type situations with people who are more confident in UDL. Maybe just to get together in a group. Maybe four of us have the same curriculum, two might be SFC students and two might be SDC. And then we kind of work together and say, 'Well, I tried this, and it was awesome!' (Interview 2, April 11, 2017)

She felt that this type of collective partnership would help teachers become “more confident and really feeling a sense of community with one another. Because I think often we run around like chickens with our heads cut off!” (Interview 2, April 11, 2017).

Isla’s suggestion to increase opportunities for collective partnerships illustrates the value she assigned to that critical feature of PD.

Ella suggested that UDL PD involving collective partnerships be extended to paraprofessionals as well as teachers.

Once the teachers get the hang of this, I think this would be something good for the paraprofessionals to be a part of as well. Because you can’t successfully implement a lesson plan if you’re not on the same page as the people you work with. (Interview 3, April 11, 2017)

She reflected that providing this PD to paraprofessionals would allow all classrooms staff to "actually collaborate across the board" (Interview 3, April 11, 2017). Teachers’ reflections – and suggestions – that they wanted more time to engage in collective partnerships can guide future PD opportunities provided at The Communication School, as discussed in the next chapter.
As a critical feature, the inclusion of collective partnerships supported and hindered teacher learning in different ways. The make-up, activities, and impact of these collective partnerships were related to teacher learning during the PTLC.

**Sub-Question Two: Summary**

In this study, the PTLC was a structured approach to providing PD to teachers. Teachers participated in the six steps of the PTLC: Study, Select, Plan, Implement, Analyze, and Adjust. Teacher interview and research journal data were examined to address the question, What features of the PD did participants feel supported or hindered their learning during the PTLC? This section explored two themes related to how the teachers felt the structure of the PTLC and critical features of PD supported or hindered their learning.

A review of the literature revealed five critical features shared across a variety of approaches to the provision of PD: content focus, coherence, duration, active learning, and collective partnerships. The first theme revealed in the data for this sub-question was that the presence of critical features of PD was more relevant to teacher learning than the structure of the PTLC. Teachers reflected at length on how the critical features impacted their learning during the PTLC. There was little evidence that teachers found the six-step structure of the PTLC relevant to the PD’s success. This does not imply that the PTLC was an ineffective vehicle for the PD. Rather, there were other elements – namely the presence of critical features – that were more relevant in the eyes of the participants.

The second theme revealed in the data for this sub-question was that teacher learning was supported and hindered by the presence of five critical features of PD.
Teachers responded differently to the presence of these critical features, thereby supporting and hindering their learning in various ways.

The PTLC maintained a content focus in that it explored how UDL promotes designs with children’s thinking and learning in mind. However, teachers expressed a desire for more concrete examples to develop a deeper understanding of the concepts and terminology of UDL.

Coherence was observed in different ways across the PTLC. Consistency with teachers’ beliefs, knowledge, performance expectations, and regular practices supported and hindered teacher learning.

As a critical feature, duration supported and hindered teacher learning in various ways for different teachers. Some teachers lauded the brevity of the training while others expressed a desire to develop more in-depth knowledge that would demand a longer duration. The contained and targeted nature of the PTLC’s duration was also a relevant feature.

The inclusion of active learning strategies in the PTLC supported and hindered teacher learning by impacting teachers’ engagement, comprehension and skills, and experiences with others in different ways.

Finally, the make-up, activities, and impact of the collective partnerships in the PTLC were instrumental in teacher learning.

These two themes address sub-question two: What features of the PD did participants feel supported or hindered their learning during the PTLC? The goal of sub-question two was to determine how teachers felt the features of PD supported or
hindered their learning during the PTLC. The evidence revealed that the teachers felt that five critical features of PD were instrumental in their learning.

**Primary Question**

The two sub-questions that have been addressed were each part of a primary question that asked, How does PD in UDL influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs? The first sub-question focused on the application of UDL to the digital media design process within this population, while the second sub-question focused on features of PD and teacher learning. In this section, I will explore how the data for these sub-questions informs the primary question.

Given that the primary question was composed of two sub-questions, the results for each sub-question informed how the primary question was addressed. The first sub-question asked, How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program. Three themes emerged, showing that teachers utilized the UDL principles, tiers, and individual guidelines to make design decisions. Their design decisions were guided by the UDL guidelines in different ways based on their experiences with UDL, student and classroom needs, and lesson goals. This implied that the UDL guidelines provided teachers with a set of structured parameters for making informed design decisions.

The second sub-question asked, What features of the PD did participants feel supported or hindered their learning during the PTLC? Two themes emerged, showing that the presence of critical features of PD was more relevant to teacher learning than the structure of the PTLC, and that teacher learning was supported and hindered by the
presence of five critical features of PD. The exact nature of how those critical features impacted teachers varied across individuals, experiences, and contexts. This implied that participation in the PTLC impacted teachers because the PD was adapted to their teaching contexts and mindful of the critical features of PD.

Taken together, this leads to a broad theme that ties together the different elements: the digital media design process of teachers in a bilingual Deaf education program for students with special needs was influenced by providing teachers with a set of structured parameters for making informed design decisions via PD adapted to their teaching contexts and mindful of the critical features of PD. This is displayed visually in Figure 4-17.

This broad theme is respectful of the unique nature of bilingual Deaf students with special needs, like those at SDC. This was not, nor will it ever be, a one-size-fits-all population. Teachers need a variety of approaches in their toolbox, and this PTLC provided teachers with another way to approach the complex process of designing for their students: universal design for learning.

**Limitations**

The results in this study are impacted by several limitations which are critical to present and discuss in order to maintain rigor. There are limitations in the results related to two areas: data collection and data analysis.

The PTLC was provided within established PD opportunities in SDC’s schedule. These included several 45-minute blocks of time before students arrived in the morning, and a longer block of time during a PD day where teachers were present at school but students were not. These specific blocks of time were established by SDC’s
administration and there was no flexibility in when to provide the PTLC. This led to two limitations related to data collection and timing.

First, the morning time blocks in particular may have impacted teachers’ participation or engagement. During the Whip Around active learning strategy for the Study stage, at least one teacher used the word “sleepy” (Researcher Journal, March 16, 2017) to describe his/her feelings for that day. However, on the same date I also noted that “overall, the room felt engaged, interested, and excited,” that participants “were actively chatting” and “I was seeing a lot of nodding and interest from participants” (Researcher Journal, March 16, 2017). The presentation on the PD day concluded on a Friday afternoon, which may also have been a challenge to some participants.

Given the timing of this presentation, participants may not have been as engaged as I hoped. Everyone was probably thinking about the weekend and tired from a long week! However, there wasn’t really any flexibility here, and I was happy to get through as much as I did. (Researcher Journal, March 17, 2017)

However, on the same day, I noted that “based on the observations I was making, many people seem excited about this” (Researcher Journal, March 17, 2017). This data shows that it is possible that teachers had a mixed reaction to the timing of the PD.

The second limitation also related to the timing of the data collection. At times, I felt rushed as a presenter to complete a presentation for a particular day. There was no flexibility in the ending times of the PD blocks: these were established as a part of SDC’s schedule. With unlimited time, perhaps I would have had the opportunity to ensure that participants had a stronger understanding of the content. However, that was not realistic given that this study took place in an authentic context. It is important to consider this limitation and how it may have impacted the participants.
Another limitation of the data collection related to student response to the UDL-based lessons. As described, this study did not focus directly on the impact of UDL on student learning. That construct was beyond the scope of this study and would demand a different approach to inquiry. However, I was interested in teachers’ view on student response to the UDL-based lessons and materials as part of this study. Therefore, I requested that teachers complete the Student Use Survey immediately following the implementation of the lesson in their classroom. I collected a total of 15 Student Use Surveys from teachers because some teachers filled out surveys over repeated implementations of their lesson, while others submitted Student Use Surveys for multiple students. In addition, I had to repeatedly ask several teachers to submit their surveys in the weeks following the Implement stage. Several of the surveys submitted later contained more detail than could have realistically been written down immediately following the implementation of the lesson. SDC classrooms were busy places and teachers would not likely have had time to sit down and write extensively. Therefore, while the information provided was useful, I suspect that the Student Use Surveys were not completed in a uniform way. They may not be a reliable measure of student response to UDL-based lessons based on the way they were filled out by participants.

The limitations described relate to the collection of data during the PTLC. There were also several limitations related to the analysis of data that occurred after the PTLC. First, based on the nature of this study, I was the only individual who engaged in the coding process. I brought the results revealed through this coding process to the teachers through member checking. However, I did not get extensive feedback from the participants regarding their views, whether positive or negative, on what was revealed in
the results. In this way, the voices of the participants could have been more strongly reflected in the results of the study if they had participated more actively in the member checking process.

This section has outlined the limitations of the study’s results. This included limitations related to data collection, such as the timing of the PD, and data analysis, such as coding and member checking processes.

**Summary**

This chapter presented the results of this study. This included the participation in the study, results for sub-questions one and two, and the primary question. The chapter concluded with a presentation of the limitation of these results. The next chapter will explore the implications and provide a discussion of these results.
Table 4-1. Attendance across PTLC stages

<table>
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<th>PTLC Stage</th>
<th>PD Session 1</th>
<th>PD Session 2</th>
<th>PD Session 3</th>
<th>PD Session 4</th>
<th>PD Session 5</th>
<th>PD Session 6</th>
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<tr>
<td>Participants present (SDC teachers; max. 10)</td>
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<td>7</td>
<td>8</td>
<td>10</td>
<td>10</td>
<td>6</td>
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<tr>
<td>Non-participants present (SFC teachers, administrators)</td>
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<td>13</td>
<td>12</td>
<td>10</td>
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<td>12</td>
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<tr>
<td>Total staff present</td>
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<td>20</td>
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Table 4-2. Data collected from teacher participants

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<td>UDL Lesson Planner</td>
<td>7</td>
</tr>
<tr>
<td>Digital media artifact</td>
<td>7</td>
</tr>
<tr>
<td>Student Use Survey</td>
<td>15</td>
</tr>
<tr>
<td>Interview</td>
<td>7</td>
</tr>
</tbody>
</table>
Table 4-3. Participant descriptions

<table>
<thead>
<tr>
<th>Teacher Name</th>
<th>Gender</th>
<th>Age</th>
<th>Years teaching (total)</th>
<th>Years teaching (SDC)</th>
<th>Student grade range</th>
<th>MA educator license</th>
<th>Teacher-reported background with UDL</th>
<th>UDL lesson topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliza</td>
<td>F</td>
<td>33</td>
<td>1</td>
<td>1</td>
<td>Preschool</td>
<td>Special education</td>
<td>A little experience</td>
<td>Life Cycle of a Plant</td>
</tr>
<tr>
<td>Ella</td>
<td>F</td>
<td>30</td>
<td>4</td>
<td>4</td>
<td>Preschool</td>
<td>None</td>
<td>No background</td>
<td>Life Cycle of a Plant</td>
</tr>
<tr>
<td>Hannah</td>
<td>F</td>
<td>35</td>
<td>13</td>
<td>3</td>
<td>Preschool</td>
<td>Special education</td>
<td>A little experience</td>
<td>Two-Dimensional Shapes</td>
</tr>
<tr>
<td>Isla</td>
<td>F</td>
<td>25</td>
<td>2</td>
<td>2</td>
<td>Elementary</td>
<td>Instructional technology</td>
<td>Already an expert</td>
<td>Germs</td>
</tr>
<tr>
<td>Molly</td>
<td>F</td>
<td>32</td>
<td>9</td>
<td>9</td>
<td>Elementary</td>
<td>Special education</td>
<td>No background</td>
<td>Cooking and Recipe Reflection</td>
</tr>
<tr>
<td>Corey</td>
<td>F</td>
<td>30</td>
<td>3</td>
<td>3</td>
<td>Elementary</td>
<td>Deaf and hard-of-hearing</td>
<td>No background</td>
<td>Microscope Lab Reports</td>
</tr>
<tr>
<td>Tina</td>
<td>F</td>
<td>60</td>
<td>36</td>
<td>33</td>
<td>Middle</td>
<td>Special education; School counselor for the Deaf</td>
<td>Had heard the term but didn’t know what it was</td>
<td>Animal Adaptations</td>
</tr>
<tr>
<td>Sean</td>
<td>M</td>
<td>26</td>
<td>3</td>
<td>3</td>
<td>High School/Transition</td>
<td>Deaf and hard-of-hearing</td>
<td>Had heard the term but didn’t know what it was</td>
<td>Planning a Community Outing</td>
</tr>
</tbody>
</table>
Table 4-4. Checkpoints from the representation guideline provide options for perception

