Implementation of Universal Design for Learning in the Classroom: Teacher Professional Development and Student Outcomes

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Abstract

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Merely accessing the general curriculum and classroom does not guarantee that students with dis/abilities will be able to participate in the learning activities and make meaningful academic progress; including diverse learners requires flexible instructional practices and methods and the belief that all students can learn regardless of ability. Universal Design for Learning (UDL) has been identified as a research-based framework that guides educators in designing and delivering instruction for all students, including students with dis/abilities. While UDL is a promising framework to ensure access, participation, and progress, the literature does not tell us how to comprehensively implement the three principles of UDL (representation, engagement, and expression) with high fidelity in a general education classroom. This study employed a non-concurrent multiple baseline across participants design and semi-structured interviews to examine the effects of a teacher training package to support the implementation of the UDL framework during a literacy lesson in an inclusive classroom context. Experimental and qualitative results indicated that the professional development activities supported implementation of the UDL framework and increased student learning.

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DEDICATION

For my mother, Sandra MacIvor Hartwell- who instilled in me that nothing is impossible and how to harness challenges and make them strengths.

For my husband, Al- we committed to *living, loving*, and *learning* together… without any idea that that I would take the learning to this level. I am so deeply grateful for all your support and love and I could not have done this without you.

For my boys, Harry and Cooper- may they come to know that learning is endless and that knowledge is the power to change.

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CHAPTER 1

INTRODUCTION TO THE PROBLEM

Inclusion, diversity, and equity are terms that have visible narratives across a variety of contexts (e.g., workplace, education, social media, entertainment industry). The recent uptake in diversity and inclusion can be attributed to the movement towards identity situated in difference (i.e., identity politics), that is, staking claim to membership of a group that has traditionally been in the margins along the dimensions of race, ethnicity, sexual orientation, socio-economic status, and ability (e.g., Hancock, 2019; Brubaker, 2015; Wimmer, 2013). Acknowledging and responding to diversity requires a change in practices and attitudes to address individual variation within a large group setting.

Within an educational context, inclusion and inclusive education is not new or trendy; for over five decades the educational system has been tasked with determining how to establish equitable learning contexts for marginalized and vulnerable groups of students (i.e., students with dis/abilities[1], ethnically and linguistically diverse students, and students from low socio-economic backgrounds) (Artilles & Kozleski, 2007; Dyson, Booth, & Ainscow, 2006; Ferguson, Kozleski, & Smith, 2003; Kalambouka, Farrell, Dyson, & Kaplan, 2005; Waitoller & Kozleski, 2013). Equitable learning contexts are described as providing access to the general education curriculum and classroom, supporting participation in learning opportunities, and maintaining

[1] A slash (/) is used to signal the social, historical, and political practices that assign the identity of 'disabled' and reinforce that biological and physical differences limit one's ability (Davis, 1995; Waitoller & King Thorius, 2016).

high expectations for increased learning outcomes for all students. Given the diverse populations in many classrooms across the United States, educators need access to high-quality practices to effectively address learner variability and create equitable learning opportunities and outcomes for these students (Council for Exceptional Children, 2014).

Inclusive education has not been seamless as it pushes stakeholders (i.e., special and general educators, administrators, policymakers, families) to re-examine the educational intent of special and general education and assumptions related to teaching and learning. From the outset, our educational system was designed for "average students, not for those with complex needs" (Hehir & Katzman, 2012, p. 5), therefore it is not surprising that efforts to create access and opportunities to participate for *all* students, regardless of ability, challenges the origins of education and historical practices. A predominant barrier in inclusive education is the firmly held belief that students who require individualized instruction also require an educational approach that is "special," different, and separate from general education teaching methods and learning contexts (Biklen & Kliewer, 2006; Kluth, Straut, & Biklen, 2003; Lalvani, 2013; Salend & Duhaney, 1999; Slee, 2011). Furthermore, the belief that the child embodies the disabling condition and is the one who needs to change, rather than the environment, contributes to teachers' beliefs that they have little control over learning until the dis/ability is removed or remediated (Hahn, 1988).

In contrast the social model of disability makes a clear distinction between the biological nature of a dis/ability and the "handicapping social environment" in which an individual with dis/abilities exists (Fine & Asch, 1988; Scheer, 1994). Within this framework, it is not the individual characteristics of the child that is disabling; instead, it is the socially-based

assumptions related to ability that are limiting factors and impact opportunity and membership (Bingham, Clark, Michielsens, & Van de Meer, & 2013; Brandon & Pritchard, 2011). Changing perspectives challenges assumptions about ability and requires a deeper reflection on how to approach teaching and learning (Thompson et al., 2014).

Inclusive education pushes up against traditional views on teaching and learning, directing educators to examine *why* it is important to include diverse learners, *where* learning occurs, *what* curriculum and content should be addressed, and *how* to provide access, participation, membership, and progress for all learners regardless of ability (Ryndak, Jackson, & White, 2013). Drawing on previous scholarly work, inclusion is defined as a shared belief that all students, regardless of ability, race, ethnicity, cultural and linguistic backgrounds, are valued and viewed as equal members of their learning community and are provided with appropriate support to achieve high academic standards (Hehir & Katzman, 2012; Skrtic, Sailor, & Gee, 1996; Olson, Leko, & Roberts, 2016). The following sections review the importance and the challenges of including students with diverse learning abilities (*why*), identifying curriculum content (*what*), determining educational contexts in which learning occurs (*where*), and professional development and learning as it relates to the instructional practices and methods (*how*).

Including Students with Dis/abilities: *Why*

The inclusion movement in education has garnered attention and controversy. It is not surprising given that educating students with and without dis/abilities in the same learning context disrupts the tradition of both special and general education (Artiles, 2003; Connor & Ferri, 2007; Kozleski, Artiles, & Waitoller, 2013). There is a sizeable body of research on

inclusive education examining: (a) how educational policy and reform has influenced the movement towards including students with dis/abilities (e.g., Dyson, 1999; Fuchs & Fuchs, 1994; Kavale & Forness, 2000; Lipsky & Gartner, 1997; Slee, 2010), (b) beliefs, perceptions, and attitudes towards inclusion and students with dis/abilities (e.g., Avramidis & Norwich, 2002; Bruns & Mogharreban, 2007; Scruggs & Mastropieri, 1996), (c) educational strategies, interventions, and practices that support inclusion (e.g., Odom, Buysse, & Soukakou, 2011; Olson, Leko, Roberts, 2016; Simpson, de Boer-Ott, & Smith, 2003), and (d) social and academic outcomes within inclusive settings (e.g., Rea, McLaughlin, & Walther-Thomas, 2002; Schwartz, Staub, Gallucci, & Peck, 1995; Scruggs, Mastropieri, & McDuffie, 2007; Waldron & McLeskey, 1998). Furthermore, inclusive research focusing specifically on the benefits of including students with significant dis/abilities has demonstrated increased engagement (e.g., Hunt, Farron-Davis, Beckstead, Curtis, & Goetz, 1994), improved literacy skills (e.g., Dessemontet, Bless, & Morin, 2012; Ryndak, Morrison, & Sommerstein, 1999), increased social engagement and social competence with non-dis/abled peers (e.g., Carter & Hughes, 2005; Ryndak, Ward, Alper, Storch, & Montgomery, 2010). Despite the empirical evidence that demonstrates the benefits and efficacy of inclusive education, including students with dis/abilities- especially students with significant dis/abilities (i.e., autism, intellectual dis/abilities, multiple dis/abilities), suggests that inclusion works for some but not all (McLeskey et al., 2010; Ryndak et al., 2014; Kurth, Morningstar, and Kozleski, 2014).

Educational Setting: *Where*

In 1975, Congress passed and has renewed several times since a law that has become to be known as the Individual with Disabilities Education Act (IDEA 2004), which ensures that

students with dis/abilities receive a Free and Appropriate Education (FAPE) in the Least Restrictive Environment (LRE). Additionally, a mandate of IDEA (2004) instituted the right for students to access general education classroom and curriculum to the "maximum extent appropriate" (20 USC. 1412(a)(5)(B). The laws guiding LRE resulted in practices known as *mainstreaming* or *integrating*.

LRE provisions a continuum of placements to address specific learning needs of students with significant dis/abilities which has authorized educational teams to determine where appropriate placement (i.e., learning context) is for a student with dis/abilities. Often that is determined to be outside the general education classroom because that is where the special education expertise is located. These practices suggest that accommodations and modifications can only be provided in a separate location and re-affirms the idea that students with dis/abilities need something different based on the perceived limitations in learning. Inclusive philosophies, situated in equity, sought to move beyond physical placement and towards a model of providing education for students with dis/abilities with same-aged peers, in general education classrooms, as equal members with a shared goal of furthering social and academic learning (Skrtic, Sailor, & Gee, 1996; Odom et al., 2011).

While there have been advancements in inclusive education, our schools continue to wrestle with how to provide equitable access and meaningful participation to achieve positive learning outcomes for students with dis/abilities, especially students with significant dis/abilities. The US Department of Education, National Center for Educational Statistics, provides national data on the percentage of students 6-21 years old receiving special education services and the percentage of these students accessing the general education classroom based on dis/ability

category (NCES, 2016). The data set illustrates the persistent challenge of including students with significant dis/abilities, as this subset of students are less likely to access the general education classroom for 80% or more of their school day than students with mild-moderate dis/abilities (e.g., specific learning dis/ability, speech, and language impairment, visual impairment). For example, when reviewing the more restrictive data- 33.3% of students with autism spend less than 40% of their school day in general education as compared to 6.1% of students with specific learning dis/abilities spend less than 40% of their school day in general education (NCES, 2016).

The National Center for Education Statistics data set, while providing useful information on access, does not specify the educational contexts that are accessed. General education consists of core content areas (e.g., math, language arts, science), specialists (e.g., music, art, physical education), and non-academic activities (e.g., lunch, recess). Accessing general education contexts and curriculum is linked to student learning outcomes, therefore, educational researchers have investigated what access means and what it looks like to better understand how to address the barriers to access (e.g., Browder, Wakeman, Flowers, Rickelman, Pugalee, & Karvonen, 2007; Dymond, Renzaglia, Gilson, & Slagor, 2007; Fisher & Frey, 2003; Soukup, Wehmeyer, Bashinski, Bovaird, 2007). An example of limited access to grade-level academic learning is literacy. Students with dis/abilities, even more so for students with significant dis/abilities, have historically been denied access to high-quality literacy instruction (Browder et al., 2009). The impact of limited access is concerning as literacy is associated with positive post-secondary outcomes. Literacy crosses multiple contexts (e.g., home, school, community) and provides individuals with the opportunity of expression, communication, and shared

understandings. The literature base on accessing literacy instruction and learning identifies the most significant barrier is low expectations of the learner and their ability to access the curriculum (Kleiwer & Biklin, 2001; Katims, 2001; Browder et al., 2009; Ruppar, Dymond, & Gaffney, 2011). This assumption limits immediate learning opportunities and has a lifelong impact on the student. Assumptions related to abilities leads to limited access to literacy learning and other core content areas.

Curriculum and Content: *What*

IDEA (1997, 2004) provides statutory language for students receiving special education services to have "access to the general curriculum" with the requirement that educational teams demonstrate how a dis/ability, with supplemental supports and services in place, impacts participation and progress. There has been considerable debate across the literature base in translating what accessing the curriculum means for students with dis/abilities, particularly for students with significant dis/abilities (Spooner, Dymond, Smith, & Kennedy, 2006).

Dymond and colleagues (2007) investigated how access to the curriculum is defined and understood by educators. Their findings suggested that general educators' definition of access centered on the grade-level curriculum provided to students without dis/abilities with support from special educators or paraprofessionals. Whereas special educators' interpretation of accessing the general curriculum as "adapted curriculum that is relevant and meaningful to the student and addresses individual student needs." (Dymond et al., 2007, p. 11). While both definitions reflect the grade level, standards-based, core-content and materials, where they differ is identifying who is responsible for delivering instruction. General education teachers consistently report that the challenge in providing access to the general education curriculum is

lack of training, expertise, and confidence (Finke, McNaughton, & Drager, 2009; McCray & McHatton, 2011; Ross-Hill, 2009) Collaboration, between special and general education educators, is essential to identify learning arrangements (i.e., peer supports, small group instruction), effective instructional practices (i.e., explicit instruction, embedded instruction), and additional supports that increase student independence (i.e., self-management, self-monitoring, visual schedules) to facilitate access to the general curriculum and classroom (Ryndak, Jackson, & White, 2013).

Instructional Practices and Professional Learning: *How*

The instructional practices that support and strengthen inclusive education are collaboration and co-teaching, cooperative learning, peer supports, and differentiated instruction (Olsen, Leko, & Roberts, 2016; Quirk, Ryndak, & Taub, 2017; Villa & Thousand, 2003). It is important to note that in addition to instructional practices there are interventions and evidence-based practices (e.g., response prompting, discrete trial training, pivotal response training) that support learning for students with dis/abilities (WWC, 2017). These instructional practices, methods, and interventions all have merit in supporting diverse learners within a general education context. For example, collaboration and co-teaching draw on the expertise of both general and special educators to develop meaningful learning opportunities; peer supports and cooperative learning enlist peers without dis/abilities to facilitate social and academic support; differentiated instruction is responsive to individual student learning needs. Understanding the composition of students, that is, who is accessing and participating in the learning context is a prerequisite to leveraging inclusive practices and strategies to address barriers present within the context and the curriculum. While the aforementioned inclusive practices may be useful for

some students, these practices are not a one-size fits all. Understanding of who the learners are within a learning context and what practices to engage requires proactive planning paired with flexible instructional practices.

Universal Design for Learning. Universal Design for Learning (UDL) claims to "reach all learners" (Meo, 2008; Hall, Meyer, & Rose 2012) including students with significant dis/abilities (e.g., Browder et al., 2008; Ryndak, Jackson, & White, 2013). UDL is a comprehensive framework that guides educators in designing and delivering instruction for *all* students, including students with dis/abilities and culturally and linguistically diverse backgrounds. The UDL framework, drawing on the architectural concept of Universal Design, seeks to make learning accessible from the outset by designing in advance of the learning opportunity, creating several entry points to the content (i.e., curriculum), and facilitating participation in learning by developing a variety of ways in which a student can interact with information and demonstrate mastery. Implementing UDL in a classroom allows educators to approach instruction proactively instead of engaging in reactive responding or retrofitting when learning is not occurring (Pisha & Coyne, 2001). Furthermore, the UDL total framework guides teachers planning process to account for diverse learners and facilitates identifying and implementing inclusive strategies and evidence-based practices (i.e., collaboration, co-teaching, peer supports, differentiated instruction, systematic instruction) to ensure access, participation, and progress (Browder et al., 2009; Israel, Ribuffo, & Smith, 2014; Ralabate, 2016; Katz, 2013; Lieber, Horn, Palmer, & Fleming, 2008; Novak; 2016; Nelson, 2015).

The UDL framework addresses the *how* (instruction) and the *what* (curriculum) while holding to the belief that all learners (*why*), regardless of ability, are entitled to high-quality

instruction and learning opportunities that produce increased academic achievement. Additionally, UDL plans for and leverages student interests and motivation, and maintains high expectations to foster and develop expert learners (Katz, Portath, Bendu, & Epp, 2012; Rose & Gravel, 2010; Rose & Meyer, 2002).

Research examining the impact of UDL in practice-based settings is emerging and obscure, at best. The comprehensive nature of the UDL framework (i.e., three principles, nine guidelines, and 31 checkpoints) has led UDL to been investigated in a variety of ways resulting in a mire of outcomes (Ok, Rao, Bryant, & McDougall, 2017; Rao, Ok, & Bryant, 2014; Roberts, Park, Brown, & Cook, 2011). The lines of inquiry have ranged from interventions utilizing *specific technologies* (i.e., computer-based programs, technology enhanced materials, and video modules); the effectiveness of a specific *instructional strategy* (i.e., use of task analysis, flexible grouping, environmental arrangements) (e.g., Browder et al., 2009; Lieber et al., 2008); *curriculum redesign* (e.g., Dymond, Renzaglia, Rosenstein, Chun, Banks, Niswander, & Gilson, 2006). UDL has been investigated at the curriculum level, classroom level (general and special), and building level (e.g., Dymond et al., 2006; Lieber et al., 2006; Katz, 2013). Intervention outcomes have been measured in a variety of ways including perceptions, student engagement, and progress on academic and social goals. To further complicate the body of research examining the impact of UDL, there is limited evidence on what specific UDL principles, guidelines, and checkpoints were applied and examined and related to intervention and student outcomes (Ok et al., 2017). While the literature has looked individual strategies that address one or two principles, there is little known about the implementation of all three principle and its impact on the students. There is also little known about what is necessary to implement UDL in a

comprehensive manner in the classroom. That is, what type of professional learning will result in high levels of implementation in the classroom.

Statement of the Problem

The educational system has been wrestling with how to effectively include diverse learners for almost five decades. Educational policy, research, and shifts in attitudes towards dis/abilities and learning have influenced efforts towards providing high-quality, equitable learning opportunities that achieve positive learning outcomes. While progress has been made in determining the contexts, content, and effective instructional strategies- this progress has been realized by some students, not all; students with significant dis/abilities remain in the margins. The limitation is problematic as it perpetuates dominant notions of who is able and who is not, and limits learning and future outcomes. Addressing this challenge requires the sequence of identifying effective instructional strategies, providing professional development, and supporting implementation to reach the desired outcome of academic achievement.

Purpose

"UDL not only has the potential to radically transform the meaning of inclusive education, but the very concept of dis/ability" (Wilson, 2015). Creating equitable access and meaningful participation in learning opportunities for the desired outcome of student progress, hinges on effective educational practices, effective professional development, and effective implementation strategies. The empirical literature base on professional development activities that support the implementation of the UDL framework in inclusive contexts and how that influences student outcomes is insufficient and unclear. This study seeks to address this gap by examining *how* professional development supports designing and delivering equitable learning

opportunities within a general education context and how that impacts positive learning outcomes for *all* students, regardless of ability.