<table>
<thead>
<tr>
<th>Checkpoint</th>
<th>Teacher</th>
<th>Description of checkpoint within each teacher’s design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offer ways of customizing the display of information</td>
<td>Isla</td>
<td>Students viewed germs on the PowerPoint, through the microscope, and projected to the Smartboard. PowerPoint included written English, pictures, and images of ASL.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Molly presented the recipe in English text, pictures, and animations. The recipe review was also customized by offering different levels of self-reflection based on students' needs.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Photos of animals were projected in Tina’s PowerPoints. She also passed out printed pictures for students to view.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Ella and Eliza included images of ASL within the PowerPoint. The lesson itself was provided in ASL, spoken English, and written English.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>The final product – lab report – was customizable based on student preference. Customization also provided within the PowerPoint for a student with low vision.</td>
</tr>
<tr>
<td>Offer alternatives for auditory information</td>
<td>Isla</td>
<td>Isla included pictures, animations, written English, and images of ASL in the PowerPoint.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Molly included pictures, animations, and written English in the PowerPoint.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Sean noted that class discussions about the community outing FlipChart took place in ASL.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Tina’s design included pictures and written English. She noted the use of ASL and AAC communication devices for discussion.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Ella and Eliza included pictures, animations, written English, and images of ASL in the PowerPoint.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Corey embedded ASL into the delivery of instruction as well as an option for the final product.</td>
</tr>
<tr>
<td>Offer alternatives for visual information</td>
<td>Isla</td>
<td>Isla created tactiley-accessible petri dishes for use in this lesson.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Object visuals and manipulatives, and spoken English provided when appropriate.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Spoken English was used when appropriate, and an individual iPad was provided for a student with low vision.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Corey encouraged a student to switch his final product from an ASL video lab report to a spoken English lab report to highlight his strengths.</td>
</tr>
<tr>
<td>Checkpoint</td>
<td>Teacher</td>
<td>Description of checkpoint within each teacher’s design</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Optimize</td>
<td>Hannah</td>
<td>Hannah provide a variety of animal tangram templates for students to select.                                                                .Mutex: 431.76</td>
</tr>
<tr>
<td>individual choice and autonomy</td>
<td>Isla</td>
<td>Students from Isla’s class were paired with students from Nicole’s high school SFC class to select an object to swab in order to see if germs would grow in the petri dish.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Molly’s three levels of digital recipe reviews strongly supported autonomy and independence by providing multiple avenues through which students could respond.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Sean optimized choice and autonomy by having students select a preferred community outing location to research.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Students chose which animal they wanted to research in order to learn more about adaptations.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Ella and Eliza provided choice to their students in the ways that the students accessed the materials and activity and through encouraging independence.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Corey’s students were given modality choices for their lab report (written/spoken English, ASL, pictures).</td>
</tr>
<tr>
<td>Optimize</td>
<td>Hannah</td>
<td>Hannah provide a variety of animal tangram templates for students to choose.                                                                .Mutex: 431.76</td>
</tr>
<tr>
<td>relevance, value, and authenticity</td>
<td>Isla</td>
<td>Isla’s PowerPoint connected to students’ authentic real-world experiences and background knowledge by reviewing how germs make you sick.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Molly’s activity was inherently relevant and valuable because students knew they could eat the recipe after they made it.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Sean’s activity was inherently relevant and authentic because if students completed the research, they would go on a class outing to the community location.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Tina’s group discussions were structured to foster and value student contributions. She connected the discussion to students’ lives by providing examples of adaptations humans make.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>The combination of digital materials to review concepts and vocabulary, and hands-on activities to recruit interest made this lesson authentic for students.</td>
</tr>
<tr>
<td>Minimize</td>
<td>Tina</td>
<td>Tina recorded all student contributions during class discussion on the classroom whiteboard. She focused on valuing all contributions and not discounting anyone’s opinions or ideas.</td>
</tr>
<tr>
<td>threats and distractions</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 4-6. Checkpoints from the action and expression guideline provide options for expression and communication

<table>
<thead>
<tr>
<th>Checkpoint</th>
<th>Teacher</th>
<th>Description of checkpoint within each teacher’s design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use multiple media for communication</td>
<td>Isla</td>
<td>Isla’s lesson was delivered in ASL and spoken English. Her PowerPoint, which was switch-accessible, included written English, pictures, animations, and images of ASL signs.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>The written English text within Molly’s PowerPoint was paired with very illustrative animations. The pictures were appropriate without being too visually busy.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Sean’s lesson was conducted in ASL, with written English and pictures in the FlipChart, and written English on the worksheet.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Tina’s PowerPoint included English text, pictures, and embedded and linked captioned video.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Multiple modalities supported the communication of information within the lab report.</td>
</tr>
<tr>
<td>Use multiple tools for construction and composition</td>
<td>Hannah</td>
<td>Hannah’s students explored multiple tangram templates, blocks, and a worksheet.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Molly’s PowerPoint included written English, pictures, and animations. The cooking activity itself was very hands-on. Self-reflection was promoted by three levels of digital recipe reviews.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Students viewed Sean’s FlipChart, which included written English and pictures. They used a written English worksheet as a guide to create a multimedia PowerPoint about their research.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Tina’s students used PowerPoint, videos, and class discussion to explore animal adaptations.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Corey’s students had multiple options for creating their lab report: paper-based (written English or picture) or video-based (spoken English or ASL).</td>
</tr>
<tr>
<td>Build fluencies with graduated levels of support for practice and performance</td>
<td>Isla</td>
<td>Isla’s PowerPoint engaged students at different levels by using pictures and asking open-ended questions followed by a response. This gave students an opportunity to respond independently before increasing the prompt level.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Molly created three levels of digital recipe reviews based on student need.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Ella and Eliza provided graduated supports as needed, such as the use of pictures labeled with written English, hand-over-hand physical assistance, prompting questions, and the use of an iPad for a student with low vision.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Graduated levels of support were apparent in the options for the lab report. Independence was supported and encouraged across all students.</td>
</tr>
<tr>
<td>Checkpoint</td>
<td>Teacher</td>
<td>Description of checkpoint within each teacher's design</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------</td>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Vary the methods for response</td>
<td>Isla</td>
<td>Students were exposed to the material and able to respond via the PowerPoint, microscopes, Smartboard, and hands-on act of swabbing objects in order to grow germs.</td>
</tr>
<tr>
<td>and navigation</td>
<td>Molly</td>
<td>Students responded to the lesson via one of the three levels of digital recipe review pages.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Students worked in a whole group followed by paired work.</td>
</tr>
<tr>
<td></td>
<td>Corey</td>
<td>Students’ response in this lesson varied based on the type of lab report they completed.</td>
</tr>
<tr>
<td>Optimize access to tools and</td>
<td>Isla</td>
<td>Isla’s lesson included the use of many assistive technologies: switch-accessible, eye-gaze, and communication devices.</td>
</tr>
<tr>
<td>assistive technologies</td>
<td>Molly</td>
<td>Molly provided access to the varied levels of the recipe review using the Notability app. She also incorporates AAC devices as needed.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Sean’s lesson was guided by a FlipChart. Student used the Internet, a worksheet and a PowerPoint to perform and share their research.</td>
</tr>
<tr>
<td></td>
<td>Tina</td>
<td>Tina provided printed pictures, a PowerPoint with written English and pictures, and captioned videos.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Ella and Eliza provided picture support and an iPad for vision support, and supported physical needs for material access, such as the use of scoop for a student with sensory defensiveness.</td>
</tr>
</tbody>
</table>
Table 4-8. Checkpoints from the engagement guideline *provide options for self-regulation*

<table>
<thead>
<tr>
<th>Checkpoint</th>
<th>Teacher(s)</th>
<th>Description of checkpoint within each teacher’s design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote expectations and beliefs that optimize motivation</td>
<td>Sean</td>
<td>Sean’s promotion of high expectations was evident throughout the design, such as the self-advocacy activity and tools to support students’ independent research.</td>
</tr>
<tr>
<td>Facilitate personal coping skills and strategies</td>
<td>Ella/Eliza</td>
<td>Ella and Eliza included the use of a positive reinforcement system – student token boards – throughout the activity. This facilitated strategies to maintain attention and participation in the lesson.</td>
</tr>
<tr>
<td>Develop self-assessment and reflection</td>
<td>Molly/Sean</td>
<td>Molly provided each student with one of three levels of a digital recipe review that included self-assessment and reflection. Sean’s worksheet involved reflecting on how the selected community outing would help students become independent adults.</td>
</tr>
</tbody>
</table>
Table 4-9. Checkpoints from the action and expression guideline *provide options for executive functions*

<table>
<thead>
<tr>
<th>Checkpoint</th>
<th>Teacher</th>
<th>Description of checkpoint within each teacher’s design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guide appropriate goal-setting</td>
<td>Sean</td>
<td>Sean embedded goal-setting into all areas of the design. He guided the students’ research into potential community outings by informing them that their research would impact the choice of where the class went on their outing.</td>
</tr>
<tr>
<td>Support planning and strategy development</td>
<td>Hannah</td>
<td>Hannah provided a choice of templates to support students in selecting and placing shapes onto the animal tangrams. Student planning and strategy was also supported by sorting blocks into piles, identifying which shapes they would need, and recording how many of each they used on a worksheet.</td>
</tr>
<tr>
<td></td>
<td>Molly</td>
<td>Within the digital media artifact (animated PowerPoint), Molly provided a list of the recipe’s materials and ingredients using written English and pictures. Recipe procedures were provided in a numbered, step-by-step format and illustrated using animations.</td>
</tr>
<tr>
<td></td>
<td>Ella/Eliza</td>
<td>Within their digital media artifact (animated PowerPoint), Ella and Eliza provided pictures of necessary materials and a step-by-step list of instructions for how to plant the grass seeds. This supported their young students in planning their actions for participation in the activity.</td>
</tr>
<tr>
<td></td>
<td>Sean</td>
<td>Sean supported planning particularly in the worksheet by prompting for activities, transportation, past experiences, and logistical concerns for the students’ chosen community outing.</td>
</tr>
<tr>
<td>Enhance capacity for progress monitoring</td>
<td>None</td>
<td>This checkpoint was not identified or observed in any designs.</td>
</tr>
<tr>
<td>PTLC Stage</td>
<td>Whip Around Responses</td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Study (Part 1)</td>
<td>Accessible learning, informative and eye-opening, knowledgeable and sleepy, barrier-free, potential, taking down barriers, I’m feeling inflexible in my thinking about all this but I’m hoping to break that down</td>
<td></td>
</tr>
<tr>
<td>Study (Part 2)</td>
<td>Planning, anxious, like it but challenging, motivated, reflective, organized, a lot of variety, reminder to move/take breaks, evaluation</td>
<td></td>
</tr>
<tr>
<td>Select &amp; Plan (Part 1)</td>
<td>Excited, student reflection, I’m feeling backwards today, integrating, interested, clarifying, adaptability, productive, motivated, a bit confused, hands-on</td>
<td></td>
</tr>
<tr>
<td>Select &amp; Plan (Part 2)</td>
<td>Less freaked out, coming together, busy, due dates, hopeful, excited, a little overwhelmed, collaboration, overwhelmed, busy</td>
<td></td>
</tr>
<tr>
<td>Analyze &amp; Adjust</td>
<td>Multimedia, satisfied, applicable, self-reflective, planning, strengthen</td>
<td></td>
</tr>
<tr>
<td>Provide options for self-regulation</td>
<td>Provide options for comprehension</td>
<td>Provide options for executive functions</td>
</tr>
<tr>
<td>------------------------------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------</td>
</tr>
<tr>
<td>1 Promote expectations and beliefs that optimize motivation</td>
<td>5 Activate or supply background knowledge</td>
<td>1 Guide appropriate goal-setting</td>
</tr>
<tr>
<td>1 Facilitate personal coping skills and strategies</td>
<td>4 Highlight patterns, critical features, big ideas, and relationships</td>
<td>4 Support planning and strategy development</td>
</tr>
<tr>
<td>2 Develop self-assessment and reflection</td>
<td>4 Guide information processing, visualization, and manipulation</td>
<td>0 Enhance capacity for monitoring progress</td>
</tr>
<tr>
<td>2 Maximize transfer and generalization</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for sustaining effort and persistence</th>
<th>Provide options for language, mathematical expressions, and symbols</th>
<th>Provide options for expression and communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 Heighten salience of goals and objectives</td>
<td>4 Clarify vocabulary and symbols</td>
<td>5 Use multiple media for communication</td>
</tr>
<tr>
<td>4 Vary demands and resources to optimize challenge</td>
<td>2 Clarify syntax and structure</td>
<td>5 Use multiple tools for construction and composition</td>
</tr>
<tr>
<td>5 Foster collaboration and community</td>
<td>1 Support decoding of text, mathematical notation, and symbols</td>
<td></td>
</tr>
<tr>
<td>1 Increase mastery-oriented feedback</td>
<td>6 Promote understanding across languages</td>
<td>4 Build fluencies with graduated levels of support for practice and performance</td>
</tr>
<tr>
<td></td>
<td>6 Illustrate through multiple media</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provide options for recruiting interest</th>
<th>Provide options for perception</th>
<th>Provide options for physical action</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 Optimize individual choice and autonomy</td>
<td>5 Offer ways of customizing the display of information</td>
<td>4 Vary the methods for response and navigation</td>
</tr>
<tr>
<td>6 Optimize relevance, value, and authenticity</td>
<td>6 Offer alternatives for auditory information</td>
<td></td>
</tr>
<tr>
<td>1 Minimize threats and distractions</td>
<td>4 Offer alternatives for visual information</td>
<td>5 Optimize access to tools and assistive technologies</td>
</tr>
</tbody>
</table>

Figure 4-1. Frequency of checkpoints used across all designs
Figure 4-2. Percentage of each UDL principle’s use across all design opportunities
Figure 4-3. Percentage of each UDL tier’s use across all design opportunities
<table>
<thead>
<tr>
<th>Engagement</th>
<th>Representation</th>
<th>Action &amp; Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide options for <strong>self-regulation</strong></td>
<td>Provide options for <strong>comprehension</strong></td>
<td>Provide options for <strong>executive functions</strong></td>
</tr>
<tr>
<td>1. Promote expectations and beliefs that</td>
<td>11. <strong>Activate or supply background knowledge</strong></td>
<td>23. <strong>Guide appropriate goal-setting</strong></td>
</tr>
<tr>
<td>optimize motivation</td>
<td>12. **Highlight patterns, critical features, big</td>
<td>24. Support planning and strategy development</td>
</tr>
<tr>
<td>2. Facilitate personal coping skills and</td>
<td>ideas, and relationships**</td>
<td>25. Enhance capacity for monitoring progress</td>
</tr>
<tr>
<td>strategies</td>
<td>13. <strong>Guide information processing, visualization,</strong></td>
<td></td>
</tr>
<tr>
<td>3. Develop self-assessment and reflection</td>
<td>and manipulation**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14. <strong>Maximize transfer and generalization</strong></td>
<td></td>
</tr>
<tr>
<td>Provide options for <strong>sustaining effort and</strong></td>
<td>Provide options for <strong>language, mathematical</strong></td>
<td>Provide options for <strong>expression and</strong></td>
</tr>
<tr>
<td><strong>persistence</strong></td>
<td><strong>expressions, and symbols</strong></td>
<td><strong>communication</strong></td>
</tr>
<tr>
<td>4. <strong>Heighten salience of goals and objectives</strong></td>
<td>15. <strong>Clarify vocabulary and symbols</strong></td>
<td>26. <strong>Use multiple media for communication</strong></td>
</tr>
<tr>
<td>5. <strong>Vary demands and resources to optimize</strong></td>
<td>16. <strong>Clarify syntax and structure</strong></td>
<td>27. Use multiple tools for construction and</td>
</tr>
<tr>
<td>challenge**</td>
<td>17. <strong>Support decoding of text, mathematical</strong></td>
<td>composition**</td>
</tr>
<tr>
<td>6. <strong>Foster collaboration and community</strong></td>
<td><strong>notation, and symbols</strong></td>
<td>28. Build fluencies with graduated levels of</td>
</tr>
<tr>
<td>7. Increase mastery-oriented feedback</td>
<td>18. <strong>Promote understanding across languages</strong></td>
<td>support for practice and performance</td>
</tr>
<tr>
<td></td>
<td>19. <strong>Illustrate through multiple media</strong></td>
<td></td>
</tr>
<tr>
<td>Provide options for <strong>recruiting interest</strong></td>
<td>Provide options for <strong>perception</strong></td>
<td>Provide options for <strong>physical action</strong></td>
</tr>
<tr>
<td>8. <strong>Optimize individual choice and autonomy</strong></td>
<td>20. <strong>Offer ways of customizing the display of</strong></td>
<td>29. <strong>Vary the methods for response and navigation</strong></td>
</tr>
<tr>
<td>9. <strong>Optimize relevance, value, and authenticity</strong></td>
<td>21. <strong>Offer alternatives for auditory information</strong></td>
<td></td>
</tr>
<tr>
<td>10. <strong>Minimize threats and distractions</strong></td>
<td>22. <strong>Offer alternatives for visual information</strong></td>
<td>30. <strong>Optimize access to tools and assistive</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>technologies</strong></td>
</tr>
</tbody>
</table>

Figure 4-4. UDL checkpoints already established in at least one design, highlighted in yellow
<table>
<thead>
<tr>
<th>Provide Multiple Means of</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engagement</strong></td>
<td><strong>Representation</strong></td>
<td><strong>Action &amp; Expression</strong></td>
</tr>
<tr>
<td>Provide options for <strong>self-regulation</strong></td>
<td>Provide options for <strong>comprehension</strong></td>
<td>Provide options for <strong>executive functions</strong></td>
</tr>
<tr>
<td>1. Promote expectations and beliefs that</td>
<td>11. Activate or supply background knowledge</td>
<td>23. Guide appropriate goal-setting</td>
</tr>
<tr>
<td>2. Facilitate personal coping skills and</td>
<td>ideas, and relationships</td>
<td>development</td>
</tr>
<tr>
<td>3. Develop self-assessment and reflection</td>
<td>and manipulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14. Maximize transfer and generalization</td>
<td></td>
</tr>
<tr>
<td>Provide options for <strong>sustaining effort and</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>persistence</td>
<td>Provide options for <strong>language, mathematical</strong></td>
<td>Provide options for <strong>expression and</strong></td>
</tr>
<tr>
<td></td>
<td><strong>expressions, and symbols</strong></td>
<td><strong>communication</strong></td>
</tr>
<tr>
<td>4. Heighten salience of goals and objectives</td>
<td>15. Clarify vocabulary and symbols</td>
<td>26. Use multiple media for communication</td>
</tr>
<tr>
<td>5. Vary demands and resources to optimize</td>
<td>16. Clarify syntax and structure</td>
<td>27. Use multiple tools for construction and</td>
</tr>
<tr>
<td>challenge</td>
<td>17. Support decoding of text, mathematical</td>
<td>composition</td>
</tr>
<tr>
<td></td>
<td>notation, and symbols</td>
<td>28. Build fluencies with graduated levels of</td>
</tr>
<tr>
<td></td>
<td>18. Promote understanding across languages</td>
<td>support for practice and performance</td>
</tr>
<tr>
<td></td>
<td>19. Illustrate through multiple media</td>
<td></td>
</tr>
<tr>
<td>Provide options for <strong>recruiting interest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Optimize individual choice and autonomy</td>
<td>Provide options for <strong>perception</strong></td>
<td>Provide options for <strong>physical action</strong></td>
</tr>
<tr>
<td>9. Optimize relevance, value, and</td>
<td>20. Offer ways of customizing the display of</td>
<td>29. Vary the methods for response and</td>
</tr>
<tr>
<td>authenticity</td>
<td>information</td>
<td>navigation</td>
</tr>
<tr>
<td></td>
<td>22. Offer alternatives for visual information</td>
<td>technologies</td>
</tr>
</tbody>
</table>

Figure 4-5. UDL checkpoints targeted in at least one design, highlighted in pink
Figure 4-6. Visual provided to Ella during her interview, displaying those UDL checkpoints she identified as already established highlighted in yellow, and those she targeted highlighted in pink.
A) Standard petri dish growing bacteria, accessible visually

B) Bottom of adapted petri dish, accessible tactiley by adding glue from a hot glue gun to represent bacteria spores

Figure 4-7. Example of options for perception in Isla’s design, including a A) standard petri dish accessible visually and B) adapted petri dish accessible tactiley for students with low vision. Photos courtesy of participant.
<table>
<thead>
<tr>
<th>Provide Multiple Means of Engagement</th>
<th>Provide Multiple Means of Representation</th>
<th>Provide Multiple Means of Action &amp; Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide options for self-regulation</td>
<td>Provide options for comprehension</td>
<td>Provide options for executive functions</td>
</tr>
<tr>
<td>4/21 = 19%</td>
<td>15/28 = 54%</td>
<td>5/21 = 24%</td>
</tr>
<tr>
<td>Provide options for sustaining effort and persistence</td>
<td>Provide options for language, mathematical expressions, and symbols</td>
<td>Provide options for expression and communication</td>
</tr>
<tr>
<td>13/28 = 46%</td>
<td>19/35 = 54%</td>
<td>14/21 = 67%</td>
</tr>
<tr>
<td>Provide options for recruiting interest</td>
<td>Provide options for perception</td>
<td>Provide options for physical action</td>
</tr>
<tr>
<td>14/21 = 67%</td>
<td>15/21 = 71%</td>
<td>9/14 = 64%</td>
</tr>
</tbody>
</table>

Figure 4-8. Percentage of each individual UDL guideline’s use in design opportunities
Figure 4-9. Percentage of each individual UDL guideline’s use in design opportunities, displayed in descending order
Who was sick with the Flu this winter?

➤ The flu is a virus that many of us share in the winter.

A) Isla’s design, adapted for specific low vision needs, incorporated written English, pictures, images of ASL signs, and animation.

B) Molly’s design incorporated written English, pictures, and animation.

**Ingredients**

Each student needs:

- 1 banana
- 3/4 cup of vanilla yogurt
- 2 TBSP honey
- 2 graham crackers

B) Molly’s design incorporated written English, pictures, and animation.

Figure 4-10. Examples of options for perception in still images of animated PowerPoint presentations from A) Isla’s and B) Molly’s designs. Images courtesy of participants.
A) In the first part of the activity, students explored a variety of tangram templates and pattern blocks.

B) In the second part of the activity, students also recorded how many of each shape they utilized in their pattern on a worksheet.

Figure 4-11. Examples of options for expression and communication in Hannah’s design through the use of multiple tools for construction in a A) tangram template and pattern block activity and B) tangram template, pattern block, and worksheet activity. Photos courtesy of participant.
Recipe Review
by _____________________________

Date

We made

Teacher write/type the name of the food here

Picture of me with my food!

I liked this recipe.

I didn’t like this recipe.

Do you want to make this again at home?

yes

no

My rating:

This recipe tasted:

great!

ok.

yucky!

Recipe Review
by _____________________________

Date

We made

Teacher write/type the name of the food here

Picture of me with my food!

My rating:

I liked because it tasted

sweet salty yummy fruity juicy rich

Would you want to make this again at home?

yes

no

I didn’t like because it tasted

bitter spicy salty yucky mushy dry

Recipe Review
by _____________________________

Date

We made

Picture of me with my food!

My rating:

I liked it

I didn’t like it

Would you want to make this again at home?

yes

no

Figure 4-12. Examples of options for self-regulation in A) Level 1, B) Level 2, and C) Level 3 of the digital recipe review designed by Molly. Images courtesy of participant.
Community Outing Research

Name of place: ____________________________

What is this place (store, park, mall, etc.)? __________________

Which website are you using to complete this research?

____________________________________

List three activities you can do at this place.

1. ______________________________________
2. ______________________________________
3. ______________________________________

How does this outing help us become independent adults?

__________________________________________

__________________________________________

What type of work do the workers do at this place?

__________________________________________

__________________________________________

How close is this outing to our school? __________________

What type of transportation should we use to get to this outing?

__________________________________________

__________________________________________

How long will it take us to get there? __________________

Have you been to this place before? Tell us about your experience.

__________________________________________

__________________________________________

Do you think this is a good community outing for our class?

__________________________________________

Figure 4-13. Examples of options for executive functions in Sean’s design including goal-setting, planning and strategy development. Image courtesy of participant.
Figure 4-14. Examples of options for executive functions in Ella and Eliza’s design through the use of A) picture-based materials list and B) step-by-step process visual. Images courtesy of participants.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Participant Reflection</th>
<th>Related Critical Feature of PD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hannah</td>
<td>“I liked it. The only… I think I mentioned it the other day… I almost wish the second day, where we did it in the small meeting room, and it was more like getting to see the lesson plan format and the components of it” (Interview 1, April 7, 2017).</td>
<td>Active learning</td>
</tr>
<tr>
<td>Isla</td>
<td>“I enjoyed it. I think that it was nice to get… obviously I’ve taken courses on UDL, but I think it’s nice to get that refresher. And I think I had mentioned in the past that UDL is not a set curriculum per se, and I think a lot of teachers think that. And they think they’re a little more hesitant about creating lessons, or they’re worried they’re not doing it right. And as I had mentioned, it’s a mindset, really” (Interview 2, April 11, 2017).</td>
<td>Content focus Coherence</td>
</tr>
<tr>
<td>Molly</td>
<td>“I liked the structure. I think maybe a few more examples of lesson plans would be helpful. I think probably because it was a lot of principles that are examples of good teaching, that I was like, ‘I think I understand this, but I want somebody to tell me that I understand this’” (Interview 6, April 12, 2017).</td>
<td>Content focus Coherence</td>
</tr>
<tr>
<td>Sean</td>
<td>“I thought it was definitely beneficial. I was happy that it wasn’t as long as we’ve had in the past” (Interview 7, April 12, 2017).</td>
<td>Duration</td>
</tr>
<tr>
<td>Tina</td>
<td>“I liked that first you explained everything. Then we could discuss in small groups, or be on our own. I liked having that choice because I don’t always feel like I fit in a small group discussion. I like working on my own, having that option” (Interview 5, April 12, 2017).</td>
<td>Active learning Collective partnerships</td>
</tr>
<tr>
<td>Ella</td>
<td>“I’m just a learn-by-doing, but from examples. So if somebody who is skilled on the subject area, like you, and I had sat down and could say, ‘You could implement this by doing it this way,’ and giving me that firm example, then I could kind of run with it. But that’s just personally how I learn” (Interview 3, April 11, 2017).</td>
<td>Content focus</td>
</tr>
<tr>
<td>Corey</td>
<td>“I thought it was great. Aside from specific examples, I thought that everything ran really well. I thought that on professional day, I liked the activity of getting up in the middle of it and walking around. I thought that was fine. I liked that you kept track of where we were in this process” (Interview 4, April 12, 2017).</td>
<td>Content focus Active learning Duration</td>
</tr>
</tbody>
</table>

Figure 4-15. Participant reflection on the structure of the PTLC, and related critical feature of PD
A) Definition, examples, and bottom line elicited from teachers for the action and expression guideline provide options for physical action.

B) Definition, examples, and bottom line elicited from teachers for the representation guideline provide options for perception.

Figure 4-16. Visuals from the Around the World active learning strategy utilized during the Study stage of the PTLC for A) providing options for physical action and B) providing options for perception. Photos courtesy of author.
Primary Question:
How does professional development (PD) in universal design for learning (UDL) influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs?

Sub-question One:
How do teachers utilize the UDL guidelines to make design decisions when designing digital media materials for students with special needs in a bilingual Deaf education program?