The primary research question guiding this study is: What are the effects of a UDL teacher training on designing and delivering UDL literacy lessons within a general education classroom? The secondary research questions are as follows: 1.) How does implementing a UDL literacy lesson effect academic progress for a student with a dis/ability? 2) How does implementing a UDL literacy lesson effect academic progress for students without a dis/ability?

The following chapter will first further review the impact of educational policy and reform on inclusive education and explore and synthesize literatures on inclusive practices. Then introduce the history of UDL, how it is located in educational policy and reform, and synthesize the empirical literature base on UDL. Finally, the chapter will substantiate the importance of professional learning and implementation to better understand how these components have influenced educational practices and student outcomes. This chapter will conclude with a through-line between the literatures by presenting a theory of change.

CHAPTER 2

REVIEW OF THE LITERATURE

Inclusive education has been defined and understood in a variety of ways across multiple contexts (i.e., schools, classrooms, nations, and literature). The range in definitions are reflective of influential factors (i.e., educational policy, research) and theoretical underpinnings (i.e., social justice, democracy). Educational policy and practice have placed an emphasis on learning contexts and content for students with dis/abilities. Theory and policy, which have guided inclusive efforts, are realized in practice-based settings with instructional practices that support the learning of all students, not just some. Inclusion is not merely providing access to the general curriculum and classroom, it requires creating opportunities for meaningful participation, engagement, resulting in increased learning outcomes (Kozleski, Artiles, Fletcher, & Engelbrecht, 2009; Kozleski & King Thorius, 2014).

The purpose of this literature review is twofold. First, this chapter will review and summarize the federal laws and initiatives that established the right for students with dis/abilities to access the general curriculum and classroom as well as explore pedagogical approaches that strengthen and support including students with dis/abilities. The second purpose of this chapter is to support the argument for Universal Design for Learning (UDL) as the means to effectively reach all students. Finally, this chapter will conclude with a theory of change model that connects UDL, professional learning, and implementation.

Federal Educational Laws and Initiatives

The pathway to access, participation, and academic progress for individuals with dis/abilities was forged by federal legislation, educational initiatives, and educational reform. Collectively these efforts supported the movement of a rights-based, social justice model that promotes equity in learning for all students, regardless of ability. The two landmark federal laws that were the driving force behind re-conceptualizing how to provide equitable education for individuals with dis/abilities were the Elementary and Secondary Education Act and Education for All Handicapped Children Act (PL 94-142).

Elementary and Secondary Education Act (ESEA). Elementary and Secondary Education Act, enacted in 1965, was the first law set forth with provisions for students whose ability to make academic gains were impacted by barriers such as race, poverty, learning difficulties, dis/ability, transience, or lived in households where English was not the primary language. ESEA was reauthorized and renamed No Child Left Behind Act (NCLB, 2001). The reauthorization held states and public schools accountable for the demonstration of adequate yearly progress (AYP) for all students, including students with dis/abilities. Every Student Succeeds Acts (ESSA, 2015), the current reauthorization of ESSA, retained accountability measures (i.e., high-stakes testing), and provided more flexibility to states and districts in designing accountability systems and interventions (ESSA, 2015). These reauthorizations preserved the right to equitable education and established the importance of implementing effective, evidence-based practices to support academic achievement for all learners. Establishing the right to access general education curriculum and classroom were supported through additional federal laws and mandates.

Education for All Handicapped Children Act (PL 94-142). In 1975, Congress enacted the Education for All Handicapped Children Act (PL 94-142) to protect the rights of infants, toddlers, children, and youth with dis/abilities. This precedent-setting law required that all local and state agencies (i.e., schools) receiving federal funding provide individuals with dis/abilities equal access to education. Furthermore, schools were required to evaluate students with dis/abilities and develop an educational plan (PL 94-142, 1966).

In 1990, EHA (1965) was reauthorized and renamed Individuals with Disabilities Improvement Education Act (IDEA). The reauthorization established the right for individuals with dis/abilities, from birth to 21 years of age, to receive a Free and Appropriate Public Education (FAPE). The reauthorization of IDEA included accountability feature was added by requiring that students with dis/abilities be included in and state and district-wide assessments (IDEA, 1997).

Successive amendments extended the law by adding categories of dis/abilities, age of entitlement, and establishing the rights of children with dis/abilities and their parents are protected through due process (IDEA, 2004). In addition to ensuring access to public education, IDEA had included statutory language that students receiving special education services had "access to the general curriculum" (IDEA, 2004). Accessing the general curriculum was interpreted as placement in the general education classroom. Least Restrictive Environment (LRE) identifies the right for students to access general education classroom and curriculum to the "maximum extent appropriate" (20 U.S.C. 1412(a)(5)(B).

Moving beyond simply accessing public education and the general curriculum, IDEA required that students' Individualized Education Plan (IEP) include statements on participation

and progress. These included (a) how a dis/ability impacts their participation and progress in the general education curriculum, (b) measurable goals that enable a student to participate and progress in the general education curriculum, and (c) services, program modifications, and supports necessary for a student to participate and progress in the general education curriculum (IDEA, 2004).

The federal laws and initiatives were the drivers to ensure that students with dis/abilities had access to standards-based and high-quality curriculum and simultaneously maintain high learning expectations for students with dis/abilities (Soukup, Wehmeyer, Bashinski, & Bovaird, 2007). While the laws established protection and guidance, the term "inclusion" is absent from the legalese leaving the opportunity inconsistent interpretations and practices.

Creating inclusive and equitable classrooms requires knowledge of effective practices and how to implement them with high fidelity to achieve the intended outcome of student learning. Following the assumption that all students can learn and are entitled to accessing learning environments with their peers- the active ingredients to creating learning opportunities that are accessible and equitable, are teachers content knowledge, flexible instructional design and delivery, and the capacity to modify and adjust the curriculum to reduce barriers (Soukup et al., 2007).

Inclusive Instructional Methods

The instructional methods that have been identified in the literatures as supporting designing and delivering instruction for a diverse range of learners, including students with dis/abilities, are collaboration and co-teaching, cooperative learning, peer supports, adaptive teaching, culturally responsive teaching, and differentiated instruction (Turnball et al., 2003;

Villa & Thousand, 2005; Katz, 2013). Evaluating instructional methods in relationship to student learning (i.e., academic performance and achievement) informs educators on what works under what conditions (Otaiba & Hosp, 2004). The following sections will review relevant research on instructional methods and the impact on student outcomes applied in inclusive classrooms.

Collaboration & Co-Teaching. In the inclusive literatures, lack of expertise is frequently cited as a barrier to implementation of inclusive practices. Collaboration between educators, special and general, strengthens the connection between learning opportunities and outcomes by selecting effective instructional practices, blending of expertise, engaging in problem-solving, and sharing resources (Condemn & Johnston-Rodriguez, 2009; Friend, Cook, Hurley-Chamberlain, & Schamberger, 2010).

Often general and special education teachers will adopt a co-teaching model in inclusive settings to develop shared instructional practices that are effective for students with and without disabilities (Cook & Friend, 1995; Mastropieri & Scruggs, 2006). However, the literature base suggests that while the co-teaching model is intended to be collaborative and a shared effort, teachers reported that in the co-teaching model general education teachers continued to assume the role of providing instruction to the classroom, and special education teachers continued to engage in the traditional role of modifying curriculum, addressing behaviors, and monitoring progress (Weiss and Brigham, 2000). In addition to the lack of clarity in teacher roles, the research identified the following barriers (a) lack of administrative support, (b) involuntary teacher commitment, (c) lack of training, and (d) lack of compatibility (Scruggs, Mastropieri, & McDuffie, 2007).

Student outcomes in co-teaching vary across the literatures. While students with dis/abilities continued to make academic gains, there is limited evidence that the co-teaching model increased overall academic achievement as measured by standardized tests (Rea, McLaughlin, & Walther-Thomas, 2002; Idol, 2006; Murawski, 2006). The insufficient evidence in increased academic gains has been attributed to (a) low fidelity of implementation, (b) variability across grade level, student groups, and subjects, and (c) limited rigorous research (i.e., few experimental or quasi-experimental studies) (Friend et al., 2010). Furthermore, consistent with the research-base on inclusive education, the barriers have been identified as lack of time, resources, training, and lack of administrative support (Kohler-Evans, 2006; Murray, 2004; Idol, 2006).

Cooperative Learning. Cooperative learning draws from theories in psychology (Deutsch, 1949, 1962), cognitive development (Piaget, 1950; Vygotsky, 1978), and behavioral and social learning theories (Bandura, 1977; Skinner, 1968). Within a cooperative learning model there is an established group goal and assigned individual tasks. Students work together collectively to achieve the learning goal and are evaluated both individually and group (Slavin, 1980). There is a distinction between cooperative group tasks and cooperative learning- the former is reflective of a momentary or specific task and the latter reflects students engaging in an on-going learning process that ensures learning for the individual as well as the members of the group (Slavin, 1990; Stahl, 1994). This distinction is important as cooperative learning is not simply grouping students together, it requires intentional planning and support for students with varying abilities to address their unique learning styles and needs (Sapon-Shevin, Ayres, & Duncan, 1994). For example, cooperative learning structures requires social interactions and

social skills (i.e., active listening, sharing ideas, providing positive feedback, accountability, asking for clarification, and reflection) for students with challenges in social communication and skills (i.e., autism) this requires additional support and training in the skills needed to engage and learn cooperatively.

Cooperative learning is a flexible instructional practice that considers learner variation and leverages peers to support engagement and academic performance for students with dis/abilities (Ryndak, Jackson, & Billingsley, 2000; King-Sears, 1997). Equitable learning opportunities, that is, learning that accounts for diversity and difference, are achieved by effectively grouping students to work together to accomplish shared learning goals (Johnson & Johnson, 1999).

Sapon-Shevin, Ayres, and Duncan (1994) discuss how cooperative learning aligns and strengthens inclusive practices. They identified the intersection of inclusion and cooperative learning as (a) an opportunity to develop peer support and collaboration that highlights strengths and addresses challenges, (b) fostering open communication about differences, (c) employing collaborative problem-solving, (d) establishing norms about when, how, and why we help others (i.e., "everyone is good at something and can help others, everyone is entitled to and can benefit from help and support from others"), (e) facilitating meaningful content by removing curriculum barriers, and (f) evaluation takes into account content and process and assessment can be based on both group and individual learning (Sapon-Shevin, Ayres, & Duncan, 1994, pp. 45-58).

Cooperative learning has been validated through considerable research that has demonstrated a range of positive outcomes (i.e., increased achievement, on-task performance, motivation, social competencies) for students with and without dis/abilities (e.g., Copeland &

Cosbey, 2008, 2009; Hunt, Staub, et al., 1994; Johnson, Johnson, & Stanne, 2000; Kamps, Barbetta, Leonard, & Delquadri, 1994; Slavin, 1984). However, cooperative learning methods vary as there is some confusion between simply grouping students together to engage in a learning activity and the structures (i.e., group goals and individual accountability) that are critical to cooperative learning, therefore the student outcome data may not be a reliable measure on the impact of cooperative learning (Slavin, 1990). Furthermore, as a stand-alone practice, it does not ensure participation and increased learning outcomes. To strengthen learning opportunities and outcomes, instructional methods are integrated into cooperative learning which may include direct instruction, small-group instruction, whole group, and independent practice. "When cooperative learning is coupled with effective instructional approaches and sound curricular adaptations for students with diverse learning styles and needs, benefits accrue to all students." (Putnam, 1997, p. 44).

Peer Mediated Supports. Peer mediated interventions, similar to and often embedded in cooperative learning structures, draw on social learning theory (Bandura, 1997) and enlists peers without dis/abilities to provide social and academic support to students with dis/abilities. In other words, students without dis/abilities are positioned as "instructional interventionists" by modeling appropriate behaviors, implementing prompting sequences, and providing reinforcement for desired or target behaviors (Carter & Kennedy, 2006; Cushing & Kennedy, 2004; Kamps, Barbetta, Leonard, & Delquadri, 1994). What sets peer supports apart from cooperative learning is a smaller number of students who are intentionally selected and trained to provide support to students with dis/abilities (Carter & Kennedy, 2006). Effective peer supports are reliant on special and general educators work collaboratively to design a peer support plan

which includes identifying, training, and providing on-going support for both the peer model and the student with a dis/ability (Brock & Carter, 2016; Carter, Cushing, & Kennedy, 2009). The peers selected are trained in adapting assignments, accommodating learning needs, and facilitating social interactions for the target student with a dis/ability (Brock, Biggs, & Carter, 2016; Cushing & Kennedy, 1997).

Research on peer supports in inclusive settings has demonstrated gains in social interactions (e.g., Banda et al., 2002; Jung, Sainato, & Davis, 2008; Katz & Girolametto, 2013), access to general education curriculum (e.g., Carter, Cushing, Clark, & Kennedy, 2005; Carter & Kennedy, 2006), and support in specific content areas (i.e., reading and math) (e.g., Fuchs & Fuchs, 2005; Calhoon & Fuchs, 2003). Peer supports have consistently demonstrated to be effective in supporting social interactions, however, there is limited research evidence on the academic gains and achievement. Academic progress has been evaluated in relationship to increased academic engagement (e.g., Carter et al., 2008; Shukla, Kennedy, & Cushing, 1999). Academic engagement is a precondition to learning and is considered a proxy to academic achievement, however, "demonstrating that peer support interventions actually enhance students' academic performance, as well as increase knowledge and skill acquisition, remains a critical challenge." (Carter & Kennedy, 2006, p. 289). Additionally, implementation factors such as peers delivering prompts and reinforcement may result in low fidelity therefore influencing outcomes (Chan, Lang, Rispoli, O'Reilly, Sigafoos, & Cole, 2009).

Adaptive Teaching. Adaptive teaching, like cooperative learning and peer supports, identifies and responds to student needs and adjusts the learning environment and activities. The theory of adaptive teaching is situated in aptitude development, that is, the ability to

acknowledge learner variation within the classroom context and provide flexible instructional practices to simultaneously promote growth in individuals and groups of students (Snow, 1996). In the development of adaptive teaching, there were two expectations- teachers adapted their instruction to individuals and "students adapt themselves to whatever instruction they receive" (Corno, 2008, p. 162). The premise is that students will intersect with multiple learning environments and instructional methods and they will be better served if they develop adaptive learning methods and will have a higher likelihood of being independent learners (Randi & Corno, 2005). Adaptive theory evolved into adapting and designing instruction to increase student independence by means of students learning how to receive and adapt instruction for themselves (Corno, 2001; Corno, 2006). Ultimately, the goal of adaptive teaching is to make learning accessible as well as impart strategies for students to adapt to and generalize across instructional conditions.

This cycle of adapting, teaching, and self-adapting over the course of ongoing activities is considered critical for the long-term development of academic ability (Corno, 2006). Randi and Corno (2005) had further expanded their definition and application of adaptive teaching to teachers identifying subgroups within the larger group context based on student needs and strengths. At the core of adaptive teaching is an educator's ability to assess student strengths and weaknesses and student characteristics (i.e., inattentiveness, lack of motivation, learning differences) that interfere with learning in order to adjust (or adapt) the learning environment effectively. Instead of teaching to the middle or mythical average, the adaptive teaching approach claims to create a middle ground which includes all learners over time (Randi & Corno, 2005). While adaptive teaching is reminiscent of the instructional practice of tracking or leveling

(Pettig, 2000), through the development of the subgrouping, the reported difference is that adaptive teaching is more fluid and dynamic by seeking to bring students to the middle ground. The middle ground is identified as “where students share experiences, develop aptitude, and the teacher can capitalize on skills available across the class to challenge and support all students" (Corno, 2006, p. 171). While adaptive teaching responds to individual student needs and sets forth to create learning conditions that support students in the immediate learning environment and generalize to other environments, it lacks empirical evidence on the implementation and effectiveness (Duffy, Miller, Parsons. & Meloth, 2009; Fairbanks et al., 2010).

Culturally Relevant, Responsive, and Sustaining Pedagogy. The demographic composition of today’s classroom reflects the dimensions of diversity (i.e., racial, linguistic, ethnic, and cultural). Consistent with the deficit model perspective towards dis/abilities, is the phenomenon on how to “fix” racially, culturally, ethnically, and linguistically diverse students (Klinger et al., 2005; Paris & Alim, 2017). In the late 1990s and early 2000, researchers and educators began to implement asset pedagogies which is the practice of valuing, exploring, and extending cultural and linguistic experiences of diverse learners within dominant, white, middle-class classroom and curricula contexts. (Paris, 2012)

Discourse and classification of asset pedagogies and practices that seek to acknowledge diverse classroom contexts have undergone several iterations (e.g., Culturally Responsive Teaching, Culturally Responsive Education, Culturally Relevant Practices, Culturally Responsive Pedagogy, and Culturally Sustaining Pedagogy (respectively, Nieto, Bode, Kang, & Raible, 2008; Ladson-Billings, 1995; Gay, 2000; Paris, 2012). According to Paris and Alim (2014), *responsive* and *relevant* do not capture the importance of engaging in practices that

preserve and honor diverse populations. Therefore, the shift towards *sustaining* emphasizes on-going efforts and critiques. The progression of terms reflects the dynamic nature of diversity which requires continual review and revision in order to uphold, value, and leverage difference in equitable learning opportunities. Fundamental to the labels and terminology is valuing student's diverse experiences, knowledge, and backgrounds to enhance instruction and learning while simultaneously and actively engaging in a "critique dominant power structures" to interrogate assumptions, learning materials, and learning activities within a diverse classroom context (Paris & Alim, 2017, p. 88).