- Teachers utilized the three UDL principles to make design decisions.
- Teachers utilized the three tiers of the UDL guidelines to make design decisions.
- Teachers utilized individual UDL guidelines to make design decisions.

Sub-question Two:
What features of PD did participants feel supported or hindered their learning during the PTLC?

- The presence of critical features of PD was more relevant to teacher learning than the structure of the PTLC.
- Teacher learning was supported and hindered by the presence of five critical features of PD.

BROAD THEME
The digital media design process of teachers in a bilingual Deaf education program for students with special needs was influenced by providing teachers with a set of structured parameters for making informed design decisions via PD adapted to their teaching contexts and mindful of the critical features of PD.

Figure 4-17. Primary and sub-questions, themes, and broad theme
CHAPTER 5
IMPLICATIONS AND DISCUSSION

The purpose of this study was to determine how professional development (PD) in universal design for learning (UDL) influences the digital media design process of teachers in a bilingual Deaf education program for students with special needs. This purpose was based on a need identified within a specific educational context and unique student population. While elements of UDL have been widely studied in the literature (National Center on Universal Design for Learning, 2011; Rose & Dalton, 2006), there is gap in the application of this framework to deaf learners, and especially bilingual Deaf learners with special needs. In addition, the majority of empirical investigations within deaf populations have focused on the representation principle of UDL, leading to a lack of data on the implementation of principles from the engagement, and action and expression principles. This study examined these gaps by providing structured PD in UDL using the professional teaching and learning cycle (PTLC) model with teachers at a school for bilingual Deaf students with special needs. This chapter presents the implications and a discussion of the results of this study.

To explore these concepts, this instrumental case study asked one primary research question: How does PD in UDL influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs? In order to address the primary question, two sub-questions were posed. The first sub-question focused on the application of UDL to the digital media design process within this population, while the second sub-question focused on the features of PD and teacher learning. These questions were:
1. How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program?

2. What features of the PD did participants feel supported or hindered their learning during the PRLC?

The goal of asking these questions was to determine how UDL can be used to develop digital media materials for Deaf students who have special needs and how teachers felt the features of PD supported or hindered teacher learning during the PTLC.

The results of the study, presented in the previous chapter, revealed three themes for sub-question one:

1. Teachers utilized the three UDL principles to make design decisions.

2. Teachers utilized the three tiers of the UDL guidelines to make design decisions.

3. Teachers utilized individual UDL guidelines to make design decisions.

In addition, two themes were revealed for sub-question two:

1. The presence of critical features of PD was more relevant to the success of the PD than the structure of the PTLC.

2. Teacher learning was supported and hindered by the presence of five critical features of PD.

These themes contributed to one broad theme revealed for the primary question:

The digital media design process of teachers in a bilingual Deaf education program for students with special needs was influenced by providing teachers with a set of structured parameters for making informed design decisions via PD adapted to their teaching contexts and mindful of the critical features of PD.

This chapter presents and discusses the implications of these findings. First, the implications of the study participants, context, and limitations are discussed. This is followed by an examination of the implementation of the UDL guidelines and PD in this
context. Then, I examine of the use of UDL as a design resource for teachers of bilingual Deaf students with special needs – both for digital media and general curriculum design. Finally, the bearing of these implications on my professional practice is explored.

**Study Participants**

The participants in this study were all employed as teachers at a small private school called the School for Deaf Children (SDC). At the time of the study, over 90% of the students at SDC had additional special needs. This implied that their teachers were charged with the complex job of designing and delivering instruction to meet the unique language and learning needs of this population.

In this study, ten teachers were given the opportunity to engage in a PD series focusing on UDL. Seven of the participants attended at least five of the six PD meetings, submitted documents, and participated in an individual interview. Three participants had low attendance across the PD meetings and did not participate in an individual interview.

The seven SDC teachers who participated fully came from a variety of backgrounds including Deaf education, special education, speech pathology, sign language interpreting, and school counseling. They ranged from 25 to 60 years of age, and had between two and 36 years of teaching experience. The study included five hearing females, one Deaf female, and one hearing male. All teachers used English (spoken and/or written) and American Sign Language (ASL) for academic and social purposes throughout the school day.

The nature of the teachers who participated in this study had implications on both the findings and the application of those findings. The results were framed by the active
participation of the seven teachers who submitted documents and volunteered to participate in individual interviews. Three teachers had low attendance to the PD sessions and did not participate in interviews. Their perspectives and thoughts were therefore not strongly reflected in the results. They were present for some sessions and therefore involved in collaboration and discussion. However, they never had an opportunity to deeply share their individual reflections on UDL, the PD, or the impact on their practice. They may have provided a unique and important view that is not observed in the results. Their absence in the data is relevant and should frame the way the implications are discussed.

Several demographic features of the seven participating teachers were also relevant to the implications of this study. Six of the seven participants were female. Six of the seven participants were hearing. Five of the seven teachers had four or fewer years of teaching experience. Therefore, the data is weighted toward young, hearing, female teachers. This was the nature of the population of teachers at SDC and therefore an unavoidable feature of the study. However, the implications of the study should be viewed with the knowledge that there are certain perspectives that are not as strongly reflected in the study. The impact of PD on UDL on male teachers, Deaf teachers, and more experienced teachers, should be examined in future studies.

As described in the previous chapter, SDC teachers came from a variety of educational backgrounds. Four participants had degrees in Deaf education, three in special education, and one in assistive technology. These foundational educational experiences may have played an impact in the way that the teachers accessed and
used the UDL guidelines in their digital media designs. This will be explored later in this chapter.

The teachers who participated in this study naturally impacted the results. While this in no way diminishes the authenticity of their experiences or responses, it is important to be cognizant of the perspectives that were and were not reflected in the study.

**Study Context**

As described, this study took place at a private school for Deaf children where over 90% of the students had additional disabilities. Classes ranged from preschool through high school/transition level. Each classroom had from three to five students and from two to four total staff. This low student-to-teacher ratio, while programmatically necessary given the nature of students at SDC, is relevant to the context of this study. Many SDC students received one-on-one instruction on a regular basis. A whole group lesson at SDC may consist of a teacher, a paraprofessional, and three to four students. The findings of this study did not come out of a more typical classroom of 20-25 typically development students, or even a more traditional Deaf education classroom of eight to ten students. SDC is a highly specialized context for unique students. The findings are therefore necessarily contextualized to this situation.

The literature review revealed a gap in the application of the UDL framework to deaf learners, and especially bilingual Deaf learners with special needs. Therefore, this study sought to address this gap by looking at the use of the UDL framework to design for these learners. However, SDC students demanded curriculum designs that were both creative and mindful of their language and learning needs. These needs were met by the dedicated and knowledgeable SDC teachers. However, the processes they
undertook to design for their students may have been inherently different from the processes used by general education, special education, and typical Deaf education teachers. The context of this study was relevant for my own professional practice but also for the opportunity to explore the process of design for this population, which is so underrepresented in the literature.

The next section of this chapter will present several limitations related to the implications of the study, followed by the implications of the themes revealed for sub-questions one and two.

**Limitations**

The previous chapter presented limitations related to data collection and analysis. This has an impact on the implications of the study as well. These limitations are described in this section.

The first limitation of the data collection was related to timing. PD was provided within established opportunities in SDC’s schedule, including several daily morning sessions and a PD day session that extended through a Friday afternoon. I also noted that at times I felt rushed to get through some of the information within the constraints of this schedule. When the morning PTLC sessions finished, teachers went immediately to their classrooms and dove into their daily responsibilities. These limitations were out of my control as a researcher, given that this study occurred in an authentic educational context. However, this implies that teachers may not have had an opportunity to fully engage with or synthesize the information.

Another limitation of the data collection related to information regarding student response. Teachers submitted the Student Use Survey as a reflection of their perspective on students’ response to the UDL-based lessons. However, I noted that
there appeared to be inconsistencies in how these surveys were completed. Therefore, implications for students’ response to the lessons should be framed with the knowledge that teachers likely filled these out in different ways. I had asked that the Student Use Surveys be completed immediately following the implementation of the lesson. However, some surveys were very brief while other contained more extensive narrative detail. This implies that not all surveys may have been completed in the same way or within the same time frame. In addition, the students themselves were not directly involved in providing their perspective on the UDL-based lesson. Taken together, this limits the implications that can be drawn from this study on student response and learning. The study does show promise in the use of UDL with bilingual Deaf learners with special needs and warrants future studies that explore student learning in a more direct way.

Limitations in data analysis were also described in the previous chapter. These included the fact that I was the only individual who participated in the coding process and that member checking did not yield significant responses from the teacher participants. This has an impact on the implications of this study. Without participants’ active participation in the member checking process, it is difficult to determine if their views have been accurately analyzed, synthesized, and presented in the results and implications of the study. The implications of this study should, therefore, be viewed with this limitation in mind.

The next several sections present implications of this study related to the UDL guidelines and professional development. Readers should be mindful of the way the study’s limitations impact these implications.
Utilization of the UDL Guidelines

In this study, teachers engaged in PD with the goal of gaining the knowledge and skills to use UDL as a framework for the design of digital materials to be used with their bilingual Deaf students with special needs. The teachers completed several documents and participated in individual interviews. I used a rubric to examine their documents and maintained a research journal. These instruments led to a corpus of data regarding the way that the teachers used the UDL guidelines (Figure 2-5) in their designs.

The UDL guidelines are “designed to help educators (novice and expert alike) consider the key sources and types of expected learner variability germane to a particular learning goal and to select or design flexible curricula that help all learners progress towards that goal” (Meyer, Rose, & Gordon, 2014, p. 110). The guidelines are presented in a structured format that includes three principles and three tiers of support. Given this matrix, there are nine individual guidelines.

The structure of the UDL guidelines was highly relevant to the three themes that were revealed by the analysis of data in this study. The first theme related to the use of the UDL principles (engagement, representation, action and expression). The second theme involved the use of the three tiers of support, and the final theme examined how teachers use individual guidelines in their designs. The implications of these three themes are explored in the following sections.

UDL Principles

The first theme stated that teachers utilized the three UDL principles to make design decisions. The data showed that teachers used the representation principle most frequently in their designs, followed closely by action and expression, and engagement.
Teachers’ utilization of the UDL principles was informed by their grounding in the field of Deaf education and the learning needs of their students. The literature review in this study revealed a dearth of information regarding the engagement and action and expression principles. The majority of studies examining the use of UDL with deaf learners have focused on the impact of providing multiple means of representation. These studies primarily looked at curricular modifications that involved providing options for perception, and more specifically, offering alternatives for auditory information (Dalton, Schleper, Kennedy, Lutz, & Strangman, 2005; Easterbrooks, 1999; Easterbrooks & Stoner, 2006; Gentry, Chinn, & Moulton, 2005; Jensema, Danturthi, & Burch, 2000; Jensema & El Sharkawy, 2000; Marschark, 2006; Nugent, 1983; Scherer, 2005; Thorn & Thorn, 1996; Vesel, 2005; Zazove et al., 2004). These studies were, therefore, primarily concerned with empirically examining the impact of one principle of UDL rather than the UDL framework as a whole. In that way, this study addresses this gap.

In this study, teachers of bilingual Deaf students with special needs used all three principles in their designs. The representation principle was used the most, but the action and expression, and engagement principles also had consistent use across designs. This shows that when provided with PD on the UDL guidelines, these teachers made design decisions that included all three principles. The students’ deafness impacted the design of the lessons in that multiple modalities were commonly seen, including spoken and written English, ASL, images of ASL signs, pictures, and symbols. This is illustrative of the representation principle. However, students’ deafness did not preclude them from benefitting from the provision of multiple means of action and
expression, and engagement. Some studies may focus so heavily on the implications of a student’s deafness that they forget to view the student as a whole – a learner who is far more alike than different from other learners, and who needs to be given opportunities to engage in learning, express herself, and show her learning in multiple ways.

The findings related to the three principles have implications for future research. This study illustrated that the action and expression, and engagement principles are important elements to holistically designing for bilingual Deaf students with special needs. Teachers noted that students responded positively to the materials they created. However, specific and exact benefits of individual principles and guidelines were not examined in this study and warrant future research. This study showed that scholars need not limit themselves to the representation principle when looking at how UDL can be used with deaf populations, both with and without special needs. All three principles played a role in the designs created in this study, and future research should explore how the provision of multiple means of engagement, representation, and action and expression impacts the learning of bilingual Deaf students with special needs.

**UDL Tiers**

The second theme stated that teachers utilized the three tiers of the UDL guidelines to make design decisions. The data showed that teachers used the lowest tier guidelines most frequently in their designs, followed by the middle tier guidelines and finally the highest tier guidelines. Teachers’ utilization of the three tiers of the UDL guidelines was influenced by reflection on their teaching practice, a desire to push into higher tiers, and the creation of designs based on the nature of the students and goals of the lesson.
As described, the tiers represent the level of support a student needs to be successful with a given activity. Guidelines at the lowest tier are teacher-centered or teacher-driven, while the middle tier guidelines are teacher- and learner-centered through scaffolding. The highest tier guidelines are learner-center or learner-driven. While there have been a significant number of studies examining how the three principles and their guidelines drive design, there is less evidence that the three tiers of the UDL guidelines have been used to frame studies. Certainly, there is ample evidence on how guidelines from the various tiers are observed in practice. However, the three tiers of support are not as strongly emphasized in the structure of the guidelines. Even the UDL guidelines visual (Figure 2-5) lists the three principles clearly but does not indicate that there is any particular purpose behind the tiered structure. Rather, this is explained narratively (Meyer, Rose, & Gordon, 2014). The utilization of all three tiers was illustrated in this study, leading to several implications.

Teachers of bilingual Deaf students with special needs used all three tiers in their designs. The lowest tier guidelines were used the most, followed by the middle tier, and finally the highest tier. The frequent use of the lowest tier guidelines is reflective of the strengths – and demands – of designing for bilingual Deaf students with special needs. These students demand highly adapted instruction in order to be successful. Teachers are therefore experienced in performing these adaptations to their materials in order to meet the needs of their students. Many of these adaptations are performed to reduce or eliminate barriers to learning within curriculum materials themselves. For example, a presentation may be created on a yellow background for a student with low vision, or ASL added to an instructional video for a student who is Deaf. Many of these adaptations
aimed at reducing barriers are elements of the lowest tier guidelines. Therefore, teachers already displayed a strength in how to implement strategies from the lowest tier, whether they were aware that they are a part of UDL or not. This led to some confusion on the part of teachers who felt they already did so much of what UDL entails. This implies that efforts should be made to help teachers recognize elements of UDL that are already in place in their learning environment. While the terminology of UDL was new to some teachers, some of the strategies to implement UDL were not. The teachers created many strong examples of UDL-based designs after only a few days of PD. Some of this knowledge, particularly that needed for implementation of elements from lower tiers, therefore, was already a part of their regular practice.

Many teachers reflected that they sought to challenge themselves and their students by pushing into higher tiers. Independence was frequently a central goal for students at SDC. Therefore, teachers connected strongly with the idea of pushing into those higher tiers that are learner-driven and require less teacher scaffolding. Teachers recognized the value of increasing students’ control of their learning, particularly for students with special needs. However, the higher tiers were used less frequently in the designs and several teachers did express in reflection that they would have liked to push into higher tiers. This implies that teachers – particularly teachers of bilingual Deaf students with special needs – need support in developing the knowledge and skills to address higher levels of learning, such as self-regulation, comprehension, and executive functions.

The findings related to the three tiers have implications for future research and practice. The strength teachers displayed in incorporating guidelines from the lower tiers
is indicative of their experience and educational background. Teachers expressed more difficulty and uncertainty in including guidelines from the higher tiers. This implies that they need more experience and education in what these guidelines mean and how they can be implemented with bilingual Deaf students with special needs.

As described, teachers came from a variety of educational background including Deaf education and special education. Teacher preparation programs differ in the targeted student population and may prepare teachers in fundamentally different ways for the process of teaching. Teachers with a background in Deaf education may not have had the opportunity to work with students with special needs. Similarly, teachers with a background in special education may not have had the opportunity to develop ASL fluency or work with Deaf students. Teacher practice is impacted when teachers from these two disciplines are tasked with teaching a student population impacted both by deafness and additional disabilities. A deeper look at how various types of teacher preparation programs address higher-level skills, such as self-regulation, comprehension, and executive functions, would be beneficial. Scholars should pursue lines of inquiry related to supporting teachers in understanding and implementing these skills.

All three tiers played a role in the designs created in this study, and future research should explore how the provision of learning opportunities across all three tiers impacts the learning of bilingual Deaf students with special needs.

**Individual UDL Guidelines**

The third theme stated that teachers utilized individual UDL guidelines to make design decisions. This theme was revealed when looking beyond the structure of the principles and tiers and looking at each of the nine guidelines individually. The data
showed that some guidelines were used more or less frequently than others. Teachers’ utilization of the individual guidelines was influenced by their experiences, goals, and knowledge of their students’ needs.

The patterns of use described in the first and second themes did not always hold true when looking at the guidelines individually. This implies that teachers of bilingual Deaf students with special needs made mindful decisions to use the individual guidelines in their digital designs. This was often determined by the exact nature of a given guideline. The four guidelines that were observed the most frequently were providing options for perception, recruiting interest, expression and communication, and physical action. Several of these guidelines are directly related to the specialized learning needs of this population. Providing options for perception promotes offering visual and auditory alternatives to information – a necessary element in Deaf education. Providing options for expression and communication promotes utilizing multiple modalities for communication and learning. Providing options for physical action promotes the use of assistive technologies – a necessary element in special education. It is therefore unsurprising that teachers were observed to frequently utilize these guidelines in their plans. This implies that teachers are using their experiences, goals, and knowledge of their students in approaching the design process.

For example, teachers used their experiences, goals, and knowledge to incorporate the guidelines related to language presentation and use. This is unsurprising given the unique language and learning needs of Deaf students, as described in the literature review. This implies that the priorities of these teachers may differ from general education, special education, and typical Deaf education teachers.
This was illustrated not only by those guidelines that teachers frequently selected, but also by those that they mindfully avoided. For example, several teachers avoided the use of one particular guideline related to syntax and structure that they felt would negatively impact attention and cause stress. Teachers therefore approached the task of designing with UDL armed with their own experiences, goals, and knowledge based on the needs of their unique students. It has been demonstrated that bilingual Deaf students with special needs demand specialized instruction. The findings of this study imply that teachers extend this to the way they use UDL to design lesson for this population: in a specialized way.

The findings also showed that two guidelines were used less than half as often as the others: providing options for executive functions and self-regulation, both of which were from the highest tier. The inclusion of these guidelines in some of the teachers’ designs indicates that there are contexts in which they are appropriate for bilingual Deaf students with special needs. This implies that teachers need support to create designs that incorporate learner-centered activities that promote self-regulation and executive function. Direction can be taken from the designs that did include these guidelines. Teachers provided options for self-regulation by setting and maintaining high expectations, incorporating structured opportunities for students to participate in self-reflection, and incorporating individual strategies for success. Teachers provided options for executive functions by guiding students in setting goals and supporting planning and strategy development. These design examples can be used to support teachers – such as those in this study – who express a desire to create designs that
push into the higher tiers, thereby increasing student independence and ownership over their learning.

One checkpoint was not observed in any teachers’ designs in this study: enhance capacity for progress monitoring. This comes from the highest tier of the action and expression guideline, which recommends that teachers provide options for executive functions. There are several possible reasons for this. Teachers may not have felt that this checkpoint was relevant to the goals of the lesson they designed. Perhaps they did not fully understand the terminology or concepts. They also may have been unsure of how to enhance progress monitoring. Regardless of the reason, this implies that teachers of bilingual Deaf students with special needs may benefit from increased opportunities to understand the concept and relevance of progress monitoring and apply it in their practice.

The findings related to the individual guidelines have implications for future research and practice. Teachers of bilingual Deaf students with special needs displayed a strength in incorporating guidelines related to language presentation and use. Guidelines related to addressing learner-centered concepts such as self-regulation and executive functions were not utilized as frequently across designs. Teachers need research-driven guidance on how to incorporate learner-centered activities that address their students’ self-regulation and executive functions. Several designs in this study show that it is possible within this population. Scholars need to examine the ways these learner-centered concepts can be provided to this specialized population, and develop ways to share that information with practicing teachers.
Individual guidelines played a role in the designs created in this study, and future research should explore how the provision of learning options across all nine guidelines impacts the learning of bilingual Deaf students with special needs.

**UDL Guidelines in This Context**

The themes revealed in the findings of this study related to the teachers’ use of the principles, tiers, and individual UDL guidelines within their designs. The implications of these findings were explored in this section.

The engagement, and action and expression principles are underrepresented in the literature but were utilized by teachers in this study. Future study on how these principles can be implemented with this population is recommended.

The teachers responded positively to the three-tier structure of the UDL guidelines despite this structure being underemphasized in the literature. Teachers’ designs showed frequent use of the lower tier guidelines that focus on reducing or eliminating barriers to materials and learning. Fewer designs incorporated the higher tier guidelines that focus on learner-centered and independent learning. Future study on how teachers of bilingual Deaf students with special needs can incorporate these higher tiers is recommended.

Finally, teachers relied on their experiences, goals, and knowledge to select guidelines for use within their designs. Teachers’ designs showed frequent use of guidelines related to language presentation and use. Fewer designs incorporated learner-centered concepts such as self-regulation and executive functions. Future study on how teachers of bilingual Deaf students with special needs can incorporate these guidelines is recommended.
This section explored the implications of this study on the utilization of the UDL guidelines. The next section discusses the implications of the PD in this context.

**Role of Professional Development**

In this study, teachers engaged in one iteration of the PTLC. This PD model is designed as a “vehicle for teacher collaboration and sharing, and the process improves alignment of curriculum, instruction, and assessment” (SEDL, 2008, p. 1). Teachers participated in different activities across the six stages of the PTLC: Study, Select, Plan, Implement, Analyze, and Adjust. Reflection on the delivery of the PD via the PTLC was examined through the research journal and individual interviews. These instruments led to a corpus of data regarding how the PD supported or hindered their learning during the PTLC.

The structure of the PTLC and the critical features of PD were highly relevant to the themes that were revealed by the analysis of data in this study. The first theme related to the role of the structure of the PTLC. The second theme explored the critical features and teacher learning. The implications of these themes are explored in the following sections.

**PTLC**

The first theme for sub-question two stated that the presence of critical features of PD was more relevant to the success of the PD than the structure of the PTLC. The data showed that the structure of the PTLC was less important to teachers than the presence of the critical features of PD. When asked about the structure of the PTLC, teachers’ responses were focused on how different critical features supported or hindered their engagement with the UDL content.
The implications of this finding are relevant to the delivery of PD. This theme does not suggest that the PTLC as a structure was unsuccessful. Rather, it suggests that there are elements beyond the structure itself that are more relevant to the success of the PD. In other words, like all PD, a successful PTLC must incorporate the critical features of PD in ways contextualized to the setting in which the teachers work. The six-step cycle of the PTLC is designed such that it promotes the presentation of the PD in a certain way. For example, the six steps of the PTLC cannot be completed in one meeting – thereby relating to the duration critical feature. The PTLC promotes active collaboration and discussion – thereby incorporating the active learning and collective partnership critical features. It is not the structure of the PTLC that makes it successful or unsuccessful as a model of PD, but how that structure leverages the power of the critical features of PD.

The findings related to the structure of the PTLC have implications for future research. Tobia (2007) notes that the PTLC was developed to give teachers an opportunity to collaborate on standards-based instructional methods. This study applied the PTLC to a different context: collaboration on the use of UDL to design digital media materials. The results show that the PTLC is promising as a model of PD in contexts other than that for which it was developed. However, additional research is needed to determine how the PTLC applies to different contexts, any modifications that need to be made, and the benefits to both teachers and students.

Additionally, more research is needed to deeply explore the relationship between the PTLC and the critical features of PD. This research could determine the ways that
the PTLC leverages the critical features of PD as well as any adaptations to the structure that could strengthen the presence of those critical features.

The next section explores the implications of the presence of the five critical features of PD.

**Critical Features of PD**

The second theme for sub-question two stated that teacher learning was supported and hindered by the presence of five critical features of PD. The data showed that participants felt that the presence of five critical features of PD – content focus, coherence, duration, active learning, and collective partnerships – supported or hindered their learning. The implications for each of the five critical features is discussed in the following sections.

**Content focus**

The PD in this study maintained a content focus because it centered on teacher practices that support students’ thinking and learning processes. However, teachers expressed a desire for more concrete examples to develop a deeper understanding of the concepts and terminology of UDL.

One feature of the PD’s content that was reflected in the data was that teachers often felt that they already incorporated many elements of UDL in their regular practice. In this way, it made the PD more successful because they had a foundational understanding of some UDL concepts, whether they had used them in the context of a UDL-based lesson or not. Other teachers expressed confusion on how UDL differed from their current practice. This implies that deeper investigation is needed regarding how UDL is reflective of and can supplement the regular practice of teachers of bilingual Deaf students with special needs. If elements of UDL are already present in their
regular practice, PD on UDL should harness this as a strength and use it to support the development of those elements that are not as strongly reflected.

Coherence

In this study, coherence was observed through consistency with teachers’ beliefs, knowledge, performance expectations, and regular practices.

As a teacher with extensive UDL background, Isla repeatedly used the word “mindset” to describe how UDL was coherent with her beliefs about teaching and learning. She also used this word to explore ideas related to why the PD may not have been as successful for some teachers as it was for her. Those teachers new to UDL had not yet developed this view of UDL as a mindset. Rather, she believed they looked at the UDL guidelines as a checklist to be completed, rather than a guide to reducing barriers to learning and creating expert learners (Meyer, Rose, & Gordon, 2014). This implies that teachers need time and experience to refine their views on what UDL is and how it can impact their practice.

Many teachers in this study expressed a desire for more concrete examples of UDL-based lessons and the UDL guidelines in practice. This has direct implications on the strength of the PD provided specifically in this context: I should have provided more examples. It also has wider implications for individuals who deliver PD across any contexts: participants seek content that supports coherence with their knowledge and practices. With more examples, the leap from research to practice would be supported.

Duration

The implications of the duration of this PD are necessarily based on the context in which it occurred. Words and phrases used by teachers in this study such as “long,” “short,” “quick,” “fast,” “instant training,” “to the point,” and “enough time” can only be
defined relative to the experiences from which those words come. This study did not produce a specific recommendation related to the span of time that is appropriate for a PTLC. Rather, the evidence implied that consideration of duration must be performed in relation to the context in which it occurs and the experiences of the teachers involved. Several relevant considerations did emerge.