Dis/ability is a dimension within diversity. Ableism is the discrimination against people with physical, intellectual, or psychiatric dis/abilities and has served to segregate and marginalize populations similar to racism (Sullivan & Thorius, 2010; Thorius & Tan, 2015). Furthermore, intersection between race, culture, ethnicity, and linguistic and dis/ability is observed in the overrepresentation of diverse students in special education. Culturally Sustaining Practices seek to dismantle inequities along the dimensions and "intersections of ability, race, language, gender, and class differences, particularly in inclusive education." (Waitoller & king Thorius, 2016). Establishing learning contexts that actively engage diversity and create learning opportunities that are accessible to all students requires a deeper examination of evaluation of assessment procedures in order to decrease referrals to special education and increase accountability (Fairbanks et al., 2010; Ortiz & Artiles, 2010; Waitoller & King Thorius, 2016).

A considerable amount of the literature on Culturally Sustaining, Responsive, Relevant Pedagogy consists of scholarly reviews, essays, and policy and opinion papers, books, or book chapters. Several literature reviews have been conducted to clarify what Culturally Relevant

Practices look like in the classroom context and the impact on student outcomes. For instance, Morrison and colleagues (2008) reviewed classroom-based research implementing culturally relevant approaches to understand and define culturally relevant pedagogy. In their investigation, they found that several instructional practices were used to address the disconnect between students with racially, culturally, ethnically, linguistically diverse (RCELD) backgrounds and the curriculum. Included in these practices were scaffolding, modeling, collaboration, and clarification of the curriculum. The starting points are high expectations and leveraging student strengths and personal experiences (Brown, 2003; Powell, 1997). Culturally responsive pedagogy is student-centered and considers student variability by removing assumptions about learning and ability based on a student's experience and background. Additionally, culturally responsive teaching is multi-dimensional by considering several teaching and learning features which are the "curriculum, learning context, classroom climate, student-teacher relationships, instructional techniques, classroom management, and performance assessments" (Gay, 2010, p.33). By leveraging student's experience educators create pathways to access, participation, and academic achievement; educators "scaffold instruction and build bridges between the cultural experiences of ethnically diverse students and the curriculum content of academic subjects to facilitate higher levels of learning." (Gay, 2010, p. 46).

Aceves and Orosco (2014), for instance, reviewed empirical research articles to identify effective culturally responsive practices and student outcomes. The authors identified consistent themes across the research. The themes were categorized into the following: general themes, emerging evidence-based practices, and recommended approaches and considerations (Aceves & Orosco, 2014). The EBPs identified in the studies include (a) collaborative teaching, (b)

responsive feedback, (c) modeling, and (d) instructional scaffolding (Aceves & Orosco, 2014, p. 13). It is not surprising that these practices also align with inclusive educational practices. This demystifies the notion that inclusion is a special education agenda, instead, inclusion is the means to address educational inequities for all students. The recommended approaches, similar to the observed EBPs, map onto inclusive educational practices (i.e., problem-solving approach, student-centered instruction, and material and assessment selections). While the authors were able to identify themes across the empirical literature base, academic achievement outcome data were "severely lacking" and they recommended "rigorous" professional development as well as examination of implementation factors. Effective professional development and implementation fidelity facilitate teachers making connections to their students' abilities and racial, cultural, linguistic, ethnic identities and processes for planning and delivery of instruction that effectively engages and acknowledges diversity (Aceves & Orosco, 2014). Responsive teaching requires knowledge in how students access and engage in their learning and instructional practices that address the barriers to learning.

Differentiated Instruction. Similar to CSP, differentiated instruction (DI) is responsive to student learning needs. The theoretical underpinning for differentiated instruction (DI) is in cognitive psychology and is connected to research related to student achievement (McTighe & Brown, 2005). DI is the process of teachers reflecting on and adjusting their instructional methods and materials to ameliorate repeated demonstration of a learner struggling to understand a concept or having challenges making connection with the content (Tomilson, 1999). In this model and it is not the student who needs to adapt to the environment, rather it is adjusting and adapting environmental features (i.e., instruction, materials) to address "varying readiness levels,

varying interests, and varying learning profiles." (Tomlinson & Kalbfleisch, 1998, p. 54). DI directs teachers to engage in flexible teaching practices, adapting curriculum, and varying methods to present information in a variety of ways to increase learning opportunities and outcomes for students who demonstrate challenges with the "one size fits all" approach (Hall, 2002).

According to Tomlinson (2001), there are four core components of the curriculum that can be differentiated which include (a) content (i.e., what a teacher plans to teach), (b) process (i.e., how the teacher plans instructional delivery), (c) product (i.e., assessment), and (d) environmental (i.e., physical classroom arrangements, student grouping arrangements, and options for materials). In the differentiated classroom teachers develop ways for students to learn that does not assume that "one student's roadmap for learning is identical to anyone else's" (Tomilson, 2005, p. 2). On-going assessment and collaboration (i.e., teacher and student) are critical components of DI as it allows for teachers to identify gaps in learning and *respond* to student needs (Fuchs & Fuchs, 2006, Tomilson, 2005).

DI has garnered much attention in educational research and practice. The areas of interest are effectiveness (e.g., Tieso, 2001; Baumgartner, Lipowski, & Rush, 2003) and instructional practices that support DI (e.g., Fisher & Frey, 2001; Odgers, Symons, & Mitchell 2000). While there is a sizeable body of research supporting DI, research indicates that the DI model presents some challenges. For instance, Rock and colleagues (2008) identified limited evidence in implementation (uptake) of DI in broader practice (Rock, Gregg, Ellis, & Gable, 2008). The authors suggest the reasons for limited implementation are teachers feeling unprepared to teach students with diverse needs, high demands for content coverage, and

interfering classroom behaviors (Rock et al., 2008, p. 34). In addition to these challenges, DI was designed to respond to limited or lack of student progress retrospectively. Evaluating student needs requires on-going assessment to identify challenges in learning or "at-risk" students. It is only after identification of barriers to learning, that educators develop differentiated practices to respond to limited or lack of student progress. This retrospective process is not only time-consuming and inefficient, it is reminiscent of the "fail first" model.

Collaboration, co-teaching, peer supports, adaptive teaching, culturally sustaining practices, and differentiated instruction are instructional approaches that have advanced inclusive education by addressing diversity in learning. Instructional approaches that seek to create inclusive learning contexts require an understanding of who the learners are and the experiences and backgrounds they bring into the classroom. Given that student's ability, race, ethnicity, cultural and linguistic backgrounds influence academic access, participation, and achievement it is essential to employ instructional practices that address diversity intentionally and effectively (Harry & Klinger, 2006; Orsoco & Klinger, 2010). When applied individually or used in combination these practices offer the opportunity to support inclusive efforts in increasing access, participation, and academic achievement.

The fundamental challenges across the aforementioned inclusive practices is implementation fidelity and limited demonstration of increased learning outcomes (i.e., academic achievement). Learning is maximized when all students have access to evidence-based instruction and academic supports (Berkely, Marshak, Mastropieri, & Scruggs, 2011). Without high implementation fidelity, it is difficult to evaluate the efficacy of these practices in relation to the intended outcome. Determining under what conditions to use which instructional method,

coupled with effective implementation is critical to providing accessible learning opportunities and achieving increased learning outcomes for all students.

The "one size fits all" tradition has been critiqued throughout inclusive educational research as being restrictive and creating barriers to learning. One can then assume that there is not a single instructional practice that is effective for inclusive classroom contexts and that in order to reach all learners several instructional practices and strategies are needed to address learner variability. Teachers need a mechanism to support instructional planning and implementation that maintains high learning expectations and effectively addresses learner variability. The UDL framework is a comprehensive framework that guides teachers in designing and delivering instruction that integrates EBPs, leverages student strengths and interests, and structures learning opportunities that are accessible and engaging, which facilitates learning for all.

Universal Design for Learning

Universal Design, an architectural term coined by Ron Mace, architect and dis/abilities rights advocate, originated from the need for public spaces to offer multiple pathways for access to accommodate for the various ways in which individuals navigate environments (e.g., wheelchairs, baby strollers, walkers) (Edyburn, 2005). The model of providing multiple entry points was fused with foundational research from cognitive neuroscience, learning sciences, and educational psychology which advanced the conceptual model of Universal Design for Learning (Rose & Gravel, 2010).

Digital imaging technology has enhanced and extended neuroscience and learning research. Understanding how the individual brain networks respond differently to presented

stimuli confirmed that variation is inherent in all individuals (Raven, Raven, & Court, 1998; Rose & Dalton, 2009). The brain-based evidence confirmed that when information is presented in a singular format, the learning experience is restrictive as it allows for a some (not all) to access and engage in the information (CAST, 2011).

Neuroscience research identified three interrelated types of brain networks that attribute to the learning process. The networks are *affective* (emotions and attitudes that influence learning), *recognition* (identification and categorization of information), and *strategic* (planning, executing and monitoring learning) (Meyer, Rose, & Gordon, 2014). The three primary neural networks (i.e., affective, recognition, strategic) correspond with Lev Vygotsky's learning theories. Vygotsky (1978) asserted that there are three conditions for learning to occur: (a) the learner must recognize patterns, (b) the learner must have strategies for responding and acting on perceived patterns, and (c) the learner must be engaged by both the patterns and strategies applied to learning opportunities (Pisha & Coyne, 2001).

Drawing on educational theory and neuroscience, reframed teaching and learning and inspired the development of a framework for designing and delivering instruction that accounts for individual variation (Hall, Meyer, & Rose, 2012). The three guiding principles of the UDL framework, connecting Vygotsky's theories and neuroscience, are identified as follows:

- *Multiple Means of Representation (accessing information)*: recognition network that identifies patterns providing students with a variety of ways to acquire information and knowledge through multiple channels such as discussion, readings, digital texts, and multimedia.

- *Multiple Means for Engagement (engagement)*: leveraging student interests, creating high expectations, and motivating students to learn through activities such as collaborative learning, instructional game, songs, virtual tours, or recorded readings.
- *Multiple Means of Action & Expression (progress)*: offering a variety of means to demonstrate evidence of learning or "show what you know" through formats such as art products, multimedia presentations, digital recordings, or traditional tests or papers.

In addition to identifying the conditions for learning, Vygotsky (1978) recognized the need to support learning process. Vygotsky developed the Zone of Proximal Development (ZPD) to address the difference between supported learner performance and unsupported (independent) learner performance. Scaffolding is a mechanism of ZPD to provide appropriate, individualized supports guide the learning process. Within the three guiding principles of UDL, there are scaffolds which are referred to as guidelines. The guidelines are further elaborated on with checkpoints (prompts) to provide educators with a deeper understanding of how to design and deliver instruction that addresses variability.

The comprehensive UDL framework (principles, guidelines, and checkpoints) serves to guide and prompt for educators in designing lessons and delivering instruction, however, understanding how to actually apply the UDL framework in practice is unclear. Educational organizations have recognized the UDL framework as a structure to guide educators and the need to have the principles, guidelines, and checkpoints be more practitioner-friendly to support educators in implementing UDL into their classrooms. The Collaboration for Effective Educator Development, Accountability and Reform (CEEDAR Center) and the IRIS Center (Vanderbilt University's Peabody College) have both developed professional development modules and

materials to provide educators with enhanced learning opportunities on the UDL framework. James Basham and colleagues at the Universal Design for Learning-Implementation and Research Network (UDL-IRN; http://udl-irn.org/) created user-friendly (simple and clear) language to describe and convey the principles of UDL. For example, UDL-IRN shifted CAST's language from *provide multiple means of representation* to *provide multiple means of representing or presenting information*. The simple shift anchors the idea in how to information is presented to students rather than represented.

Design. Designing a lesson using the UDL framework is proactive instructional planning, that is, designing instruction in advance that accounts for learner differences. "UDL is not simply a listing of various flexible options and strategies; rather it is the process of designing intentionally to reduce cultural cognitive, behavioral, and physical barriers." (Smith et al., 2019. P. 4). The instructional designing process is similar to traditional lesson planning (i.e., learning objective, materials, methods, instructional sequence, assessment, and reflection), however, the critical difference is that the UDL framework emphasizes that learning challenges are not situated in the student, rather in the challenges are in the learning context. Rose and Meyer (2002) describe how the interaction with the curriculum is the barrier and not individual learner differences and further state, "when education fails, the curriculum, not the learner should take the responsibility for the adaptation" (p. 20). Table 1. provides a comparison between traditional lesson planning and UDL lesson planning.

Table 1.

Comparison of Traditional Lesson Planning and UDL Lesson Planning

Component	Traditional Lesson Planning	UDL Lesson Planning
Learning Goals	Goals taken from CCSS and/or scripted curriculum which are often unclear and vague.	Clearly written goals that connect the skills to the content using flexible language to allow for variability and maintain high expectations.
Methods	Conventional methods (e.g., lecture format)	Flexible methods that support and challenge all learners.
Materials	Textbooks and pencils	Flexible and varied materials that include low- and high-tech
Assessment	Standard paper-and-pencil tasks or assessing learners in one way	Assessment techniques that are sufficiently flexible and inform instruction as well as evaluate student understanding and knowledge.

Note: CCSS = Common Core State Standard

Additional frameworks have been advanced to highlight the difference between traditional lesson planning and UDL lesson planning. CAST (2004) developed a process called Planning for All Learners (PAL) that includes a four-step process for collaborative, instructional team to develop UDL lesson plans (Meo, 2008). The four steps include: (1) setting goals, (2) analyzing the current status of the curriculum and classroom, (3) applying the UDL framework to lesson planning, and (4) implementing the UDL-aligned lessons (CAST, 2004; Meo, 2008).

UDL-IRN, in addition to their efforts to adjust the language to be practitioner-friendly, the organization seeks strengthen implementation of UDL by providing educators with clear steps for designing instruction. They developed a tool referred to as Instructional Planning Process framework to assist educators in designing lesson plans. This framework uses a backward design process (starting from the outcome) and the steps include: (1) establish clear outcomes, (2) anticipate learner variability, (3) establish measurable outcomes and assessment

plan, (4) identify instructional sequence, and (5) reflect on instruction and learner outcomes. (UDL-IRN, 2018).

Rao and Meo (2016) describe how educators can deconstruct CCSS to develop UDL lessons. The authors describe the process as "unwrapping the standard" (cited in text, Ainsworth, 2003) and applying the UDL framework to the four lesson components (goals, assessments, methods, and materials). Within this model, educators can attend to the standard by identifying and separating the core skills and the concepts. In doing so, educators can then develop a lesson plan that adheres to the standard and provides options for how students are going to meet the standard. The authors developed a set of questions to augment the lesson planning process, they are as follows:

- Goals: Based on the academic standard addressed in this lesson, what are the skills and concepts we want students to master?
- Assessments: How can students demonstrate achievement of the identified goals in varied ways?
- Methods: What supports and scaffolds can be used as part of instruction to help students acquire the content and demonstrate what they have learned?
- Materials: What resources, materials, and tools can be used to provide multiple means to represent and express information and concepts or to engage with content? (Rao & Meo, 2016, p. 5)

Beginning with a clear understanding of the starting points (learning goals) and the final destination (assessment for mastery), implementing the UDL framework provides educators with ways to think about potential barriers in the curriculum (e.g., print text, activities reliant upon

paper-and-pencil tasks, limited response opportunities) plan for student variability, and select instructional methods and materials that provide multiple pathways to ensure access and participation (Meyer, Rose, & Gordon, 2014; Nelson, 2014; Novak & Rose, 2016; Ralabate, 2016).

Lowrey and colleagues (2017) engaged in a narrative inquiry where seven teachers shared their experiences of implementing the UDL framework. The teachers were enlisted from school districts that had undergone a district-wide implementation of UDL. Each teacher participant had a range of learners, including students with intellectual dis/abilities, in their classrooms. The teachers discussed how the UDL framework supported their instructional designing process. Specifically, they identified how intentional planning (i.e., identifying methods, materials, and assessment strategies) for specific student needs increased student access, engagement, and outcomes.

Delivery. In addition to identifying instructional methods and materials, the UDL framework leverages evidence-based practices (EBP) to effectively address learning needs within a classroom (Israel, Ribuffo, & Smith, 2014; Ralabate, 2016; Novak; 2016; Nelson, 2014; Lieber et al., 2008; Browder et al., 2009; Katz, 2013). Systematic and explicit instruction may be embedded across multiple learning opportunities. An example of fusing an EBP with UDL is Browder and colleagues (2009) investigation of planning and implementing shared stories for students with multiple dis/abilities utilizing a task analytic instruction. The UDL principles were used in combination with a task analysis to increase student responses. The task analysis, developed collaboratively, facilitated clear steps of the instructional process for the individual students which resulted in increased student engagement and independent responding.

Additionally, the authors emphasized team planning between special and general education teachers as a critical component as it allows for collective expertise to work together and identify the ways in which students access and participate in learning (Browder et al., 2008).

The UDL framework has 31 checkpoints supported by previous research as well as scholarly reviews and expert opinions. For each principle there are three guidelines and corresponding checkpoints. These checkpoints serve to improve lesson planning and implementing the UDL framework. The following example illustrates how UDL guides instructional delivery:

- Principle: Multiple Means of Representation
    - Guideline 1: Provide Options for Perception
        - Checkpoint 1.1: Offer ways of customizing the display of information
        - Checkpoint 1.2: Offer alternatives for auditory information
        - Checkpoint 1.3: Offer alternatives for visual information
    - Guideline 2: Provide Options for Language and Symbols
        - Checkpoint 2.1: Clarify vocabulary and symbols
        - Checkpoint 2.2: Clarify syntax and structure
        - Checkpoint 2.3: Support decoding of text, mathematical notation, and symbols
        - Checkpoint 2.4: Promote understanding across languages
        - Checkpoint 2.5: Illustrate through multiple media
    - Guideline 3: Provide Options for Comprehension
        - Checkpoint 3.1: Activate or supply background knowledge

- Checkpoint 3.2: Highlight patterns, critical features, big ideas, and relationships
- Checkpoint 3.3: Guide information processing and visualization
- Checkpoint 3.4: Maximize transfer and generalization (CAST, 2018)

Appendix A provides the UDL framework descriptions, examples and non-examples of each checkpoint.