The duration of PD should balance the benefit of the content with the needs of the teachers. Several teachers in this study lauded the brevity of the training and the fact that they felt they could implement elements of UDL right away. This implies that PD of more extended duration may only be beneficial if it pays frequent dividends to teachers through benefit to practice. This impacts the way that the PD is designed. While the literature suggests that PD must be sustained over time in order to be effective (Garet, Porter, Desimone, Birman, & Yoon, 2001), this study also showed that teachers can have negative responses to PD that is extended over time due to disengagement and frustration. This does not imply that extended duration PD is ineffective, but rather the duration should be determined by how that time allows teachers to be engaged in beneficial learning activities. PD will not necessarily be successful just because it is sustained over time. PD designers need to examine what opportunities that duration may provide and design activities to meet the goals of the PD. In this study, beneficial learning activities were successfully built into a relatively shorter duration opportunity. This implies that duration should be determined by the learning activities required to meet the goals of the PD, rather than to fulfill a span of time predetermined outside of the context of the learning environment.
Active learning

In this study, teachers participated in a variety of active learning strategies, such as discussion, collaboration, planning, and reflection on practice. Teachers’ reflections on these activities yield several implications. As an active learning strategy, discussion with other teachers generated many positive responses from teachers. This implies that providing opportunities for meaningful discussion is a valuable active learning strategy that can be built into PD. This also relates to the duration and collective partnerships critical features because time and opportunity must be provided for teachers to authentically engage with others in these discussions.

Several teachers also had positive responses to activities that moved beyond the monotony of attending a presentation without being provided the opportunity to engage more deeply. These activities can be designed and used in PD in myriad ways. However, several teachers reflected that particular active learning strategies negatively impacted their engagement based on their learner preferences. This implies that while active learning strategies as a whole can be beneficial, the inclusion of particular strategies should be based on individual teacher’s needs.

This study implies that incorporating particular active learning strategies into PD can positively impact teacher engagement, reflection on practice, and learning. Designers should remain aware of individual learner preferences when considering how to incorporate active learning strategies in PD.

Collective partnerships

The context of this PD was unique in that two school programs came together for the PD training. This allowed for cross-program collective partnerships that may not be possible in all settings. There were many positive reflections on the benefit of working
with individuals with different experiences, as observed when SDC and SFC teachers collaborated. Still others reflected that the unique nature of their classroom left them feeling isolated and unable to relate to the experiences of others. This implies that PD should be designed to provide teachers with the opportunity to work with individuals outside of their immediate age- and grade-level cohort. The key word here is opportunity. Teachers appreciated that cross-program collective partnerships were available to them during this PD but were not forced. In keeping with UDL, I provided multiple means of engagement by optimizing individual choice and autonomy and minimizing threats and distractions for my teachers as learners. Teachers had the choice to engage in collective partnerships or work individually. For some, forcing them to engage in such an activity would have been a threat and distraction and thereby not beneficial. This implies that collective partnerships, as an active learning strategy, can be incorporated into PD in ways that are respectful of teachers as learners.

The key word opportunity, as it relates to collective partnerships, also has implications for the other critical features of PD. Teachers in this study described how the time provided to engage with others in collective partnerships was a valuable experience for them. This relates to the duration of the PD. The opportunity to participate in these meaningful discussions helped teachers understand how the content of the PD supported and supplemented their regular practice. This relates to the content focus and coherence critical features. This implies that the critical features of PD cannot be considered in isolation. The presence of certain critical features may support the incorporation of other critical features.
By considering the smorgasbord of options provided by the inclusion of the critical features of PD, trainings can be designed to meet the needs of teachers in unique educational contexts, such as teachers of bilingual Deaf students with special needs.

**PD in This Context**

The examination of the structure of the PTLC and the presence of the critical features of PD led to several suggestions for future research. As described, research on the role of the PTLC is needed to determine how that model supports learning within different educational contexts. In addition, scholars should examine how the critical features of PD support the PTLC model and what combinations of features leverage the power of the PTLC.

On a more specific level, the critical features individually yield recommended research directions. More research is needed on how to harness teachers’ basic content knowledge of UDL to support attaining higher-level skills. Deeper examination is needed on how to support novice teachers in developing coherence with the belief that UDL is a mindset. The role of duration in relation to PD goals and activities should be examined more closely. Additionally, research is needed on the specific active learning strategies and opportunities for collective partnerships that support teacher engagement and learning within a PTLC.

This section explored the implications of this study on the design of PD. The next section reflects on the broad potential of UDL as a design resource for teachers of bilingual deaf students with special needs.
A Reflection on UDL as a Design Resource for Teachers of Bilingual Deaf Students with Special Needs

The implications garnered from the examination of the sub-questions can be examined more holistically. The broad theme identified by the primary research question was that the digital media design process of teachers in a bilingual Deaf education program for students with special needs was influenced by providing teachers with a set of structured parameters for making informed design decisions via PD adapted to their teaching contexts and mindful of the critical features of PD. The structured parameters identified in this theme are the UDL guidelines, provided to teachers via PD designed for their teaching context.

In this study, the implications of this broad theme are based around two primary areas: the use of UDL by teachers of bilingual Deaf students with special needs as a design resource for digital media design, and more globally in general curriculum design. These are explored below.

Given the affordances of digital media to support the language and learning needs of Deaf students, this study provided an opportunity to explore how UDL could support the design process. As a researcher, my intention was to provide strong PD to the teachers in my context that they could then use to design digital media to meet the needs of their diverse and unique students. As described in the previous chapter, there were elements of the PD that supported and hindered teacher learning in various ways. SDC teachers can use UDL as a design resource for this population. However, as a researcher I recognize that the application of UDL in this study went beyond the narrow window of digital media design. UDL is, as described by Isla, a mindset. Rather than utilizing UDL for the singular purpose of designing digital media, teachers utilized UDL
to design holistic lessons, of which digital media was one element. While several teachers were novices to UDL, they showed emerging understanding of using UDL as a mindset to design their lesson rather than apply it only to their digital media design. With additional PD, teachers can deepen their knowledge of UDL and hone their skills in applying it across their environment. Namely, they can make it their mindset. While this study sought to determine the influence of PD on UDL specifically on digital media designs, the implications are more global. UDL shows promise as a design resource for teachers of bilingual Deaf students with special needs not only for digital media design but for general curriculum design. More research is needed to explore how the UDL framework can support teachers – and curriculum designers – for this unique population.

**My Professional Practice**

This study has direct implications for my professional practice. The willingness of SDC’s administration to support this project illustrates their dedication to providing teachers access to research-based approaches to the design and implementation of instruction for bilingual Deaf students with special needs. Given my role as a Curriculum Coordinator, I will have the opportunity to continue to explore how UDL can impact the teachers and students of SDC.

Several SDC teachers indicated that they plan to continue to use UDL in the future. There was an overall positive response to this PD and teachers found benefit in the content. As a Curriculum Coordinator, I am well placed to explore how UDL can continue to be an element of design for teachers in their lesson and unit plans. I can make connections between teachers who would benefit from collaborating with one
another. In addition, I hope to continue asking questions about how UDL can be used to support language and learning for bilingual Deaf students with special needs.

Another implication of this study for my professional practice relates to the design and delivery of PD. The response of teachers to the presence of the critical features can inform the way that PD is designed in the future. Teachers and therapy staff had performed research on specific therapeutic strategies, and instructional and communication approaches in this setting. However, to my knowledge, this was the first empirical look at how PD is provided to teachers at The Communication School. The data from this study can be presented to the administration of SDC and used to guide future design and delivery of PD.

The future looks bright for teachers and students at The Communication School.

Concluding Thoughts

As stated, the purpose of this study was to determine how UDL was used to develop digital media materials for Deaf students who had special needs and how features of PD supported or hindered teacher learning. The literature review provided a foundation of knowledge and identified gaps in scholarship related to Deaf bilingual learners with special needs, learning through multimedia, UDL, and PD. The methodology was selected to address the research questions of the study and harvest data reflective of the stated purpose. A rigorous qualitative analysis was performed using a variety of tools and approaches. The results revealed themes which were then examined for their implications to practice at SDC and beyond.

Dani, Kelly, and Caleb, the students from the fictional vignette, still faced many challenges. PD in UDL did not change the communication mismatch that Dani experienced on a daily basis. It did not change the types of behavioral intervention and
strategies that Kelly needed to be successful. It did not change the impact of Caleb’s physical or medical conditions. However, PD in UDL *can* make a difference in these students’ lives. It can provide their teachers with a powerful tool to approach the task of designing instruction that empowers them to be purposeful, motivated, resourceful, knowledgeable, strategic, and goal-directed. In other words, with UDL implemented mindful to their needs as bilingual Deaf students with special needs, Dani, Kelly, and Caleb can be expert learners.
Universal Design for Learning @ [Redacted]
Professional Development
Spring 2017

Agenda
- Objectives
- Introduction
- Activities
- Participant Consent
- Questions
- Whip Around

Objectives
At the end of this presentation, you will
1. Describe the goals and basic steps of the professional development project
2. Determine your willingness to participate in the study by granting or denying informed consent

Introduction
For the next several weeks, you are invited to participate in this professional development series. We will focus on UDL – universal design for learning.

What is UDL?

What is UDL?

Universal Design for Learning (UDL) is a framework to improve and optimize teaching and learning for all people based on scientific insights into how humans learn.

What is UDL?
The goal of universal design for learning is to reduce or eliminate barriers to learning by systematically designing curriculum and materials.
Activities: What will we be doing?

This PD is designed to mesh with our school as a PLC. We will use a model called the PTLC – or the professional teaching and learning cycle.

- Study
- Select
- Plan
- Implement
- Adjust
- Analyze

Activities: What will we be doing?

- Study: Learn about UDL through a structured presentation.
- Select: Plan your UDL-based lesson and digital media materials.
- Plan: Create your UDL-based digital media materials in collaboration with your peers.
- Implement: Use the UDL-based digital media materials with your students and reflect on their responses.
- Analyze: Reflect on the design process.
- Adjust: Reflect on the PD process.

Participant Consent

This professional development series is part of my doctoral dissertation at the University of Florida.

This project is designed to explore the question:

*How does professional development in universal design for learning (UDL) influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs?*

Participant Consent

My goal is to learn more about how we can use UDL to improve instruction for our unique student population.

If you would like to help me do this, I need your written consent to collect and analyze the information we create.

This is not mandatory. You can still participate in the training without consenting to be a part of my study. You may also choose to participate and later withdraw.

Gators

Any questions?

Whip Around

Each participant shares a word or short phrase that represents how they are feeling about the professional development project so far.
APPENDIX B
PARTICIPANT CONSENT

Protocol Title: How does professional development in universal design for learning influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs?

Please read this consent document carefully before you decide to participate in this study.

I am conducting research to explore how professional development in universal design for learning (UDL) influences the digital media designs that teachers create for bilingual Deaf students who have special needs. Our school setting and school population are quite unique and I wish to explore the pedagogy, instructional approaches, and best practices for educating this population of students. The overarching goal is to gain a deeper understanding of how to provide the most appropriate education to our students.

Purpose of the research study:
Teachers of bilingual Deaf students with special needs face a unique challenge in designing instructional tools for their population of learners. While the bilingual language and learning philosophy guides the pedagogy of teacher of traditional bilingual Deaf learners who do not have additional special needs, this philosophy does not make specific recommendations on how instruction should be adapted for bilingual Deaf students with multiple additional special needs. This study will explore another framework to examine the influence on the digital media design process: universal design for learning (UDL). The purpose of this study is to determine how structured professional development in UDL influences the digital media design process of teachers in a bilingual Deaf education program for students with special needs.

What you will be asked to do in the study:
Participation will occur within established professional development periods. Participation will include group discussions and activities, and the completion of a document, survey, and an interview. Group discussions will focus on the design process and the professional development. The document will guide the design of a lesson plan and digital media materials. The survey will examine student response to the digital media designs. You will be asked to put your name on the document and survey to ensure that the researcher knows which data sources go together. The researcher will remove all names when analyzing and reporting results.

Time required:
Approximately 6 morning professional development periods (45 minutes)
Approximately 1 afternoon professional development period (2 hours)
Approximately 1 mutually convenient interview session (1 hour)
Risks and Benefits:
No risks are anticipated. There are no direct benefits to you for participating in the study. Your participation will allow researchers to improve understanding of how professional development in UDL influences the digital media design process of teachers of bilingual Deaf students with special needs.

Compensation:
None

Confidentiality:
Your identity will be kept confidential to the extent provided by law. Your name will not be used in any report.

Voluntary participation:
Your participation in this study is completely voluntary. There is no penalty for not participating.

Right to withdraw from the study:
You have the right to withdraw from the study at anytime without consequence.

Whom to contact if you have questions about the study:
Principal Investigator: Sarah Brandt, BSD Curriculum Coordinator. Phone: 978-927-7070. Email: sarahbrandt@ufl.edu

Faculty Supervisory: Dr. Kara Dawson, G518C Norman Hall, School of Teaching and Learning, University of Florida. Phone: 352-273-4177. Email: dawson@coe.ufl.edu

Whom to contact about your rights as a research participant in the study:
IRB02 Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone 392-0433.

Agreement:
I have read the procedure described above. I voluntarily agree to participate in the procedure and I have received a copy of this description.

Participant: ________________________________ Date: _________________

Principal Investigator: __________________________ Date: _______________
Universal Design for Learning @ [Redacted]

Presentation Agenda
- Objectives
- History and Definition of UDL
- 3 Core Concepts of UDL
- Neural Networks in UDL
- UDL Guidelines
- Reflection

Objectives
At the end of this presentation, you will describe the
1. Evolution
2. Core concepts
3. Role of neural networks
4. UDL Guidelines
of universal design for learning.