UDL and Public Policy. UDL has been recognized and referenced in the in the 2004 reauthorization of the Individuals with Disabilities Education Act (P.L. 94-142), Higher Education Opportunity Act (HEOA, 2008), Every Student Succeeds Act (ESSA, 2015), and the *National Educational Technology Plan* (U.S. Department of Education, 2010, 2016).

IDEA 2004 moved policy in the direction of UDL with the adoption of National Instructional Materials Accessibility Standard (NIMAS) and the movement towards Response to Intervention (RTI). NIMAS (2004) explicitly references UDL by requiring publishers and school districts to have digitized versions of texts (Hehir, 2009). RTI provisions addresses the identification of students with specific dis/abilities by providing tiered interventions for students struggling with the curriculum (Hehir, 2009).

Every Student Succeeds Act (ESSA, 2015), which replaced No Child Left Behind (NCLB, 2001), references UDL as a method to create access to the curriculum for all learners-including students with dis/abilities and English Language Learners. UDL is outlined explicitly in sections that address assessment, literacy, and the distribution of funds to support technology that assists instructional strategies.

In 2008, UDL was defined and included under federal law in the Higher Education Opportunity Act of 1965 (HEOA, 2008). This law provides a number of provisions to improve access to postsecondary education for students with intellectual dis/abilities. Additionally, HEOA provided recommendations on a variety of ways that UDL should be incorporated into preservice teacher preparation programs, in-service teacher training, and in postsecondary instruction.

The Department of Education published, *Transforming American Education: Learning Powered by Technology*. *National Educational Technology Plan*, *2010*, which outlines applying advanced technologies to improve student learning, advance scaling up the adoption of effective practices, and the use of data for on-going improvement. (Department of Education, Office of Educational Technology, 2010). The report specifically identified the application of UDL principles to increase student achievement regardless of background, language, or disabilities.

UDL has been recognized in educational laws and policy, these efforts situate UDL as a valid instructional framework to support learning from elementary to post-secondary settings. While educational policy guides educators, research on the implementation of UDL has been problematic (Smith, Rao, Lowrey, Gardner, Moore, Coy, Marino, & Wojcik; 2019).

UDL and empirical evidence. Much of the literature on UDL is consists of scholarly reviews and expert opinions touting the merits and benefits of UDL in K-12 classrooms (e.g., Howard, 2004; Hunt & Andreasen, 2011; Lieberman et al., 2008; McPherson, 2009) or in post-secondary education (e.g., Burgstahler & Cory, 2008; Gradel & Edson, 2009; Scott, McGuire, & Shaw, 2003) There is insufficient evidence of the impact of implementing the UDL as a

comprehensive framework (Browder et al., 2008; Dymond et al., 2006) and how that effects student academic achievement.

UDL has been investigated in a myriad of ways, under varying conditions, with a range of populations, leaving consumers of the research with inconsistent evidence of efficacy and outcomes. Given the comprehensive nature of UDL (i.e., principle, guidelines, and checkpoints) it is not surprising that research has focused on particular aspects of UDL. Studies have investigated specific technologies, instructional planning methods and strategies, and redesigning at the classroom and building level using the UDL framework. For the scope of this study, the criteria for selecting studies was: (a) research was conducted in K-12th grade settings (studies conducted in post-secondary were omitted), (b) studies were empirically based (i.e., qualitative, quantitative, single-case, or mixed-method), (c) studies reporting academic or social outcomes, and (d) studies were published in a peer-reviewed journal. The inclusion criteria yielded 14 studies- two employed quantitative methods, three used qualitative methods, and nine used quasi-experimental methods. Effect sizes ranged from small to large. Target populations included students with and without dis/abilities, as well as English language learners. See Appendix B which outlines the research methods, participants, interventions, dependent variables, and effect sizes for the studies included in this review.

Specific technologies. UDL has mistakenly been interpreted as the exclusive use of technology (i.e., computer-based instruction and academic software programs) in a classroom. While technology provides an alternate avenue to access (representation), participation (engagement), expression (academic achievement), it's use alone does not translate to a universally designed classroom or instruction. Several studies aimed to examine how specific

technologies support learning in a UDL environment (e.g., Coyne et al., 2012; Dalton, Proctor, Uccelli, Mo, & Snow, 2011; Marino, 2009; Kennedy, Thomas, Meyer, Alves, & Lloyd, 2014). Coyne and colleagues (2012) applied digital text to understand how flexible options lead to increased learning outcomes in literacy learning for 16 students with significant disabilities in grades K-2. They used a concept called, Literacy by Design (LBD), which utilized software that had embedded scaffolds to support phonemic awareness, phonics, comprehension, fluency, and vocabulary. When a student encountered a word or an unfamiliar task, the software gave additional prompts in the form of a hyperlink where the student could access more information and guide their learning. The software also had the following features: read aloud, highlighted text, animation, and photo essays. The results of the study indicated that students who had access to the software (treatment group) made more significant gains in comprehension than students who did not have access (control group). Kennedy and colleges (2014) studied how digital materials supported and increased 32 high school students' learning in science and social studies by using Content Acquisition Podcasts (CAPs). Science and social studies content information was delivered using visuals and simplified explanations in a digital format. The results of the study showed that providing content through a variety of means made a substantial increase in learning as observed through curriculum-based measurements. While these examples leverage technology and demonstrate the principles of UDL, they are merely the means and not the ends to instructional delivery and design.

Instructional planning methods and strategies. Two studies explored instructional planning and delivery strategies using a UDL lens. Browder and colleagues (2009) adapted books and designed a read-aloud experience for three students with multiple disabilities. The

environmental arrangements were proactively designed and included low lighting, varying output devices, and providing a choice of book selection. Additional tactile materials were used so students could interact with the story being read. Browder et al. (2008) emphasized the teaming process as critical to instructional design and task analysis to support instructional delivery. This quantitative research (SCRD) demonstrated that students with significant disabilities benefit from an adapted read-aloud using a UDL approach (i.e., collaboration, varying materials, use of evidence-based practices).

Lieber and colleagues (2008) developed a UDL curriculum applying flexible grouping, environmental arrangements, and peer supports to increase student access and engagement for students with learning, cultural, and linguistic differences. These practices align with the UDL principles of representation and engagement. The assessment of academic progress showed varying results from small to large. This study highlights the utility of planning in advance for diverse learners and embedding supports (Lieber et al., 2008).

Redesigning at the classroom and building level. Two studies examined implementation of UDL at the classroom level (i.e., science class) and the building level (i.e., five schools) Dymond et al. (2006), using a participatory action research approach, collaborated with high school teachers to redesign two sections of a secondary-level science class which included general education students and students with significant cognitive dis/abilities. The teacher participants did not receive a formal training on UDL, rather the researchers and teacher participants discussed relevant literatures that helped formulate questions for the re-design. The questions were developed to guide teachers in their planning process. For example, in addressing clear goals the question proposed was, “What are the general standards you are

addressing in this unit or lesson?"; for intentional planning the question asked was, "How will I provide instruction in a variety of ways?"; prompting for flexible methods and materials the question was, "How will I provide students with choices related to materials, grouping, and teacher and self-directed learning activities?" The findings of the qualitative study were: (a) students with significant dis/abilities made progress on their IEP goals which were embedded in the course content, (b) special educators preferred to be involved in the proactive planning process, and (c) paraeducators were unfamiliar and uncomfortable with providing support to small groups versus a one-to-one arrangement. However, data on all student outcomes were not collected.

Katz (2013) developed a curriculum referred to as the Three Block Model of UDL. The blocks consisted of 1.) social-emotional learning, 2.) evidence-based instructional practices (i.e., Understanding by Design, DI, Curriculum Integration, Inquiry, & Assessment for Learning), and 3.) student engagement and autonomy. The design of the Three Block Model of UDL draws on research which has established a relationship between social inclusion, inclusive instructional practices, and student engagement and increased student outcomes (e.g., Specht & Young, 2010; Wiggins & McTighe, 2005; Tomilson, 2010). The Three Block Model was implemented across six schools. The outcomes of the study varied with greatest gains reported in student engagement and teacher's use of a variety of instructional practices. While the instructional practices implemented were aligned with UDL, there was no explicit connection between the three guiding principles of UDL and the Three Block Model. Additionally, the author did not report the characteristics or learner profiles but did state that the schools enlisted had inclusive educational philosophies and mission statements.

While the research emerging, it is important to consistently and comprehensively apply the framework to evaluate effectiveness in relationship to student outcomes. In the reviewed research, how researchers interpreted and applied the framework varied across the studies. Two studies (Browder et al., 2008; Dymond et al., 2006) which examined UDL more comprehensively in terms of applying the UDL framework to a content area. While these studies included descriptions of the UDL framework and how the three guiding principles influenced their interventions, it was not clearly stated which UDL principles, guidelines, and checkpoints were leveraged to change instructional design or delivery, instead it was more broadly discussed. Research has yet to examine the UDL framework cohesively, comprehensively, and explicitly with limited evidence on how UDL impacts academic achievement.

This significant gap in the literature and the "elusive" ways in which UDL has been examined recently stimulated a group of researchers and practitioners affiliated with higher education, local educational agencies, and educational policy to address the "ambiguity of how UDL is defined, the different measures used to characterize it as a construct or variable, the manner in which UDL is implemented and the assortment of other inconsistencies." (Smith et al., 2019). Understanding how the UDL framework effectively addresses student variability, providing cohesive professional learning is critical to implementation fidelity.

Professional Learning and Implementation

Professional Development and Learning

Educator skills and knowledge for teaching and learning begin in teacher preparation (pre-service), are further developed practice-based experiences, and supported and strengthened by on-going professional development (in-service). Professional development, defined by

Gusky and Sparks (2000), is "processes and activities designed to enhance professional knowledge, skills, and attitudes of educators so they might, in turn, improve the learning of students (p.16). Professional learning is not simply acquiring new knowledge and skills, it requires the transfer of new knowledge and skills to the immediate classroom context in order to achieve desired student outcomes (Guskey& Sparks, 2000).

There are many constellations of professional development that seek to serve specific purposes (i.e., learning related to curriculum, assessment, instructional strategies, instructional materials) and agendas (i.e., addressing educational reform or state, district, and school initiatives) (Garet, Porter, Desimone, et al., 2001). Additionally, educators can access professional learning through a variety of formats such as workshops, conferences, on-line learning, school-wide training traditional, and coaching (Guskey & Yoon, 2009; Darling-Hammond, Hyler, & Gardner, 2017). However, often times the content, learning activities, or both are decontextualized and are then less likely to be successfully implemented into practice (Lieberman & Mace, 2008).

An extensive amount research has been directed towards professional development content and activities. Professional development activities are guided by federal mandates (i.e., IDEA, ESSA) and state and local initiatives. These initiatives set the agenda for professional learning and often times the content is not immediately relevant, insufficient, or lacks evidence (Richardson, 2003; Guskey, 2002). The mismatch between professional learning needs and professional learning provisions does not lead to the intended student outcome (Richardson, 2003). Researchers have identified the gap between the intention of the professional

development and the lack of evidence linking teacher learning to student outcomes (Guskey & Yoon, 2009; Darling-Hammond et al., 2017; Yoon et al., 2007).

Understanding the relationship between professional learning and student outcomes is critical for developing future professional development activities. Darling-Hammond and colleagues (2017), extended previous research (see Darling-Hammond et al., 2009), and investigated effective professional development research demonstrating positive student outcomes. The studies reviewed were included based on rigorous methodology (i.e., experimental or quasi-experimental comparison group) and presence of core features of professional development (Darling-Hammond et al., 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 2000; Guskey & Sparks, 2002).

The core features of effective professional development as: *content focus* (i.e., specific content that relates to teacher's context), *active learning* (i.e., how teachers engage and learn activities), and *coherence* (i.e., alignment with school and district priorities related to standards and educational reform) (Birman et al., 2000; Desimone, 2011; Garet et al., 2001). Building off the previous frameworks of effective professional development and upon review of 35 studies that met the inclusion criteria for methodological rigor and positive associations between professional learning, instructional practices, and improved student learning outcomes, Darling-Hammond et al. (2009, 2017) extended these core elements of effective professional develop. The authors included *collaboration* (i.e., sharing ideas and experiences within professional learning communities), models and modeling (i.e., demonstration of effective practice), *coaching* (i.e., providing one-on-one support within a classroom context that focuses on a specific practice), *feedback and reflection* (i.e., feedback and reflection are embedded to facilitate change

in practice), and *sustained duration* (sufficient time to learn, practice, and implement new practices). In addition to evaluating effective professional development and learning, we need to also consider how that learning translates to changes in teachers' practices (i.e., implementation) and student outcomes.

Implementation of Educational Practices

Implementation science seeks to understand the critical factors and conditions that facilitate effective practices being successfully carried out and sustained to achieve the intended outcomes (Fixsen, Naoom, Blasé, Friedman, & Wallace, 2005; Aarons, Hurlburt, & Horwitz, 2011). The aim of implementation science is to translate research to practice with the end product of quality and effectiveness of services. Fixsen and colleagues (2005) describe implementation as "a specified set of activities designed to put into practice an activity or program of known dimensions" (p.5). The tradition of implementation science, rooted in healthcare and public health, has been adopted by a variety of disciplines that seek to bridge the gap between research to practice (Eccles & Mittman, 2006). In educational contexts, implementation science has gained momentum in an effort to address the gap between established evidence-based practices (EBPs) reaching classrooms.

In attempting to understand what inhibits the research-to-practice gap, researchers have identified the following barriers and facilitators: characteristics, attitudes, and beliefs of end users (implementers), contextual factors related to the organization including policies and procedures, and the influence of external factors on the organization (Fixsen et al., 2005; Greenhalgh et al., 2004; Rogers, 2003). To address the barriers and strengthen implementation efforts researchers have developed strategies which are the ["activities"] set forth in a systematic

way to apply an intervention in a specific context to achieve the desired outcome (Powell et al., 2014). The relationship between *implementation practices* and *intervention practices* is interdependent; both need to adhere to the specific set procedures to achieve the intended outcome (Fixsen et al., 2005). Dunst and colleagues (2013) refined the implementation science framework developed by Fixsen et al., (2005) to include the role professional development plays in the interaction between implementation practices and intervention practices. Dunst et al. (2013) revised the definition of implementation as "a specific set of [professional development] activities designed to put into practice an [intervention] activity of known dimensions" (Fixsen et al., 2005, as cited in Dunst et al., 2013, p. 88).

Implementation fidelity is described as "the degree to which specified procedures are implemented as planned" (Dusenbury, Brannigan, Falco, & Hansen, 2003, p. 240). Implementation fidelity seeks to evaluate "how much and how well a practice was used as intended" (Dunst et al., 2013, p. 92). Several frameworks that have been proposed to measure adherence to implementation practices that maintain the integrity of the intervention (e.g., Century, Rudnick, & Freedman, 2010; Power et al., 2005). If we remove the possibility that there were flaws or mis-steps in the implementation process (i.e., low fidelity) then we can fully evaluate the outcomes in relationship to the intervention. Fidelity data collection not only informs researchers, it also helps guide educators in selecting an intervention (Swanson, Wanzek, Haring, Ciullo, & McCulley, 2011). Implementation fidelity checklists are often used to serve as a measure for the intervention steps by identifying what the steps are and if they were completed accurately and consistently.

Proposal for Implementing Universal Design for Learning

Effective Practices (*what*). Research has demonstrated that including students with dis/abilities not only provides an opportunity to access the general curriculum, students are able to make considerable social and academic gains in an inclusive setting (e.g., Ryndak, Morrison, & Sommerstein, 1999; Staub, Schwartz, Gallucci, & Peck, 1994; Williams & Downing, 1998). Instructional practices supporting inclusive education have been identified as collaboration and co-teaching, cooperative learning, peer support, adaptive teaching, responsive teaching, and differentiated instruction. The UDL framework provides the opportunity to embed these practices through proactive planning.

Effective professional learning (*how*). Effective professional development has several core components. Amongst the researchers there is consensus at to the attributes of effective professional development (i.e., content focus, active learning, and coherence). Darling-Hammond and colleagues (2017) have extended those attributes to include: collaboration, coaching, feedback and reflection, and sustained duration. Given the comprehensive nature of UDL, professional development and learning is further supported when it is situated in context and tailored to individual classroom needs; professional learning becomes relevant and meaningful, resulting in the desired outcome of change in practice and student outcomes (McKlesky & Waldron, 2010).

Effective implementation (*how*). Implementation of the UDL framework is guided by principles, guidelines, and checkpoints. UDL as a total framework provides educators with the means to reach all learners and increase student outcomes. Implementation Fidelity of the UDL framework is not measured by a set number of checkpoints utilized in the design or delivery of

instruction. The CAST website (www.cast.org) states that educators do not need to use every guideline or checkpoint in every learning opportunity, rather educators should mix and match based on the learning objective. The design process is intended to align guidelines and fidelity, given that there is no standardized "way" to implement the UDL framework, the UDL Classroom Implementation Fidelity Checklist and the UDL Lesson Design Implementation Fidelity checklist provide the means to operationalizing the guidelines and checkpoints and lesson planning process to measure adherence to the UDL design and delivery implementation.

Drawing on Dunst et al.'s (2013) revised definition of implementation, which identifies the professional development as the set of activities that bridges the research-to-practice gap, the theory of change illustrates the overlap between practice, professional development, and implementation (Dunst et al., 2013; Fixsen et al., 2005). See Figure 1.