What is UDL?

UDL = Universal design for learning

Where did UDL come from?
Center for Applied Special Technologies (CAST)
Established in 1984 in Salem, MA with the goal of exploring ways of using “new technologies” to provide better educational experiences to students with disabilities.
Where did UDL come from?

By the mid-1990s, CAST refined their principles, priorities, and vision. They came to a new understanding of how to improve education using flexible methods and materials, and called the approach Universal Design for Learning (UDL).

Now in Wakefield, MA, UDL shapes all of CAST’s research and development, focusing on students of all abilities.

Where did UDL come from?

Through strategic collaborations, CAST is seeding the field of curriculum planning, software development, state and national policy, teacher preparation and support, and education research with UDL-based solutions.


Where did UDL come from??

Universal design is an approach to design that works to ensure products and buildings can be used by virtually anyone, regardless of their level of ability or disability.

Universal design is essential for some, and good for all.

Where did UDL come from?

Can you think of other examples of universal design in the everyday environment?

Universal design is about reducing or eliminating barriers in products or buildings.

Has this building been universally designed?
3 Core Concepts of UDL

There is no "average learner."

What can we do?

Avoid the "Myth of the Average"

Variability is the rule, not the exception.

1. Goals
2. Variability
3. Context

Expect variability
Design with options
Avoid the "myth of the average"

Environment matters

Change the environment:
- not the child.
- to reduce barriers for all.
- to provide opportunities to show abilities.

low | average | high
memory, language, knowledge, reading, vocabulary, curiosity, perceptual, cognitive, interest

Environment matters
3 Core Concepts of UDL

Environment matters

Objectives
History and Definition of UDL
3 Core Concepts of UDL
Neural Networks in UDL
UDL Guidelines
Reflection

Neural Networks

Affective Network
The way of learning
For personal, motivated learners, stimulate interest and motivation for learning
Provide multiple means of engagement

Recognition Network
The what of learning
For knowledgeable learners, present information in different ways
Provide multiple means of representation

Strategic Network
The how of learning
For strategy, goal-directed learners, differentiate the ways that students can express what they know
Provide multiple means of action and expression

The goal of UDL is to engage all the neural networks to create expert learners through the provision of multiple means of engagement, representation, and action and expression.

UDL utilizes the neural networks in proactive designs to create a problem solving framework.

Objectives
History and Definition of UDL
3 Core Concepts of UDL
Neural Networks in UDL
UDL Guidelines
Reflection
Emotions and Learning

How do we communicate about emotions?

Energy

Pleasantness

Emotions and Learning

How do we communicate about emotions?

Energy

Pleasantness

Emotions and Learning

How do we communicate about emotions?

Energy

Pleasantness

Emotions and Learning

How do we communicate about emotions?

Ask yourself:
• Where am I?
• Where do I need to be?
• What strategies can help me get there?

Ask your students:
• Where are you?
• Where do you need to be?
• What strategies can help you get there?

Emotions and Learning

Physical Actions

- Basic physiology
- Heart rate
- Blood pressure
- Skin response
- Blood glucose

Emotions

- Higher order cognitive centers
- Perception
- Language & communication
- Action
- Executive function

Cognitive Actions

Provide options for recruiting interest:

- Interest inventories
- Offer choices
- Autonomy over learning
- Authentic, relevant examples & experiences
- Minimize threats and distractions to learning

Consider the impact of emotions on learning! It is important explore strategies that support mental readiness and excitement for learning. In other words, we become purposeful and motivated learners.
Multiple Representations allows information to be accessed in new and unique ways to support every individual. In other words, we become resourceful learners.

Representation

Provide options for perception:
- Font, size, color, layout, speed/timing of video, volume, speech rate, etc.
- Input choices
  - Spoken/signed descriptions, speech-to-text, captions, diagrams, graphic organizers, ASL translations, tactile materials, physical objects, etc.

Provide options for language, mathematical expressions, and symbols:
- Visuals/annotations
- Visual dictionaries (word, phrase, idiom, math, etc.)
- Use first and second languages
- Audiobooks (as appropriate)
- Use multiple media
Representation

Provide options for comprehension:
- Activate prior knowledge
- Real-world experiences
- Use images and video
- Graphic organizers to show relationships between ideas
- Use rubrics for teaching and assessment

Universal Design for Learning Guidelines

How can effective visuals support students in becoming strategic learners?

Effective Visuals

Classroom Schedules

Individual Schedules

Effective Visuals

Learning Processes

Our Writing Goals

Learning Processes
Effective Visuals
Task Boards

The use of effective visuals helps students become independent, goal-directed, and self-regulated. In other words, they become strategic learners.

Action & Expression
Provide options for physical action:
- Consider your classroom layout
- Station-based learning
- Scavenger hunt (language, math, QR codes)
- Take brain and body exercise breaks
  - GoNoodle
  - Cosmic Kids Yoga
  - Brain Gym
  - Total Physical Response

Action & Expression
Provide options for expression and communication:
- Visual brainstorming
- Graphic organizers
- Technology-based instruction
- Explain Everything app
- Book Creator app
- Hands-on learning (step away from the SmartBoard)
- Graduated levels of support

Action & Expression
Provide options for executive functions:
- Involve students in setting goals
- Graphic organizers
- Student planners
- Self-assessment
- Visual timers
- Rubrics
- Visual task boards (visual schedule, first-then board, scrub board, task board, etc.)

Action & Expression
“Around the World” Activity
Explore the UDL principles by completing each chart paper placed around the room. For each guideline, share your thoughts about the Definition, Examples, and Bottom Line.
Presentation Agenda
- Objectives
- History and Definition of UDL
- 3 Core Concepts of UDL
- Neural Networks in UDL
- UDL Guidelines
- Reflection

Reflection
- What is different about UDL as a design process?
- Does anything about UDL surprise you?
- What do you think about UDL as a design process?
- What are you excited about?
- What other thoughts do you want to share?

Presentation Agenda
- Objectives
- History and Definition of UDL
- 3 Core Concepts of UDL
- Neural Networks in UDL
- UDL Guidelines
- Reflection

Whip Around
Each participant shares a word or short phrase that represents how they are feeling about the professional development project so far.

Additional Resources
- National Center on Universal Design for Learning
  National Center on UDL
  Examples and Resources

- National Center on Accessible Educational Materials
  National Center of ACM

- CAST
  CAST Free Learning Tools
  CAST Free Webinars
  CAST Professional Learning
APPENDIX D
RESEARCH JOURNAL GUIDE: ALL STAGES

RQ: How does professional development in universal design for learning influence the digital media design process of teachers in a bilingual Deaf education program for students with special needs?

RQ1: How do teachers utilize the UDL guidelines to make decisions when designing digital media materials for students with special needs in a bilingual Deaf education program?

RQ2: What features of PD did the participants feel supported or hindered their learning during the PTLC?

<table>
<thead>
<tr>
<th>Date</th>
<th>Description of research activity</th>
<th>Participants' knowledge</th>
<th>Participants' collaboration</th>
<th>Participants' design process</th>
<th>Participants' teaching practice</th>
<th>Research process</th>
<th>Other</th>
</tr>
</thead>
</table>


APPENDIX E
TRAINING MATERIALS: SELECT AND PLAN STAGES

Universal Design for Learning @

Professional Development
Spring 2017

Study  □  View  □  Plan  □  Implement  □  Analyze  □  Adjust

Objectives

By the end of this presentation, you will
1. Select UDL guidelines and plan a lesson by completing the UDL Lesson Planner
2. Design and create lesson materials
3. Gather feedback from others
4. Make adjustments as needed
5. Prepare for implementation by reviewing the Student Use Survey

PTLC Progress

- Study: Learn about UDL through a structured presentation
- Select: Plan your UDL-based lesson and digital media materials
- Plan: Create your UDL-based digital media materials in collaboration with your peers
- Implement: Use the UDL-based digital media materials with your students and reflect on their responses
- Analyze: Reflect on the design process
- Adjust: Reflect on the IO process

Universal Design for Learning Guidelines

- Multiple Means of Engagement
  - Provide multiple means of expression
  - Provide multiple means of presentation
  - Provide multiple means of action and expression

- Multiple Means of Representation
  - Provide multiple means of perception
  - Provide multiple means of action and expression
  - Provide multiple means of physical action

- Multiple Means of Action and Expression
  - Provide multiple means of perception
  - Provide multiple means of action and expression
  - Provide multiple means of physical action

UDL Lesson Planner

- The UDL Lesson Planner is a lesson planning template that we will use to design our UDL-based lesson and digital media
- Let’s walk through each element of the UDL Lesson Planner now
**UDL Lesson Planner**

<table>
<thead>
<tr>
<th>Your Name</th>
<th>Sarah Smith</th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Lesson</td>
<td>Aids for Emotional Support</td>
</tr>
<tr>
<td>Subject Area</td>
<td>Social Studies</td>
</tr>
<tr>
<td>UDL Plan</td>
<td>2/3</td>
</tr>
<tr>
<td>Other</td>
<td>ASL, English, and AAC used in this statement</td>
</tr>
</tbody>
</table>

**What are the learning goals of the lesson?**

- Students will collaborate to create a digital portfolio that includes relevant details (time, location, and activities).

**What activities will address these goals?**

- This lesson is part of a larger unit in which students have prepared a short biography of Percival for the blind to be performed for the school's students. Students have chosen different roles to act out in various scenes (e.g., those of their parents, characters, etc.).

**UDL Lesson Planner: An Example**

<table>
<thead>
<tr>
<th>UDL Lesson Planner: An Example</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Use the UDL Guidelines visual on the next page to answer the following questions:</td>
<td>Use the UDL Guidelines visual on the next page to answer the following questions:</td>
</tr>
<tr>
<td>What barriers to learning are you facing in this environment?</td>
<td>What UDL checkpoints are already practiced in this learning environment?</td>
</tr>
<tr>
<td>What UDL checkpoints will you focus on in this lesson?</td>
<td>Why did you choose these UDL checkpoints?</td>
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**Let's view an example of a completed UDL Lesson Planner document together.**

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<td></td>
</tr>
</tbody>
</table>

**Let's view an example of a completed UDL Lesson Planner document together.**
**UDL Lesson Planner**

- The next step to fill out the UDL Lesson Planner
- You may work individually or collaboratively
- Your lesson must include some piece of digital media
- Design a lesson for any content area that you wish

**Remember:** UDL focuses on the proactive design of the curriculum in order to meet the needs of as many students as possible. Therefore, design your lesson for at least 2 students, though you may implement the materials at different times.

---

**Concluding Thoughts**

What do you think about UDL as a design process?

What other thoughts do you want to share?

---

**Next Step: Implementation**

- Now that your lesson is planned and your materials are created, the next step is to implement in your classroom
- Over the next 2.5 weeks, use your materials in your classroom. They may be used with a small group or individually across multiple students.
- If appropriate, please try to use the materials several times.
- Each time you implement the materials, you will reflect on the students’ response to the materials by filling out the Student Use Survey. Let’s go over that now.

---

**Student Use Survey**

<table>
<thead>
<tr>
<th>Your Name</th>
<th>Student ID</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Compared to materials used in the past, when using the UDL based digital media material, my students...

- Increased
- Decreased
- Stayed the same

**Motivation**

What observations make you think so?

**Knowledge**

What observations make you think so?

---

**Independence**

What observations do you think so?

---

**Educational mission**

What is your overall view on this digital media material?

In what ways would you change it?
Questions or Comments?

 Whip Around

Each participant shares a word or short phrase that represents how they are feeling about the professional development project so far.
<table>
<thead>
<tr>
<th>Your Name</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Lesson</td>
<td></td>
</tr>
<tr>
<td>Subject Area</td>
<td></td>
</tr>
<tr>
<td>Unit Plan</td>
<td></td>
</tr>
<tr>
<td>Grade(s)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
</tr>
</tbody>
</table>

What are the learning goals of this lesson?