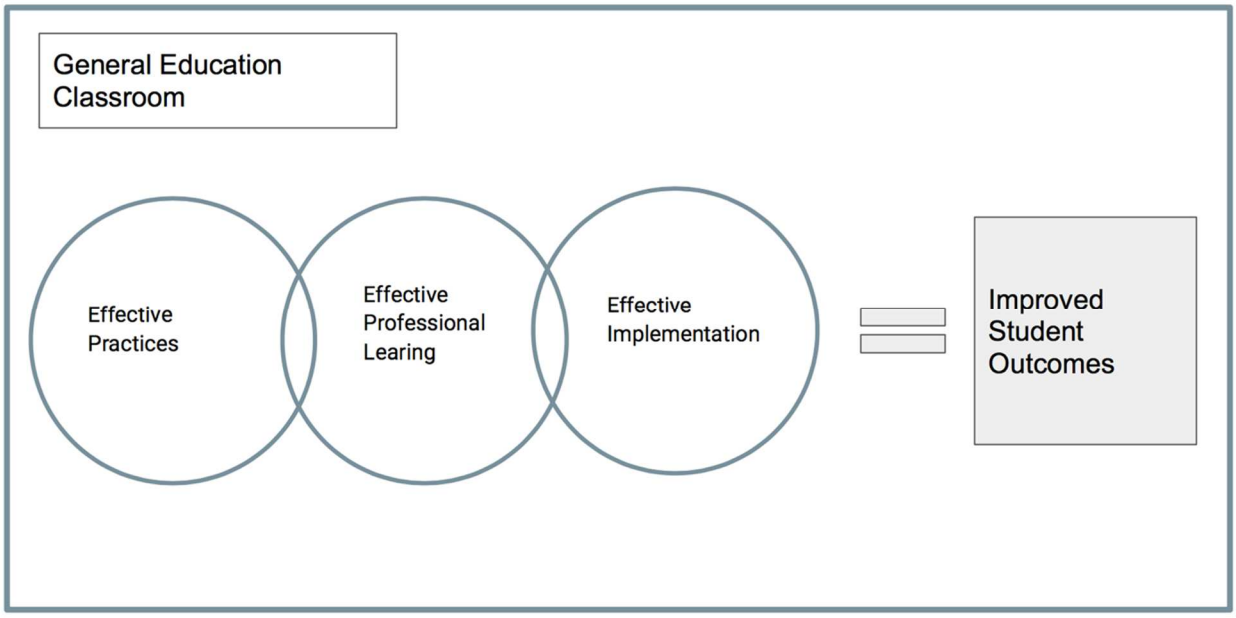

Figure 1. Theory of Change Model for Implementing the UDL Framework

Purpose of the Study

Addressing diversity in the classroom requires high-leverage instructional practices implemented with fidelity to create equitable learning opportunities and outcomes. Given the range of learner ability, it is essential to have flexible practices that are responsive to student needs. UDL "holds promise" for "reaching all learners", we have yet to realize these testimonies given that research has not provided sufficient evidence on the impact of implementing the UDL framework. This study seeks to understand implementation of the UDL framework by drawing on the literatures of professional learning (content focused, active learning, collaboration, modelling, and feedback) situated in the classroom context. Effective implementation is strengthened by measuring fidelity. The research questions guiding this study are as follows:

1. What are the effects of a UDL teacher training on designing and delivering UDL literacy lessons within a general education classroom?
2. How does implementing a UDL literacy lesson effect academic progress for a student with a dis/ability?
3. How does implementing a UDL literacy lesson effect academic progress for students without a dis/ability?

CHAPTER 3

METHOD

This study employed a sequential mixed-methods design which integrates quantitative and qualitative measures to examine the effects of a teacher training on implementing the UDL framework and how that influenced student outcomes (Creswell & Clark, 2017; Clark & Ivankova, 2016). The experimental phase of the study employed a single-subject, non-concurrent multiple-baseline across teacher participants (Watson & Workman, 1981; Christ, 2004). This design addresses multiple behaviors, settings, and participants and measures independent responses to experimental conditions (Gast & Spriggs, 2010). This single case method is a variation of the traditional concurrent multiple baseline design (Kazdin, 2011)- in a non-current multiple baseline the data series are not temporally aligned (i.e., observations across participants are not simultaneous). Watson and Workman (1981) proposed the non-concurrent design to address conducting research in applied settings. A non-concurrent multiple baseline design requires a random assignment of a priori baseline, and the same independent variable be implemented across tiers, and the same dependent variable is repeatedly measured. The a priori baseline durations and random assignment of participants "bolsters the design's potential to demonstrate experimental control." (Christ, 2007, p. 454). A non-concurrent multiple-baseline across participants allows for a randomized introduction of the independent variable across participant or groups of participants.

The qualitative phase consisted of one-to-one semi-structured interviews. The interviews provided insight on social validity (i.e., acceptability, usefulness, satisfaction, relevancy) which provides a richer understanding how a teacher training on the UDL framework influenced

whether or not the teachers implemented UDL and subsequent student outcomes (Creswell, Plano, & Clark, 2011). Data collection and analysis occurred during both stages of the study. Comparing the results of both methods strengthens conclusions about the phenomena under investigation (Clark & Ivankova, 2016). Employing quantitative and qualitative methods facilitated conclusions related to professional learning and factors influencing implementation as well as the impact on student learning. Figure 2. illustrates the sequence of the stages.

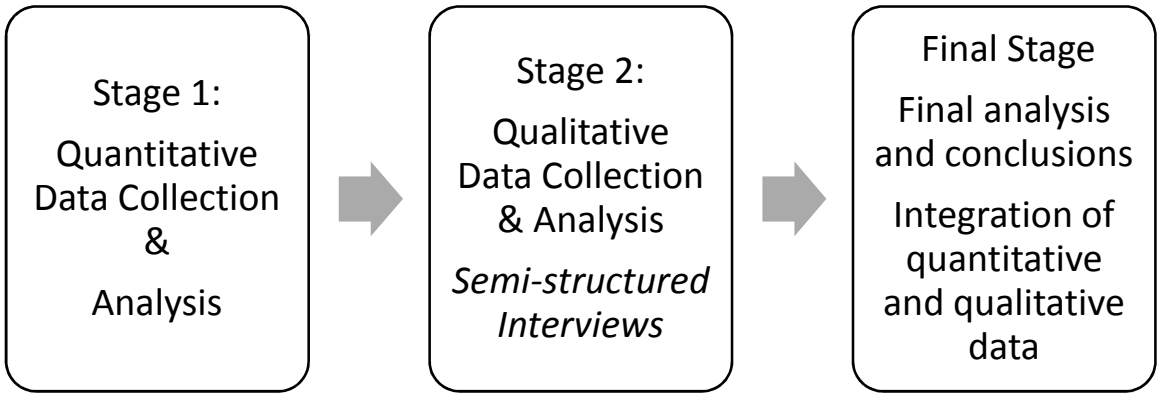

Figure 2. Sequence of design stages.

Across both the quantitative and qualitative stages, data was collected and analyzed adhering to the methods of analysis within each design. The first stage utilized a non-concurrent multiple baseline across participants. This stage allowed for causal conclusions related to the effects of a teacher training on design and delivery on implementation of the UDL framework and student academic progress. At the conclusion of that stage, one-to-one interviews were conducted with teacher participants to investigate further the acceptability, relevancy, and satisfaction related to the intervention and outcomes.

Participants

The primary participants in this study were three elementary general education teachers from three different general education classrooms. The secondary participants were six elementary aged students. Within each classroom, there was a dyad consisting of one child with dis/abilities and one child without an identified dis/ability.

General education teacher participants. Three general education elementary (grades K-4) teachers were recruited based on a) nomination from building administrator, b) providing literacy instruction for students with and without dis/abilities- including students with autism, c) actively consulting with special education teacher(s) on in-class modifications and accommodations as outlined in student's IEPs, and d) willingness to participate in study. The teacher participants signed consent forms reviewing the reporting of demographic information (i.e., race, ethnicity, age, and level of education), procedures for securing data, and ability to withdraw from the study at any point in time.

All teachers had obtained a Master's in Education (M.Ed.), with one teacher having a law degree before entering the field of education. The participants teaching experience ranged from 4-19 years, and all three taught at different elementary grades levels throughout their careers. Demographic data about each teacher participant is included in Table 2. Pseudonyms are used for all the teacher participants in order to maintain confidentiality.

Table 2

Demographic Information for Teacher Participants

Teacher	Gender	Race	Age	Level of Education	Certifications	Years of Experience	Grade/Classroom/ School
Geraldine	Female	White	46	JD M.Ed.	Elementary Ed	9	3rd Grade General Education School A
Mary	Female	White	42	M.Ed.	Elementary Ed	4	1st Grade General Education School B
Evelyn	Female	White	51	M.Ed.	Early Childhood	19	2nd Grade General Education School B

Note. Information obtained from teacher participants.

Student participants. A total of six elementary students participated in this study- three participant had a documented dis/ability, and three participants did not have an identified dis/ability or learning difference. Students with dis/abilities were recruited based on (a) a documented dis/ability, (b) IEP with annual goals in the area of reading which may include one or more of the following: phonemic awareness, phonics, vocabulary development, fluency, and comprehension, (c) receiving literacy instruction in a general education classroom, (d) teacher nomination, (e) parent/guardian consent, and (f) teacher report of consistent attendance. Participants had the study explained to them, and assent was obtained and recorded based on verbal and/or gestural agreement (see Appendix C). Demographic and evaluation information for each student can be found in Table 3 and 4 respectively.

Three elementary aged students without an identified dis/ability were recruited based on (a) not undergoing an evaluation for learning challenges or concerns, (b) receiving literacy instruction in the same general education classroom as the primary student participants, (c) teacher nomination, (d) demonstration of consistent attendance, and e) parental/guardian consent.

The study was explained to the participants, and assent was obtained through a recording of verbal and gestural responses from the participants. Demographic and evaluation information for each student can be found in Table 3 and 4 respectively.

Table 3

Demographic Information on Student Participants

Student	Age	Grade	Gender	Ethnicity
1A	10	3rd	Female	African-American
1B	10	3rd	Female	White
2A	9	2nd	Male	White
2B	8	2nd	Male	White
3A	7	1st	Male	White
3B	7	1st	Female	White

Note. **Obtained from student records and special education files.**

Table 4

Characteristics of Students with Dis/Abilities

Characteristic	1A	2A	3A
Age/Gender	10/Female	9/Male	7/Male
Evaluation Tools	ASRS ABAS ADOS SRS-2 KTEA-3 WISC-V	NICHQ Vanderbilt Sensory Profile DAP Test TOLD- P:4 PPVT-4 WISC-V	ADOS KTEA-3 WPPSI-IV
Diagnosis	ASD	ADHD, Obsessive Behavior, Adjustment Reaction Disorder	ASD
Eligibility Determination	ASD	OHI	ASD
FSIQ	83	127	55

Note. ASRS = Autism Spectrum Rating Scale (Goldstein & Naglieri, 2009); ABAS = Adaptive Behavior Assessment System, 3rd Ed. (Harrison & Oakland, 2015); ADOS = Autism Diagnostic Observation Schedule (Lord, Rutter, DiLavore, & Risi, 1989); SRS = Social Responsiveness Scale, 2nd Ed. (Constantino, 2011); WISC-V = Weschler Intelligence Scale for Children, 5th Ed. (Weschler, 2014); WPPSI-IV = Weschler Preschool and Primary Scale of Intelligence, 5th Ed. (Weschler, 2012); NICHQ Vanderbilt = National Institute for Children's Health Quality (American Academy of Pediatrics, 2002); Sensory Profile, 2nd Ed. (Dunn, 2014); DAP = Goodenough-Harris Draw-A-Person Test (Goodenough & Harris, 1963); Test of Language Development-Primary, 4th Ed. (Hammill & Newcomer, 2008); PPVT = Peabody Picture Vocabulary Test (Dunn & Dunn, 2007); KTEA = Kaufman Test of Educational Achievement, 3rd Ed. (Kaufman & Kaufman, 2013).

Setting and Materials

The study procedures were conducted in three elementary general education classrooms located in a suburban school in the Pacific Northwest region of the United States. The school district is relatively small with just over 3500 students in grades K-12. Within the school district, three elementary school buildings serve a total of 683, K-4th-grade students. Evelyn and Mary's classrooms were located in one elementary school building, and Geraldine's classroom was in a separate elementary school building. The Marshall Elementary School, where Evelyn and Mary

teach, has 24 classrooms with three general education teachers assigned at each grade level (K-4th). In addition, there are three special education programs with three special education teachers focused on resource, behavior, and intellectual and multiple dis/abilities. Across the three special education programs, the teachers provide push-in and pull-out services. Both general education teachers collaborated with the special education teacher to provide services to students with and without dis/abilities in each of the classrooms. Geraldine teaches at Brigham Elementary School, which has 25 classrooms and three teachers assigned for each grade level. There is one special education teacher that is identified as a resource room model that utilizes both push-in and pull-out services. Title I services are also provided.

The study was conducted during routine literacy instructional block time. Literacy learning was divided into two sections- reading and writing. The reading component targets phonemic awareness, phonics, fluency, vocabulary, and comprehension. While writing is integrated into this learning opportunity, grammar and writing conventions were targeted during written language instructional blocks. For both schools, the reading component of the literacy block was addressed four days a week. Consent and assent for direct observations were obtained from teachers, parents/guardians, and students before the study.

Classroom arrangements and materials. Geraldine's classroom had 21 students. The physical arrangement of the classroom consisted of desks arranged in groups of 4 or 5 in the center of the classroom, large round table located at the back of the classroom, a small reading area with beanbag chairs and alternative lamp lighting, and a large carpeted area at the front of the classroom. Whole group instruction was provided while students were at their desks or on the large carpet area. Small group instruction was delivered at the back table, and partner and

independent work took place at students' desk or the reading area. Student materials were kept in their desks as well as in bins on a bookshelf located near the small group table. Students had their materials organized in literacy folders. Additionally, there were Chromebooks (small laptop device) available for each student and kept in a cart at the back of the class. Students accessed the Chromebooks for classroom assignments located in Google Classroom, writing projects, unit tests, and literacy-related software program-Razz Kids. The texts provided for the students for independent and choice reading opportunities were selected based on the student reading levels

Evelyn and Mary, while located in the same building, their classrooms were in different sections of the school building. Evelyn's literacy instructional block consisted of 18 students, that were arranged based on reading levels across the three first grade classrooms. The students participating in literacy instruction had been identified as low or at-risk readers. The classroom desks were arranged in groups of four, a large carpet area at the front of the classroom with a small table adjacent. In the back of the room, there was a small reading area with alternative seating (beanbag chairs, cushions, floor chair with back supports, and fold out 'popcorn' chairs). During literacy instruction, small groups of students rotated daily between direct instruction activities, independent work, and partner work.

Mary's classroom, similar to Evelyn, consisted of students from across the second-grade level who had been grouped based on ability. However, Mary's students were considered either highly capable or above grade level performance. The classroom had 19 students and was organized with two long rows of desks, two-desks wide, with the desks rotated so that desk fronts were facing inward. At the end of the row, the end-cap desks faced forward. A small group table was located at the back of the classroom with a carpet area off to the side. Whole

group instruction was provided when students were sitting at their desks or the small carpet area. Students were placed in literacy groups of four and rotated through independent work, partner work, and small group reading instruction.

Curriculum. Teacher participants continued to use the literacy/language arts curriculum that was provided by the school district. Evelyn and Mary used a newly adopted literacy curriculum (Center for Collaborative Classroom®) that was developed for kindergarten through second-grade literacy learning. Embedded in this curriculum is a Walk-to-Read model where students across the grade level were grouped according to abilities. Geraldine used a variety of sources to develop her literacy curriculum and provided literacy instruction for her 3rd-grade class.

Behavioral Definitions

Independent variable. The independent variable is a teacher training package that consists of two components: *general overview* and a *re-design workshop.* The two-part design of the professional was developed to provide an in-depth understanding of the UDL framework followed by an interactive learning opportunity (i.e., re-design) to strengthen learning and adoption of UDL practices to their classrooms as intended. Content focus (i.e., connecting learning about UDL to teaching strategies), active-learning (i.e., designing and implementing new teaching strategies), collaboration (i.e., exchange of ideas and sharing in the learning), and models of effective practice (i.e., providing models to support independent practice) are the core components of effective professional development that guided the development of the teacher training and are outlined in further detail below (Darling-Hammond et al., 2017).

General overview. The first part of the training was led by the researcher using a Google slide presentation which consisted of: (a) history of UDL, (b) research supporting UDL, and (c) detailed explanations and visual examples of the three guiding principles, guidelines, and checkpoints. The section on the history of UDL included the development of the framework and its origination and why it was created. The review of the research included how the UDL framework (principles, guidelines, and checkpoints) is supported by the existing literature on evidenced-based-practices for meeting the needs of students. Finally, the presentation had embedded models of the UDL principle. See Table 5. for a description of content and resources used to support professional learning.

Table 5

Training Components and Resources of General Overview

Component	Description
History of UDL	• Describes why CAST applied the architectural concept of Universal Design to develop means to support accessibility; • Describes how learner variability has been demonstrated through neuroscience and the alignment to UDL practices; • Connects instructional practices that address the what, why, and how of learning.
Research and educational policy supporting UDL	• Briefly reviews the empirical evidence and outlines the educational policy (IDEA, 2004; HEOA, 2008; ESSA, 2016).
Understanding the three guiding principles, guidelines, and checkpoints	• Reviews the connection between what, why, and how to engagement, representation, and expression; describes the nine guidelines which direct teachers to developing options; • Describes the 31 checkpoints which demonstrate means to achieving the guidelines; • Provides high-tech and low-tech examples of the principles in applied settings.
Resources	
Instructional Videos (Ralbate, 2016)	Publications / Web-Based Sources
• Overview of 6 Steps of UDL Lesson Planning • Taking a Variability Perspective • Selecting Accurate, Appropriate, and Meaningful Assessments • Choosing Materials and Media	• *Universal Design for Learning: Theory & Practice* (Gordon, Meyer, & Rose, 2018) • *Your UDL Lesson Planner: The Step-by-Step Guide for Teaching All Learners* (Ralbate, 2016). • *UDL Now! A Teacher's Guide to Applying Universal Design for Learning in Today's Classroom* (Novak, 2016). • *A Practical Reader in Universal Design for Learning* (Meyer & Rose, 2011) • https://iris.peabody.vanderbilt.edu/module/udl/ • www.udlcenter.org/ • http://udlguidelines.cast.org • http://blachan.com/shahi/ (visual dictionary) • https://dcmp.org (described and captioned media • http://udltheorypractice.cast.org • http://mast.ecu.edu/modules/udl • http://udlexchange.cast.org

The presentation was intentionally designed to model each of the principles of UDL (i.e., multiple means of representation and multiple means of engagement) to further demonstrate how the principles support engagement in learning. For example, the researcher-developed Google slide presentation used highlighted text and embedded video links. Paper copies of the presentation were also made available for the teachers to use as a guide. The presentation led the discussion about how the UDL framework supports teachers in designing and delivering instruction to address variability in learning.

Re-design. The re-design workshop was scheduled 1-2 days following the general overview training, lasted approximately an hour, and was individualized and tailored based on the teacher's baseline levels of the three principles. The session consisted of three components: examining the teacher's baseline data of implementation of UDL principles, modelling the design of a lesson plan using UDL principles and the UDL checklist, and practicing designing their own lesson plan with UDL principles.

Dependent variables. Two dependent variables in this study for teacher participants were the percentage of components for UDL lesson design and percentage of checkpoints for UDL instructional delivery. Student outcomes, for students with and without dis/abilities, were also measured.

***Design*.** Designing a UDL lesson was defined as proactively and deliberately developing clear and measurable long-term and short-term goals; identifying barriers to learning based on student learning needs and curriculum constraints; creating flexible assessment strategies; identifying differentiated methods and materials; making explicit connections between UDL checkpoints and instructional methods and materials. To measure the presence of UDL

components in a lesson plan, the researcher designed UDL Lesson Design Components was used. The UDL lesson design consists of ten components, see Appendix D for the components, operational definitions, examples, and non-examples.

Delivery: UDL delivery was defined as the presence of UDL checkpoints observed during a literacy lesson instruction. See Appendix A for UDL checkpoint operational definitions, examples, and non-examples. Within each UDL principle (representation, engagement, action, and expression) there are corresponding checkpoints; representation has 12 checkpoints, engagement has 10 checkpoints, and action and expression have 9 checkpoints. A percentage of checkpoints used within each principle was measured to during baseline and the intervention phase. The UDL Checkpoint Checklist documented the presence of checkpoints and was developed using the information from CAST (www.cast.org; 2019). See Appendix E. The checklist was organized to provide operational definitions for each checkpoint to provide clarity and establish consistency with the UDL framework language.

Curriculum-Based Assessment. Academic progress was operationally defined as student demonstrating mastery of the identified learning goal. Teacher developed curriculum-based assessments (CBA) were used to measure academic performance prior to the intervention and following the intervention. For example, Evelyn a curriculum-based assessment for decoding and fluency. She met with students individually for the assessments. The decoding assessment consisted of target words that students had to independently read aloud. During the fluency assessment the students were timed while reading aloud a short passage.

Procedures

Baseline (pre-intervention phase). A priori baseline phases were set at 5, 9, and 13 sessions (Christ, 2007). At the beginning of the study, classrooms were randomly assigned to baseline condition (Watson & Workman, 1981). During the baseline phase, literacy block schedules were identified, and direct observations were conducted for a 30-minute session. During baseline instructional design and delivery and student assessments were conducted in a manner that was considered "business as usual;". The teachers were asked to provide copies of the lesson plans two times per week. In addition, teachers were asked to provide the researcher with the weekly curriculum-based assessment data.

Intervention. Following the pre-set baseline phase, the researcher provided a teacher training with the two sequences of general overview training and a re-design workshop. Teachers implemented UDL checkpoints, like in baseline, the only changes were the various UDL checkpoints that they intentionally targeted to include in instructional delivery.

General overview. The general overview trainings were delivered for each teacher participant and scheduled at the teacher's convenience and provided after school in the teacher's classroom and did not exceed one hour. Special education teachers, who were the assigned case manager to the students with dis/abilities, were invited to and joined the presentation for all three teacher participants.

The researcher provided specific examples of UDL checkpoints that were observed during the baseline phase within the training. In each training, the teachers were invited to ask questions and comment during the presentation. In addition to the power point presentation,

teachers were provided with the UDL Checkpoint Checklist (see Appendix E) to review, more extensively, the guidelines and checkpoints.

In an attempt to adhere to the time element, several of the embedded video links were not watched during the general overview training due to the amount of dialogue and discussion during the training. The Google Slide presentation was shared with the teachers, so they could continue to access the information after the training and watch the videos

Re-design workshop. The re-design workshops (i.e., UDL lesson planning) were scheduled at the convenience of the teachers and were conducted after and before school. These workshops were scheduled within 1-2 days after the general training and were an hour long.

First, the researcher and teachers used the UDL Checkpoint Checklist to review the three principles, guidelines, and checkpoints. Included was a review of examples for each principle. The review process bolstered the discussion between what the teachers were currently doing in their practice that aligned with the UDL framework and where the gaps existed. Then, the teacher and researcher collaboratively identified areas of the UDL framework that the teachers needed to target supported the designing of UDL literacy lessons.

Next, the researcher guided the teachers through designing instruction with a fully developed UDL lesson plan, using the UDL Lesson Plan Template (see Appendix F), during the re-design workshop. Providing a model further illustrated how the key components of UDL designing are addressed.

For example, the starting point for designing a UDL lesson is developing a clear goal. Evelyn and Mary used a scripted curriculum which is aligned to the CCSS and had pre-generated learning goals. In the individual re-design workshops, we discussed these goals and reviewed

the language to establish whether or not they were flexible and allowed for all student to achieve mastery or if they were too restrictive or broad. A specific example of this was observed when Evelyn's students were learning how to decode words with the final -e and -ed. The short-term goal from the curriculum stated: *Students will be able to decode words correctly with final -e sound and -ed sounds*. We adjusted this learning goal to *Using a variety of materials (e.g., magnetic boards, whiteboards, printed text) and methods (e.g., highlighted text, tapping, Bossy -e), students will demonstrate how to decode words with the final -e and -ed*.

Geraldine, on the other hand, did not have a scripted curriculum and therefore developed her learning goals based on the CCSS. Together we worked through deconstructing a CCSS learning goal by parceling out the skill and concept to develop flexible, UDL learning goals.

Data Collection and Analysis

Data collection began upon receiving consent from teachers and parents/guardians, and after the student participants assented to the study. Data collection included direct observation and permanent product. Data were collected during the literacy lesson in each of the three general education classrooms and lasted 30 minutes per session.

Percentage of UDL lesson design components. The UDL Lesson Design Components (see Appendix D) was used to score the presence (1) or absence (0) of the ten lesson planning components across baseline and intervention phases. The total number of components present were multiplied by 100 to obtain a percent value. Data were collected using permanent product (i.e., lesson plans).

Percentage of UDL checkpoints delivered. UDL checkpoints were collected during direct observations of literacy instruction to measure instructional practices that were present and

aligned with the UDL framework. The presence of checkpoints observed during an instructional session were scored using the UDL Checkpoint Checklist (See Appendix E). Percentage earlier defined, used UDL Checkpoint Checklist to measure presence of checkpoints. The percentage was calculated by counting the number of checkpoints within a principle, dividing by the total number of checkpoints and multiplying by 100 to obtain a percent value. The number of checkpoints in each principle are as follows: Representation (12), Engagement (10), and Action/Expression (9). For example, during the first session of baseline data, Evelyn demonstrated the use of five checkpoints for the Representation principle. The percentage was calculated by dividing five (checkpoints observed) by 12 (total checkpoints in Representation principle) yielding a result of .41666 which was then multiplied by 100. Evelyn utilized 41.7% of the possible checkpoints during this session.

Academic achievement. Academic outcomes were measured by the percentage of correct responses on a curriculum-based assessment. Geraldine and Mary used a teacher-developed curriculum-based assessment, and Evelyn used a curriculum assessment designed by the publishers of the literacy curriculum that guided instruction. The assessments were administered weekly, and the teachers provided both the data as well as the permanent product for analysis. The students in Geraldine and Mary's classrooms were evaluated on comprehension measures and for the students in Evelyn's classroom fluency and decoding were the measures used to evaluate student outcomes. For Geraldine, during baseline phase, she used a computer-based comprehension measure that had multiple choice questions and open-ended questions. During the intervention phase, she used a rubric to assess and score for comprehension. Mary assessed comprehension based on journal responses required students to

produce five sentences that made self-to-text connections. Evelyn used a curriculum-based measurement to assess sight word, fluency, and decoding. The fluency measure had a timed element.

The student participant academic achievement was converted into percentage correct. Dependent variable data for teacher participants implementation and student participants academic achievement was graphed using Microsoft Excel software and analyzed to observe the amount of change during the intervention phase. Data were analyzed through visual inspection which facilitated the organization and interpretation of the intervention effects and provided the basis for "research decisions, judgments, and conclusions" (Parsonson & Baer, 1978, p. 133-134). Visual analysis procedures were conducted within phase and between phase conditions (Kazdin, 2011). Level, trend, variability, immediacy of effect, overlap, and consistency of data patterns were included in the visual analysis.

Interobserver Agreement

Interobserver agreement (IOA) data addresses the reliability of the same behaviors being coded across two observers (Cooper, Heron, & Heward, 2007). For a minimum of 30% of data collection sessions involving direct classroom observations of teacher instructional delivery, a second observer conducted independent observations of the same instructional delivery. Four individuals were trained for interobserver agreement. Three were employees of the school district, and their roles were as follows: special education teacher, autism specialist, and a paraeducator. The fourth individual was an associate faculty at a local university whose expertise is in early childhood special education and applied behavior analysis. The training consisted of several sessions of practice observations to support the learning of the UDL

principles and checkpoints. The practice sessions ranged from 1-3 times and were dependent on background knowledge. Point-by-point comparisons were used during the training as well as the recorded IOA data sessions. For the permanent product (i.e., lesson plans and student outcome data), IOA was supported by the special education teacher and collected for 100% of the opportunities.

Procedural Integrity

Procedural integrity measurements were conducted to ensure that the teacher training was consistent across participants, and teacher implementation of UDL was reliable and accurate. The researcher provided the A UDL Training Fidelity Checklist (see Appendix G) that was filled out by the teacher participants following the training, and the UDL Checkpoint Checklist served as the second measure.

Qualitative Stage

Qualitative research methods provide a 'thick description' of the activity within a context (Merriam, 2014) and describe insights relating to attitudes and interactions (Scruggs, Mastropieri, & McDuffie, 2006; Brantlinger, Jimenez, Klingner, Pugach, & Richardson, 2005; Pugach, 2001). The qualitative measure, semi-structured interviews, were employed after the completion of the quantitative measurement (single subject, multiple baseline). This stage involved the analysis of individual interviews with the teachers to understand the dimensions of social validity better and inform the theory of change that guided this study.

Social Validity

Social validity seeks to understand how consumers judge an intervention or product in terms of usefulness and practicality (Wolf, 1978). The central features of social validity are

relevancy, acceptability, usefulness, and satisfaction of the intervention (Schwartz & Baer, 1991). Addressing social validity using a qualitative measure allows for insight on contextual influences (i.e., attitudes, beliefs, perceptions) related to the intervention (UDL training), implementation, and outcomes. The semi-structured interview provided a framework to address social validity and allow for the participant's opportunity to offer additional insights on their experiences implementing UDL. More specifically, this method explored how the UDL framework fits in with the teacher participants instructional values and practices and the level of satisfaction in applying the UDL framework during literacy instruction. This method addressed the independent variable (teacher training) and the processes that influenced the dependent variable (student academic progress).

Method

The semi-structured interviews were used to collect data on social validity and inform the theory of change model presented in this study. The one-to-one conversational format was guided by questions targeting the teacher's beliefs, practices, and observations related to learner variability, and processes of implementation. The guided questions served to target specific areas of interest (i.e., acceptability, relevance, satisfaction) as well as provide openings for the teachers to describe and discuss their individual experiences. The interviews were conducted at the conclusion of the study to enable reflection on the professional learning and implementation of UDL. The one-to-one interviews were scheduled after or before school, guided by a semi-structured interview protocol, and audio-recorded (as outlined in the teacher consent form) to allow for verbatim transcription.

The interviews were held in the teacher's classrooms. Each interview opened up with demographic questions (i.e., years teaching, certification, age, gender identification, race) and then was followed by a scripted pre-amble (see Appendix H) that provided information on the intent of the interview and the interviewing process. Participants were assured that the audio-recording would remain in a secure location, and it merely served the purpose of data collection accuracy. While a semi-structured protocol guided the interview process, there were opportunities for the teachers to elaborate and offer additional information.

Data Analysis

The interviews were transcribed through an online software program (temi.com), which converts audio to text. Each transcribed interview was reviewed by replaying the audio-recording and reading the transcription to check for speaker errors (text did not match identified speaker) and language errors. Following this process, the data was analyzed using a "start list" of codes that map onto social validity which included: (a) acceptability/unacceptability (i.e., effort, time, ethical considerations), (b) importance/relevancy (i.e., having contextual meaning, perceived need), and (c) satisfaction with outcomes (i.e., predicted and unpredicted outcomes) (Wolf, 1978; Miles & Huberman, 1994). These codes served as a way to organize the transcribed interviews and engage in data reduction, starting with open coding and followed by focused coding (Glaser & Strauss, 1967; Charmaz, 2001).

Coding. Open coding is the line-by-line process of labeling concepts and based on the frequency of specific terms and labels that were used to describe the activities within the set of themes outlined in the protocol (i.e., student variability, designing and delivering instruction, and implementation). This preliminary process seeks to organize and identify patterns and to take

the "phenomena" (events or experiences under investigation) and identify its dimension and relationships with other events and experiences (Strauss,1987). Following open coding was focused coding. Focused coding is the process of categorizing the data into specific themes that emerged and related to the line of questions asked. For example, acceptability- *planning for diverse learners* was a category that emerged during the focused coding from terms (*mindful, different ways, reflecting, locating resources, modeled practice)* identified during the open coding process. Codes facilitate interpretation and making meaning of the data (Delamont, 1992; Coffey & Atkinson, 1996).

CHAPTER 4

RESULTS

The results of the effects of a teacher training on designing and delivering instruction using the UDL framework and student academic achievement are presented in this chapter. This chapter is organized into two major sections. The first section presents the results from the single-subject, non-concurrent multiple baseline across teacher participants which includes: (a) interobserver agreement, (b) effect of teacher training on the implementation of the UDL framework of lesson design and delivery based on principles of UDL, and (c) the effect of UDL literacy lessons on student academic progress. The second section reports the results for the qualitative measure of interviews across the three teacher participants, which specifically addressed social validity and how that informs the theory of change model presented in Chapter 2.

UDL Lesson Design Components

UDL lesson design components were evaluated based on the presence of a UDL lesson design component (see Appendix C) Lesson plans were scored during the baseline phase and the treatment phase (see Figure 3). For each participant, the (a) level, (b) trend, (c) variability, (d) immediacy of effect, and (e) percentage of nonoverlapping (PND) data are presented.

Geraldine. During baseline, Geraldine's mean percentage of design components present in her lesson plans was 22%, range 20%-30%, representing a flat trend and stable data. Following the UDL re-design workshop, Geraldine's percentage of design components applied during independent practice increased significantly to a mean of 98% (range 90-100%), with an increase in level and immediacy of effect. There was 100% of non-overlapping data.

Evelyn. Evelyn's mean percentage of UDL lesson design components present in lesson planning during baseline was 32.5% with a range of 30%-40%, representing low variability with no trend. During the intervention phase, data were variable. Following the design workshop, Evelyn's design components increased to a mean of 75.71% and a range of 50%-100%. While Evelyn's data increased immediately to 100% for three data points indicating an immediacy of effect. Her data then fell below 80% for three data points which reached the criteria for receiving coaching. After receiving coaching for one session, Evelyn's percentage of design components increased (*M*=90, range 80%-100%). Within the intervention phase, the trend was flat, and there was 100% of non-overlapping data.

Mary. During the baseline phase, Mary's percentage of UDL lesson design components were stable and flat (*M*=30%). This was attributed to her lesson planning process during baseline was to follow the scripted curriculum without additions or changes. Following the UDL training (i.e., intervention), there was an immediate effect and change in level (*M*=95.55%, range 80-100%). Within the intervention phase, the data path there remained stable and flat. There were no overlapping data (PND=100%).