What activities will address these goals?
Use the UDL Guidelines visual on the next page to answer the following questions:

<table>
<thead>
<tr>
<th>What barriers to learning are you trying to reduce/eliminate?</th>
<th>What UDL guidelines/checkpoints are already established in the learning environment?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>What UDL guidelines/checkpoints will you focus on in this lesson?</td>
<td>Why did you choose these UDL guidelines/checkpoints?</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

298
Provide Multiple Means of

<table>
<thead>
<tr>
<th>Engagement</th>
<th>Representation</th>
<th>Action &amp; Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide options for <strong>self-regulation</strong></td>
<td>Provide options for <strong>comprehension</strong></td>
<td>Provide options for <strong>executive functions</strong></td>
</tr>
<tr>
<td>1. Promote expectations and beliefs that</td>
<td>11. Activate or supply background knowledge</td>
<td>23. Guide appropriate goal-setting</td>
</tr>
<tr>
<td>2. Facilitate personal coping skills and</td>
<td>ideas, and relationships</td>
<td>development</td>
</tr>
<tr>
<td>3. Develop self-assessment and reflection</td>
<td>and manipulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14. Maximize transfer and generalization</td>
<td></td>
</tr>
<tr>
<td>Provide options for **sustaining effort and</td>
<td>Provide options for **language, mathematical</td>
<td></td>
</tr>
<tr>
<td>persistence**</td>
<td><strong>expressions, and symbols</strong></td>
<td></td>
</tr>
<tr>
<td><strong>4. Heighten salience of goals and objectives</strong></td>
<td>15. Clarify vocabulary and symbols</td>
<td></td>
</tr>
<tr>
<td>**5. Vary demands and resources to optimize</td>
<td>16. Clarify syntax and structure</td>
<td></td>
</tr>
<tr>
<td><strong>challenge</strong></td>
<td>17. Support decoding of text, mathematical</td>
<td></td>
</tr>
<tr>
<td><strong>6. Foster collaboration and community</strong></td>
<td>notation, and symbols</td>
<td></td>
</tr>
<tr>
<td><strong>7. Increase mastery-oriented feedback</strong></td>
<td>18. Promote understanding across languages</td>
<td></td>
</tr>
<tr>
<td></td>
<td>19. Illustrate through multiple media</td>
<td></td>
</tr>
<tr>
<td>Provide options for <strong>recruiting interest</strong></td>
<td>Provide options for <strong>perception</strong></td>
<td>Provide options for <strong>physical action</strong></td>
</tr>
<tr>
<td><strong>8. Optimize individual choice and autonomy</strong></td>
<td>20. Offer ways of customizing the display of</td>
<td>29. Vary the methods for response and navigation</td>
</tr>
<tr>
<td><strong>9. Optimize relevance, value, and authenticity</strong></td>
<td>information</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22. Offer alternatives for visual information</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX G
STUDENT USE SURVEY: IMPLEMENT STAGE

<table>
<thead>
<tr>
<th>Your Name</th>
<th>Students Using Materials</th>
</tr>
</thead>
</table>

Compared to materials used in the past, when using the UDL-based digital media materials, my students:

<table>
<thead>
<tr>
<th></th>
<th>Increased</th>
<th>Stayed the same</th>
<th>Decreased</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motivation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Independence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Educational success</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

What observations make you think so?

What is your overall view on this digital media material?

In what ways would you change it?
APPENDIX H
TRAINING MATERIALS: ANALYZE AND ADJUST STAGES

Universal Design for Learning @ [Redacted]

Professional Development
Spring 2017

Slide | Next | Plan | Implement | Analyze | Action

Appendix

Lessons

Agenda
- Review UDL Guidelines
- Lesson Highlights
- Small Group Reflection: Design Process
- Small Group Reflection: PTLC
- Concluding Thoughts

Universal Design for Learning Guidelines

Provide Multiple Means of Engagement
- Physical: Verbal, visual, kinesthetic, auditory
- Cognitive: Logical, sequential, holistic
- Social: Collaborative, interactive

Provide Multiple Means of Representation
- Physical: Text, diagrams, models
- Cognitive: Multilingual, symbolic
- Social: Collaborative, interactive

Provide Multiple Means of Action & Expression
- Physical: Manipulating objects, movement
- Cognitive: Problem-solving, critical thinking
- Social: Collaborative, interactive

Lesson Topics

Animal Adaptations to the Environment

Lesson Outline

What barriers to learning are you trying to reduce/eliminate?

"We all fall into rut and I want to make sure that if I'm using a PPT, I'm making something more with it."

"Less lecturing; more students involved discussion."

"Retract to completing work independently."

What UDL checkpoint(s) are already established in the environment?

<table>
<thead>
<tr>
<th>Engagement</th>
<th>Representation</th>
<th>Action &amp; Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Promote expectations and beliefs that equal opportunity</td>
<td>1. Provide options for alternative input</td>
<td>1. Provide options for engagement and self-selection</td>
</tr>
<tr>
<td>2. Provide options for optional output and expression</td>
<td>2. Provide options for alternative output</td>
<td>2. Provide options for outputs and display of information</td>
</tr>
<tr>
<td>5. Provide options for varied output methods</td>
<td>5. Provide options for alternative output</td>
<td>5. Provide options for feedback and self-evaluation</td>
</tr>
</tbody>
</table>

Microscope Lab Report

Animal Shapes

Sens

Life Cycle of a Plant

Homing a Community Outing

301
What UDL checkpoint(s) did you target in your lesson?

<table>
<thead>
<tr>
<th>Private Reflective</th>
<th>Engagement</th>
<th>Representation</th>
<th>Action &amp; Expression</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Use of positive encouragement</td>
<td>2. Physical representation</td>
<td>2. Auditory representation</td>
<td></td>
</tr>
<tr>
<td>5. Recognition of students' efforts</td>
<td>5. Touch representation</td>
<td>5. Olfactory representation</td>
<td></td>
</tr>
</tbody>
</table>

Why did you choose these UDL checkpoints?

- "I want to increase their desire to do the activity on their own."
- "Researching a variety of methods of response due to the variety of students and needs of communication."
- "Multiple avenues to achieve the same goal."
- "Wanted to help them make connections between what they are learning and real-life activities."
- "Would like students to become more observant of the world around them and to realize how it affects their daily lives."

Small Group Reflection

Break into small groups. Using the questions on the next slide as a guide, discuss how your experiences in this PD influenced the design process, implementation, and future use of UDL. Be prepared to share a few thoughts with the whole group.

Small Group Reflection

Break into small groups. Using the questions on the next slide as a guide, discuss how your experiences in this PD influenced the knowledge, design process, collaboration, teaching practice, and overall view of UDL. Be prepared to share a few thoughts with the whole group.

Small Group Reflection

Design Process
5. What is your opinion on the use of UDL with your population of students?
2. How did you use the UDL Guide to help you design your digital media?
3. Which UDL guidelines did you find most affecting your teaching practices? Why?
4. Were there any UDL guidelines that you consciously chose not to follow? Why?

Implementation
5. Did you have enough knowledge of UDL to successfully design and implement it in your classroom?
2. What are your student(s) using digital media, what did you notice? Think about their motivation, knowledge, independence, and educational success.

Future Use
1. Do you expect to continue to use UDL in your teaching practice? If so, how? If not, why not?
2. How do you see the engagement, representation, and action & expression guidelines impacting your teaching practice?
3. What else would you like to explore related to the implementation of UDL in your classroom?
Concluding Thoughts

What do you think about UDL as a design process?

What do you think about the PTLC as a model of PD?

What other thoughts do you want to share?

Whip Around

Each participant shares a word or short phrase that represents how they are feeling about the professional development project.

Thank you for your participation!
APPENDIX I
DOCUMENT RUBRIC: POST-PTLC

<table>
<thead>
<tr>
<th>Participant Code</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Title of Lesson</td>
<td></td>
</tr>
<tr>
<td>Subject Area</td>
<td></td>
</tr>
<tr>
<td>Targeted UDL Checkpoints</td>
<td></td>
</tr>
</tbody>
</table>

Using the UDL-based lesson and digital media artifact, examine each targeted and observed checkpoint from the UDL guidelines by completing the rubric on the following pages. The levels of performance are provided in the chart below.

<table>
<thead>
<tr>
<th>Level</th>
<th>Text</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Not observed or present in the design</td>
<td>This indicates that there is no evidence of this UDL checkpoint in the design. Not all checkpoints can be included in every design. A score of “0” should not be considered a negative – this particular checkpoint may simply not have been targeted in this design.</td>
</tr>
<tr>
<td>1</td>
<td>Weakly observed or present in the design</td>
<td>This indicates that there is some evidence of this UDL checkpoint in the design. However it may only be observable in parts of the design or in limited contexts.</td>
</tr>
<tr>
<td>2</td>
<td>Moderately observed or present in the design</td>
<td>This indicates that there is significant evidence of this UDL checkpoint in the design. It is observable in most parts of the design and in most contexts. There remain some opportunities for increasing the application of this checkpoint.</td>
</tr>
<tr>
<td>3</td>
<td>Strongly observed or present in the design</td>
<td>This indicates that there is ample evidence of this UDL checkpoint across all aspects of the design.</td>
</tr>
<tr>
<td>UDL Checkpoint</td>
<td>Rating</td>
<td>Researcher Comments</td>
</tr>
<tr>
<td>----------------</td>
<td>--------</td>
<td>---------------------</td>
</tr>
<tr>
<td>#________</td>
<td></td>
<td></td>
</tr>
<tr>
<td>__Already Established (by teacher)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>__Targeted (by teacher)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>__Observed (by researcher)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#________</td>
<td></td>
<td></td>
</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>__Observed (by researcher)</td>
<td></td>
<td></td>
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<td>__Already Established (by teacher)</td>
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<td>__Targeted (by teacher)</td>
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<td>__Observed (by researcher)</td>
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<tr>
<td>Engagement</td>
<td>Representation</td>
<td>Action &amp; Expression</td>
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| Provide options for **self-regulation**  
1. Promote expectations and beliefs that optimize motivation  
2. Facilitate personal coping skills and strategies  
3. Develop self-assessment and reflection | Provide options for **comprehension**  
11. Activate or supply background knowledge  
12. Highlight patterns, critical features, big ideas, and relationships  
13. Guide information processing, visualization, and manipulation  
14. Maximize transfer and generalization | Provide options for **executive functions**  
23. Guide appropriate goal-setting  
24. Support planning and strategy development  
25. Enhance capacity for monitoring progress |
| | Provide options for **sustaining effort and persistence**  
4. Heighten salience of goals and objectives  
5. Vary demands and resources to optimize challenge  
6. Foster collaboration and community  
7. Increase mastery-oriented feedback | Provide options for **language, mathematical expressions, and symbols**  
15. Clarify vocabulary and symbols  
16. Clarify syntax and structure  
17. Support decoding of text, mathematical notation, and symbols  
18. Promote understanding across languages  
19. Illustrate through multiple media | Provide options for **expression and communication**  
26. Use multiple media for communication  
27. Use multiple tools for construction and composition  
28. Build fluencies with graduated levels of support for practice and performance |
| Provide options for **recruiting interest**  
8. Optimize individual choice and autonomy  
9. Optimize relevance, value, and authenticity  
10. Minimize threats and distractions | Provide options for **perception**  
20. Offer ways of customizing the display of information  
21. Offer alternatives for auditory information  
22. Offer alternatives for visual information | Provide options for **physical action**  
29. Vary the methods for response and navigation  
30. Optimize access to tools and assistive technologies |
APPENDIX J
INTERVIEW GUIDE: POST-PTLC

1. Please describe your professional background, including your teaching experience here at SDC.

Design Process
2. Before this PD, what did you know about UDL?
3. What is your opinion on the use of UDL with this population of students?
4. How did the UDL Guidelines influence your design process?
5. How did the UDL-based design process differ from what you have done in the past?
6. Which UDL guidelines did you choose to focus on in your design? Why?
7. Were there any UDL guidelines that you consciously chose not to include? If so, why?

Implementation
8. When your student was using your digital media design, what did you notice? (What did they do or say? How did they respond?)
9. What did you notice about student motivation?
10. What did you notice about student knowledge?
11. What did you notice about student independence?
12. What did you notice about overall educational success?

Future
13. Do you expect to continue to use UDL in your teaching practice?
   a. If so, how?
   b. If not, why?
14. How do you see the Engagement Guideline impacting your teaching practice?
15. How do you see the Representation Guideline impacting your teaching practice?
16. How do you see the Action & Expression Guideline impacting your teaching practice?
17. What else would you like to explore related to the use of UDL in your classroom?

Professional Development
18. Please describe your overall impressions about the professional teaching and learning cycle.
19. Which activities were the most valuable to you? Why?
20. How did the professional development impact your knowledge of UDL?
21. How did the professional development impact your design practice?
22. Please describe how you collaborated with other teachers.
23. Was this collaboration valuable? Why?
24. How did the professional development impact your overall teaching practice?
<table>
<thead>
<tr>
<th>Question</th>
<th>Responses</th>
</tr>
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<tbody>
<tr>
<td>Name</td>
<td>Open-response</td>
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<tr>
<td>Age</td>
<td>Open-response</td>
</tr>
<tr>
<td>Years of teaching experience (total, through the end of the 2017 school year)</td>
<td>Open-response</td>
</tr>
<tr>
<td>Years of teaching experience (at SDC, through the end of the 2017 school year)</td>
<td>Open-response</td>
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<tr>
<td>Massachusetts Teaching License (check all that apply)</td>
<td>☐ am not a licensed educator</td>
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<td>☐ have a license in Deaf/hard-of-hearing</td>
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<td>☐ have a license in special education</td>
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<tr>
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<td>☐ Other: ____________</td>
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<td>Background with UDL (core concepts, UDL guidelines, etc.) before attending this training.</td>
<td>☐ had no background with UDL. I had never heard of UDL before.</td>
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<tr>
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<td>☐ had heard the term &quot;UDL&quot; or &quot;universal design for learning,&quot; but I didn't really know what it was.</td>
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<td>☐ had a little experience with UDL.</td>
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<tr>
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<td>☐ had a lot of experience with UDL.</td>
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<tr>
<td></td>
<td>☐ was already an expert with UDL.</td>
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</table>
LIST OF REFERENCES


Vesel, J. (2005). Signing science! Andy and Tonya are just like me! They wear hearing aids and know my language!? *Learning and Leading with Technology, 32*(8), 30–35.


BIOGRAPHICAL SKETCH

Sarah E. Brandt has worked in the field of Deaf education for over 11 years. She is a Curriculum Coordinator at a school for Deaf children with special needs, formerly holding the positions of Teacher of the Deaf, Deaf Education Specialist, and Media Specialist. She holds an Ed.D. from the University of Florida (2017) in curriculum and instruction with a concentration in educational technology, a Master of Arts from the University of Arizona in special education with a concentration in deaf and hard-of-hearing, and a Bachelor of Arts from the University of Rochester in American Sign Language and linguistics. Her research interests include digital media design and use, language and literacy development, and curriculum development for bilingual Deaf learners, particularly those with special needs.