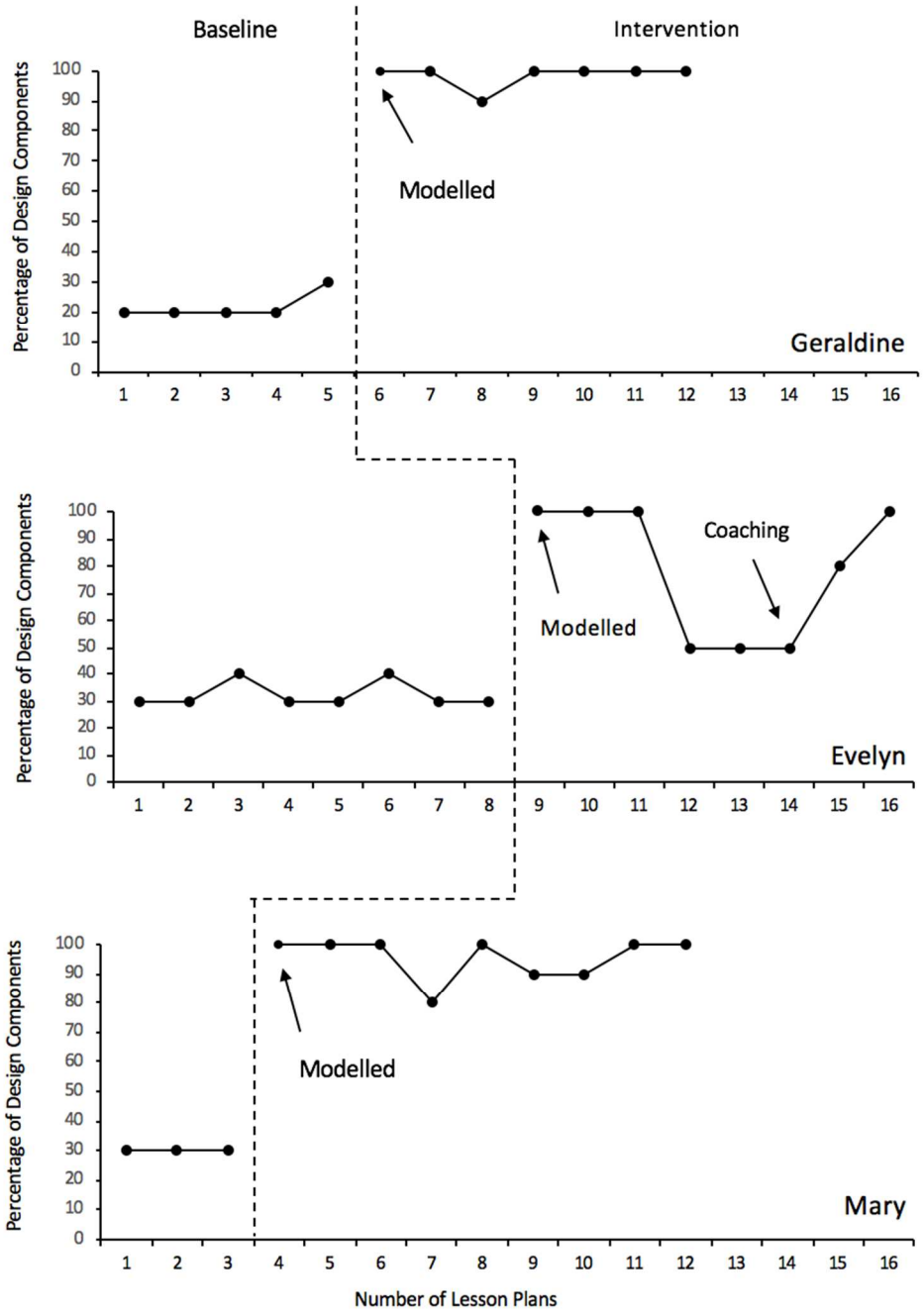

Figure 3. Percentage of UDL lesson design components across all participants.

UDL Checkpoints: Delivery

The second dependent variable examines how many UDL checkpoints were applied within an observed instructional session. The first section describes an aggregate of the 31 checkpoints across the three guiding principles (i.e., representation, engagement, and expression) and are presented in Figure 4. Percentages were calculated by taking the overall number of observed checkpoints divided by 31 total checkpoints yielding a quotient that was multiplied by 100 to convert to a percentage.

Delivery: Principles Combined

Geraldine. During the baseline phase, Geraldine's percentage of checkpoints observed was low with a mean of 30.55% and range of 26%-42%. The data path was variable and had no trend. Following the training, a significant improvement in the level, and an immediacy of effect was observed (M=85.36%; range=71-90%). The data was stable with a flat trend line. There were no overlapping data points between baseline and intervention phase.

Evelyn. Evelyn's baseline phase demonstrated that she utilized a little more than half of the UDL checkpoints during baseline (*M*=53%; range=29-71%) and had an accelerating trend line. However, her data were variable. Following the training, there was an improvement in level (M=84.25%; range=77-93%), and the data were stable with an accelerating trend line. The variability during baseline is further noted as half the data points (50%) within the intervention phase overlapped with baseline data. However, an immediacy of effect was observed.

Mary. During baseline, Mary applied less than half of the overall checkpoints during the literacy lessons (*M*=38.66%; range=22-55%). The data were variable and had an accelerating

trend line. Mary increased her use of UDL checkpoints following the training (*M*=71.58%; range=42-90%), with an accelerating trend. The data remained variable. There was no immediacy of effect and 84% of the data were nonoverlapping.

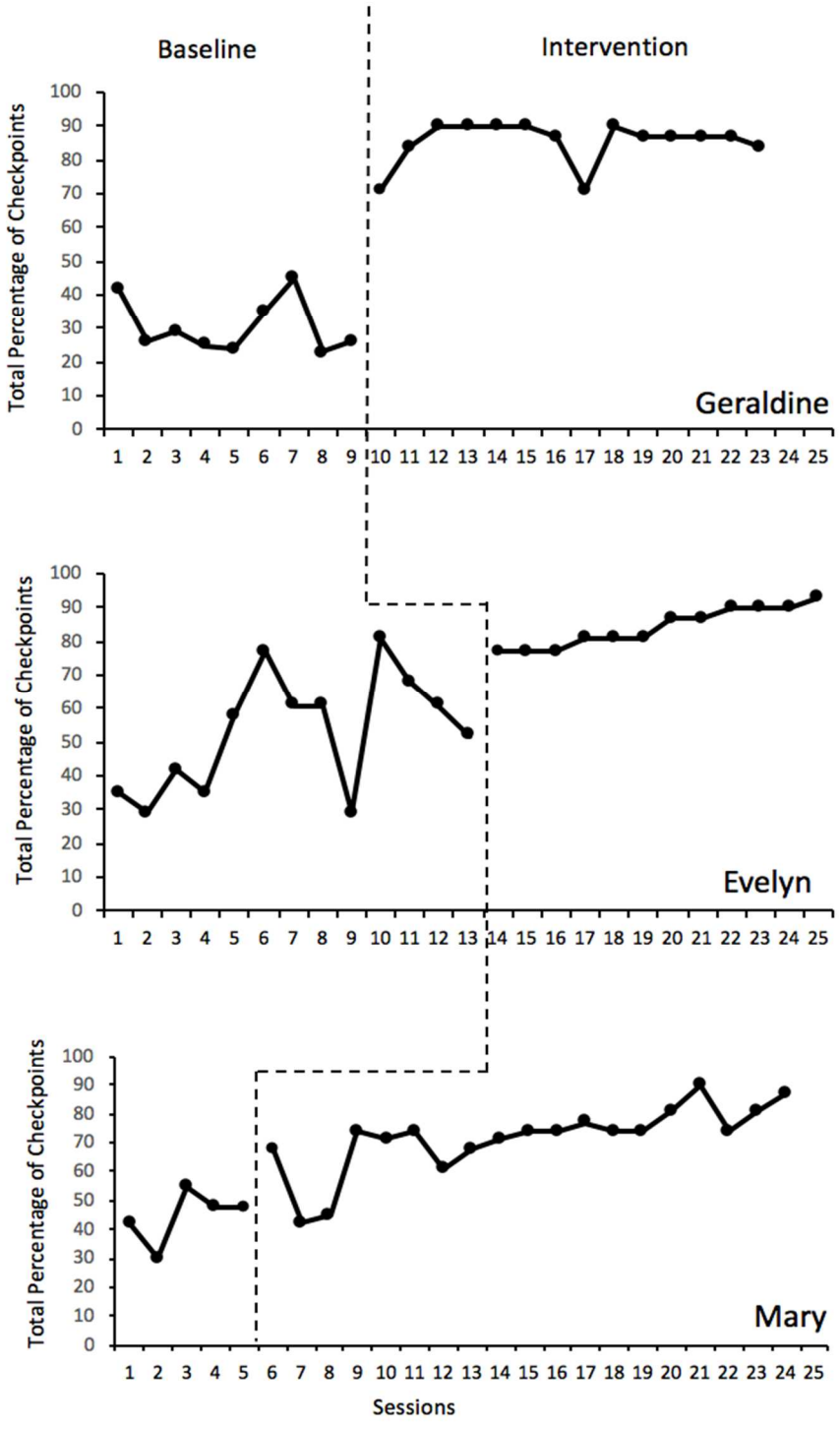

Figure 4. Deliver: total percentage of checkpoints across all participants.

Delivery: By Principle

The UDL Checkpoint Checklist (CAST, 2019) provided data on the number of checkpoints used within each principle. The following is the breakdown of checkpoints: *Representation*- 12 checkpoints; *Engagement*- 10 checkpoints; *Action & Expression*- 9 checkpoints. CAST suggests that checkpoints are selected based on the learning activity and learner; there is no formula or criteria for how many checkpoints are utilized (CAST, 2019). The following section is provided to illustrate the changes across the phases for each principle with each participant to examine changes and effects observed between the baseline phase and the intervention phase (see Tables 6, 7, and 8, figures 5, 6, and 7).

Geraldine. During baseline, Geraldine demonstrated low percentages of Action & Expression checkpoint (see Table 6, Figure 5). During the training and lesson designing workshop, Geraldine reflected that Action & Expression was an area that needed improvement with her instructional barrier of understanding how to assess learning in a variety of ways. While Geraldine improved in implementation fidelity across all the principles by delivering more checkpoints, her most considerable improvement was observed in Action & Expression. Furthermore, immediacy of effect and no overlapping data points were observed. Geraldine also saw improvement in level from baseline to intervention phase for representation. The data was variable within each phase; as a result, immediacy of effect was not observed. Data from the baseline showed 86% of the data was non-overlapping in the intervention phase. Data for engagement indicate there was a change in level and trend. The data was variable across both phases. There was an immediacy of effect and no overlapping data point in the intervention phase.

Table 6

Geraldine: Implementation of UDL Checkpoints by Principle

Principle	Baseline	Intervention	Trend	Variability	PND	IE
Representation	Mean=34% Range 17-41%	Mean= 84.46% Range 67-92%	Bsln: Accelerating Int: Flat	Bsln: Variable Int: Variable	86%	Observed
Engagement	Mean=38.88% Range=20-60%	Mean=90.71% Range=80-100%	Bsln: Flat Int: Accelerating	Bsln: Variable Int: Variable	100%	Observed
Action & Expression	Mean=19.55% Range=11-33%	Mean=83.5% Range=67-100%	Bsln: decelerating Int: Flat	Bsln: Variable Int: Variable	100%	Observed

Note. IE = Immediacy of Effect

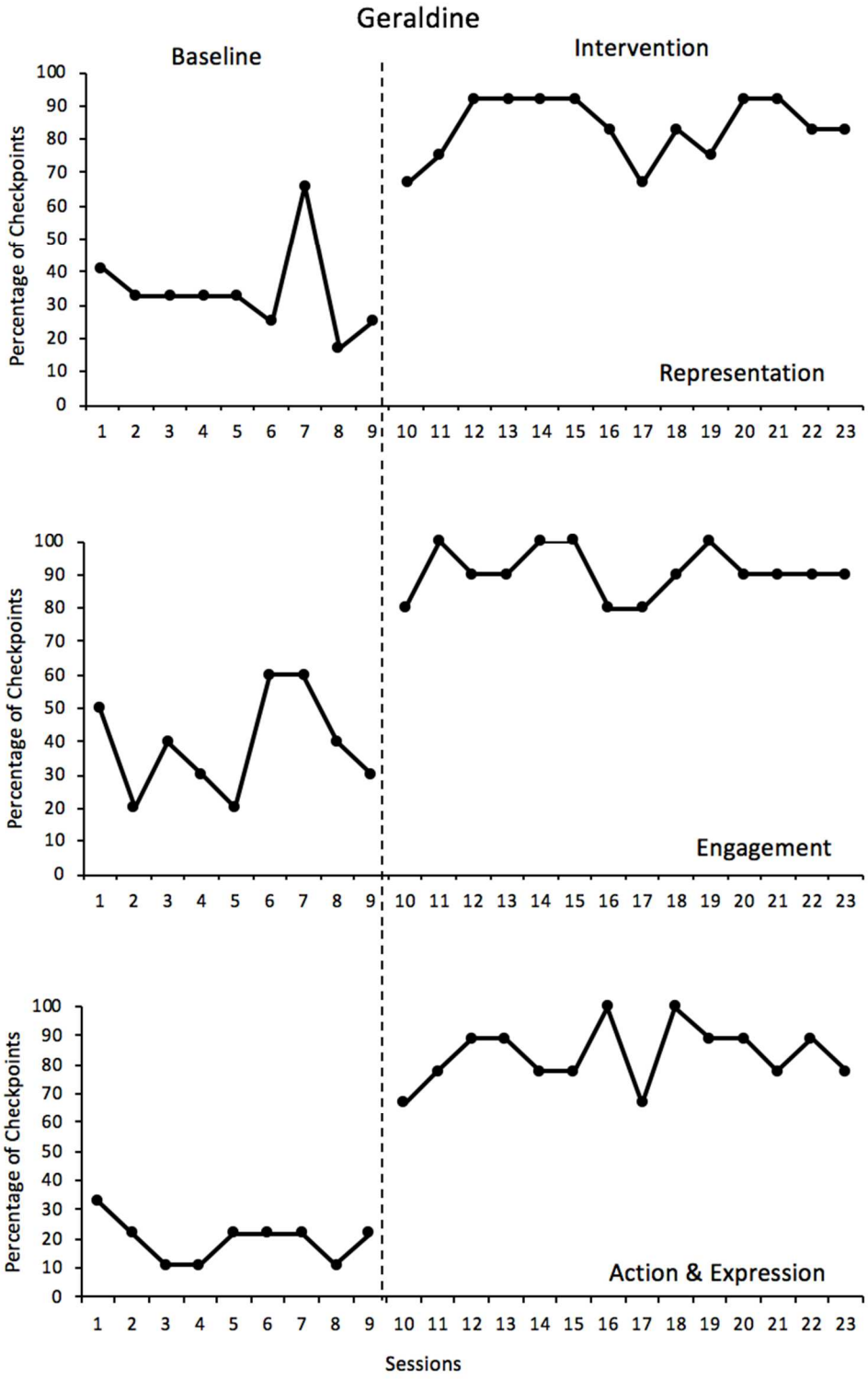

Figure 5. Geraldine's Percentage of UDL checkpoints by principle

Evelyn. Evelyn demonstrated variable levels of UDL checkpoints for each principle during the baseline phase (see Table 7, Figure 6). Following the training, Evelyn's improvement in level and variability was observed across all three principles. The most significant amount of change in level, between baseline and intervention phase, was in Representation. During the training, while all three principles were emphasized, a focus was on supporting student self-monitoring. In addressing this area, Evelyn specifically targeted checkpoints 9.3 (Support Self-Monitoring and Assessment) and 6.3 (Use Tools to Manage Information) which are located in the principles of Engagement and Action and Expression. Interestingly, in these two areas, immediacy of effect was not observed, and half of the data overlapped, however, the data became stable. For Representation, there was a change in level and trend. The data became stable following the training; however, 50% of that data was overlapping data and there was no immediacy of effect.

Table 7

Evelyn: Implementation of UDL Checkpoints by Principle

Principle	Baseline	Intervention	Trend	Variability	PND	IE
Representation	Mean=52% Range=25-83%	Mean=85.5% Range=75-92%	Bsln: Accelerating Int: Flat	Bsln: Variable Int: Stable	50%	Not Observed
Engagement	Mean=56% Range=40-80%	Mean=85% Range=80-90%	Bsln: Accelerating Int: Flat	Bsln: Variable Int: Stable	50%	Not Observed
Action & Expression	Mean=55% Range=22-89%	Mean=80.75% Range=56-100%	Bsln: Flat Int: Accelerating	Bsln: Variable Int: Stable	50%	Not Observed

Note. IE = Immediacy of Effect

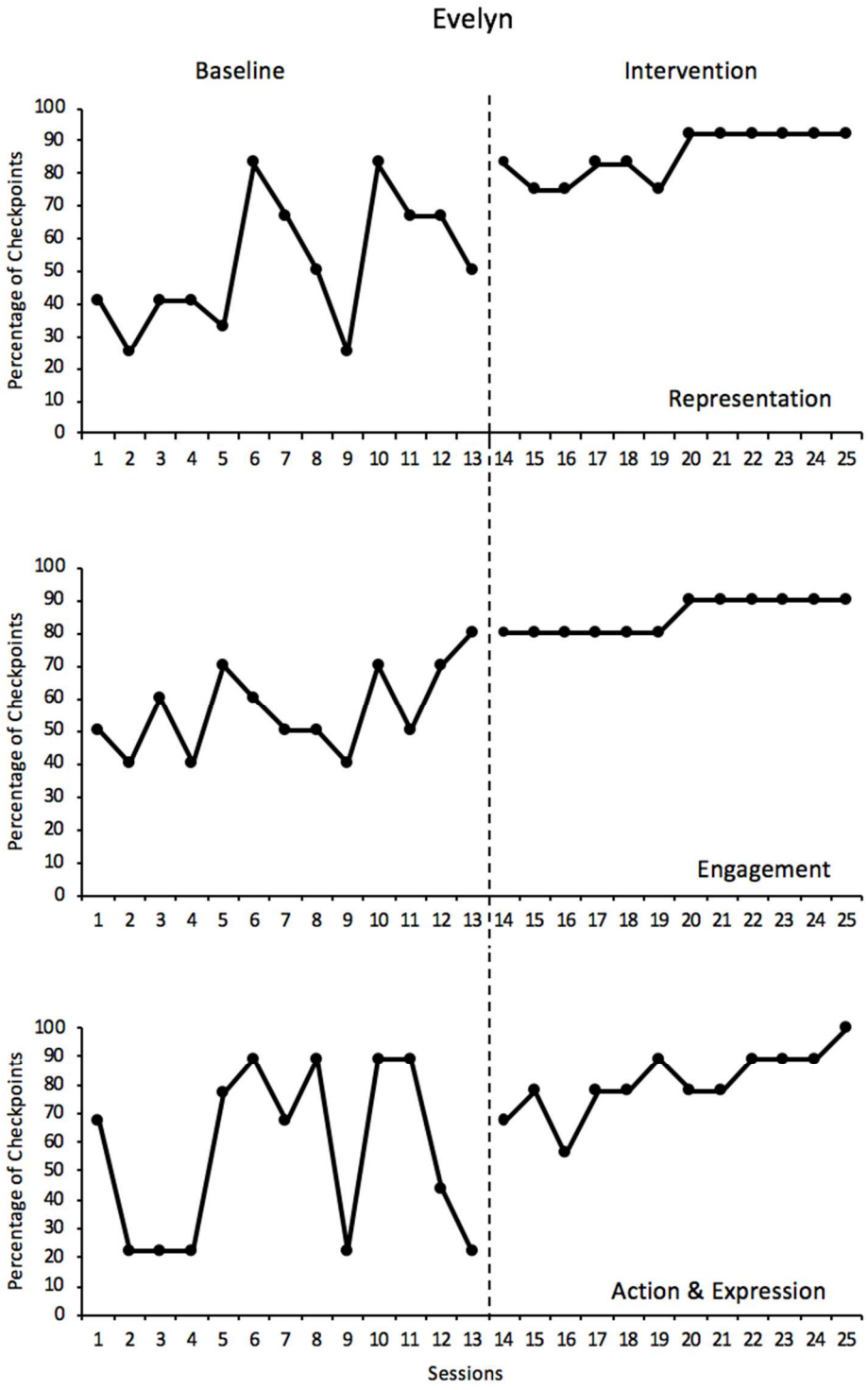

Figure 6. Evelyn's percentage of UDL checkpoints by principle.

Mary. Across the five sessions of baseline data Mary's data shows variability in the principles Representation and Action and Expression. For the Representation she had an accelerating trend. Following the training, Mary targeted Engagement and Action and Expression as areas to enhance. Overall, across the three principles, Mary had an improvement in level (see Table 8, Figure 7). While Mary became stable in her implementation of Action and Expression checkpoints, there was no immediacy of effect observed. Under the principle of Engagement, Mary's data suggest an effect was observed by immediacy of effect and no overlapping data points. Furthermore, the data for Engagement and Action and Expression became stable in the intervention phase. In the area of Representation, there was a change in level and trend, with 47.36% of overlapping data and no immediacy of effect.

Table 8

Mary: Implementation of UDL Checkpoints by Principle

Principle	Baseline	Intervention	Trend	Variability	PND	IE
Representation	Mean=42% Range=17-67%	Mean=63.05% Range=42-75%	Bsln: Accelerating Int: Flat	Bsln: Variable Int: Variable	47.36%	Not Observed
Engagement	Mean=56.66% Range=30-70%	Mean=84.21% Range=70-100%	Bsln: Flat Int: Flat	Bsln: Stable Int: Stable	100%	Observed
Action & Expression	Mean=26% Range=11-33%	Mean=70% Range=11-100%	Bsln: Accelerating Int: Accelerating	Bsln: Variable Int: Stable	89.47%	Not Observed

Note. IE = Immediacy of Effect

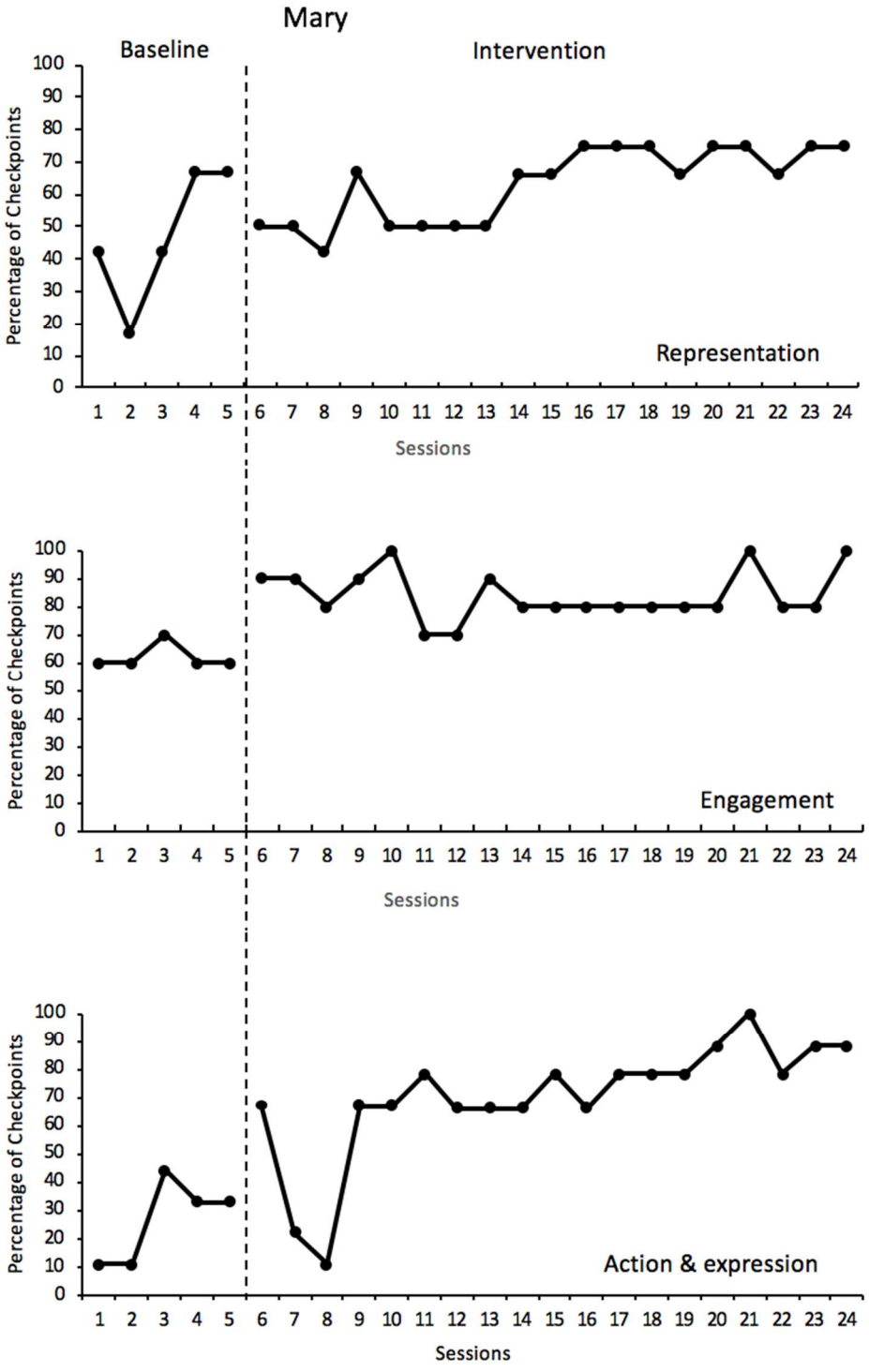

Figure 7. Mary's Percentage of UDL checkpoints by principle

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Student Outcomes: Curriculum-Based Assessment

Figure 8. displays student academic progress in percentage correct and in relationship to the teacher's percentage of delivery of UDL checkpoints. For the students with dis/abilities, they experienced significant gains, and students without dis/abilities continued to make progress. Following the training, each teacher sought ways to increase access and participation with the intent to increase student outcomes for all their students.

Geraldine's student outcome data reflects a curriculum-based measure on comprehension. During baseline phase, the measurement was a computer-based assessment. Following the training, Geraldine developed flexible assessments guided by a rubric. In both baseline and treatment phases, the scores were converted to percentage correct.

Evelyn's academic measurements remained consistent across the baseline and intervention phase. She used a curriculum-based measurement assessing for site word, fluency, and decoding skills. Student participants received the same measurement.

For Mary, the curriculum-based measurement addressed comprehension in the form of a journal response that required five sentences on text-to-self connections. This measurement remained consistent across the phases of the study; however, Mary provided alternative means (e.g., speech-to-text) to demonstrate evidence of learning.

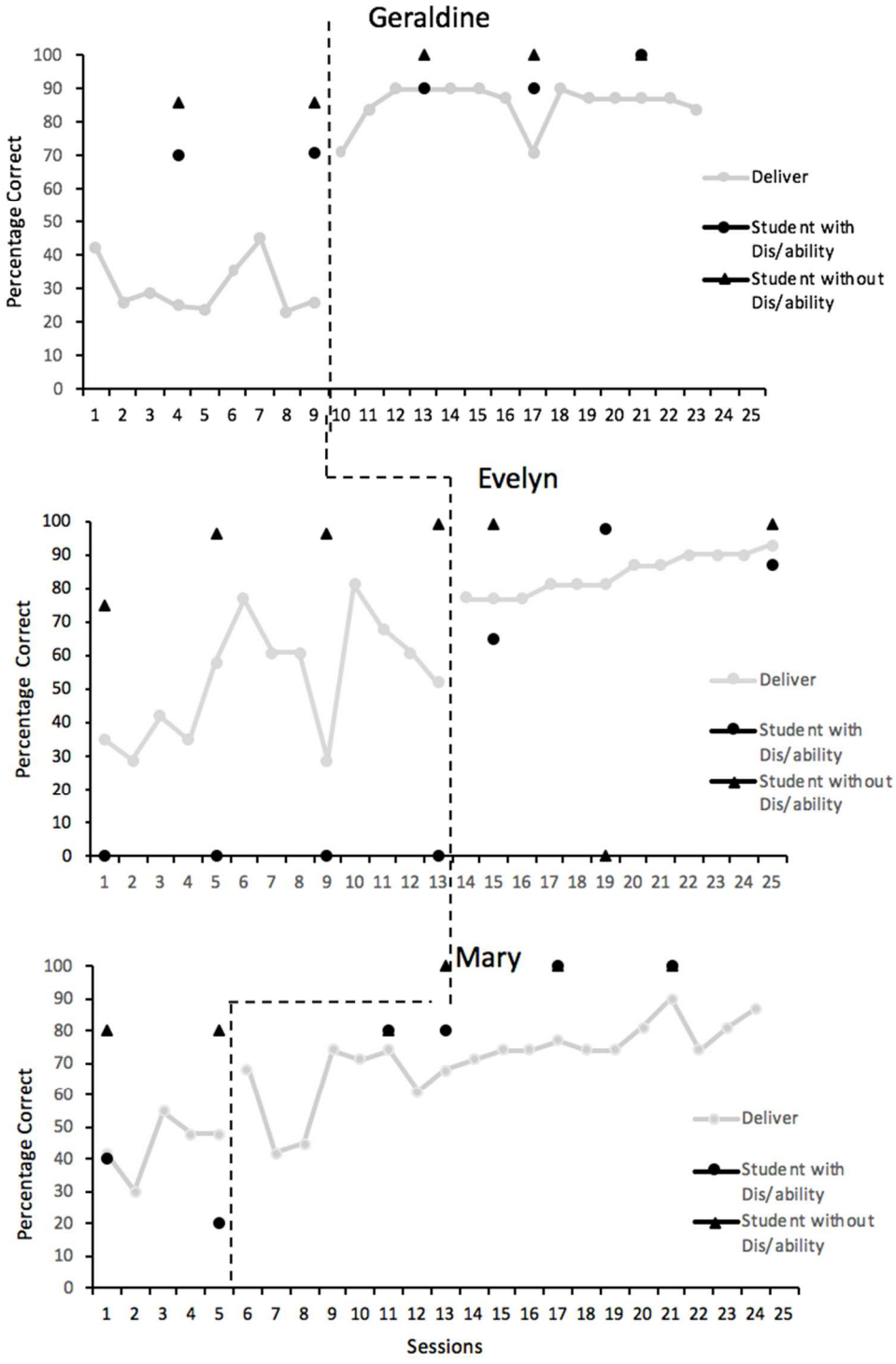

Figure 8. Student Outcome Data

Interobserver Agreement

Interobserver agreement (IOA) was calculated for the design components, delivery of UDL checkpoints, and student academic progress data. IOA was calculated on a point-by-point basis (Kazdin, 2011). Two observers, separately, had to agree on each component for an agreement to count. The total number of agreements was divided by the total number of agreements plus disagreements. The point-by-point agreement yielded a quotient, which was multiplied by 100 to obtain the percent of agreement. IOA was calculated for a least 25% of all direct observations for each teacher participant, with at least one data point from each phase. Table 9 provides a summary of the IOA data as it relates to the dependent variables and participant (Gast, 2010). The percentage of agreement for Geraldine was 99% (range: 90-100%), 98% for Evelyn (range: 80-100%), and 100% for Mary. The percentage of agreement for delivery of checkpoints for Geraldine averaged 93.25% (range: 83-100%), 94.12% for Evelyn (range: 83-100%), and 96.47% for Mary (range: 90.6-100%). IOA for student progress was 100% for all participants with the exception of Geraldine's student (1A) who had a range of 80-100%

Table 9

Interobserver Agreement

Design Components			
Participant	IOA	Range	Percentage of Observations IOA Collected
Geraldine	99%	90-100%	100%
Evelyn	98%	80-100%	100%
Mary	100%	-	100%
Delivery of UDL Components			
Geraldine	93.25%	83-100%	27%
Evelyn	94.12%	83-100%	28%
Mary	96.47%	90.6-100%	32%

Student Academic Progress				
Student	IOA	Baseline Range	Intervention Range	Percentage of Observations IOA Collected
1A	97.14%	100%	80-100%	100%
1B	100%	100%	100%	100%
2A	100%	100%	100%	100%
2B	100%	100%	100%	100%
3A	100%	100%	100%	100%
3B	100%	100%	100%	100%

Social Validity

Social validity was addressed post-intervention. Social validity ascertains the relevancy, acceptability, usefulness, and satisfaction of the intervention (Schwartz & Baer, 1991). Teacher participants were interviewed, in a one-to-one format, guided by a semi-structured protocol to evaluate professional learning and implementation of the UDL framework. See Appendix E for the semi-structured interview protocol.

Qualitative Findings

This section provides key findings from the qualitative analysis of teacher interviews. Interviews provide rich insight into attitudes and experiences. The interviews served to address social validity (i.e., acceptability, relevancy, satisfaction) and provided insight on the experiences

relating to professional learning, implementation, and student outcomes (theory of change model guiding this study). Guided by a semi-structured protocol, the one-to-one interviews were conducted after the quantitative measure (single-subject, nonconcurrent, multiple baseline).

Finding 1. Relevancy: Teachers found the UDL training to support their learning process and implementation practices. The UDL framework was relevant to the teacher's practices as they provided instruction to a diverse range of learners. The terms "intentional" and "mindful" were used with a high frequency and connected to thinking about who their learners are and how to best provide instruction to support engagement and learning outcomes. Furthermore, they agreed that having professional learning that immediately connects to their practice-based setting, both in enhancing their practices and addressing the challenges, they found to be highly effective.

The teacher training provided teachers with both an overview of UDL as well as made direct connections to their everyday instructional practices. The elements of the teacher training that were identified as supporting their learning were: (a) contextualized learning (e.g., connecting new information to their classroom and practices), (b) modeling/collaboration (e.g., providing examples, co-designing lesson plans and rubrics), and (c) problem-solving (e.g., generating ideas, working through barriers). For example, Mary reported that she liked the power point presentation and the information that it contained, however, she reflected that had she only had that source of information she would not have felt as competent implementing the UDL framework. She stated, "I may be left with some ideas [after viewing power point], but the beauty of having you in the classroom, your eyes and taking things in, and sharing what you observed was incredible." Evelyn, who had received coaching on lesson planning, viewed the

coaching support as brainstorming and collaborative. Evelyn stated, "I would say for me, I get the most out of like coaching, mentoring type approach because it's never a one fits all situation. So, coaching and mentoring are a brainstorming process…"

Geraldine was able to articulate her learning style clearly and reported that the teacher training format was useful in both how the information was provided and the guidance on how to apply the UDL framework to lesson planning. She further reflected on her most recent experiences with professional development and learning and stated, "In elementary school, we're so used to dealing with little guys that when we do professional development, we treat each other as if we were students…your training had good information that I could engage in without having to do some jigsaw-like activity." She continued to say, "This method of you providing training, resources, and actually being in my classroom worked and helped me change my practice."

Finding 2. Acceptability: Teachers found the UDL framework as a mechanism to enhance their instructional practices and increase engagement. Unanimously, the teachers agreed that the UDL framework supported their current practices and also provided them with guidance on how to address specific areas that are more challenging in designing and delivering instruction to diverse learners. Furthermore, they reported that UDL, while comprehensive, aligned with their instructional values and beliefs.

The teachers described UDL as "child-centered", "mindful", "intentional," and "explicit." Additionally, they made connections between their practices before and after learning about UDL. Both Evelyn and Mary stated, separately, "It's [UDL] just good teaching." Geraldine commented that she liked how the checkpoints gave her a "frame of reference" as well as helped

guide her planning process. Mary put it in terms of her own beliefs, “I believe in finding a way to reach every single student and give them access to their learning in a whole bunch of different ways. I've become inspired to be more mindful about it all.”

Across the three teachers, they observed that by changing their practices student engagement and learning increased. Evelyn reflected on her student with dis/abilities who had not been accessing the general curriculum. Following the training he began to access the small group learning opportunity, she stated, "In thinking about [student with dis/abilities] I was reminded to hone into what am I doing and why and I doing it and I could be doing it better.” Mary commented, "UDL is a way to try new things out and observe the shift in the students' performance."

Geraldine commented that she noticed increasing levels of engagement when she shifted from the standardized comprehension assessment of multiple choice and short answer to a project-based assessment when students could choose how to demonstrate their learning. She noticed that both the student who was presenting and the students watching were equally engaged. She followed up by saying, “When everybody has access to different kinds of learning and choosing routes that works best for them, the success is visible.”

When asked about implementing the UDL framework, the teachers reported that it was not difficult. Evelyn explained, “I guess it was all kind of easier to do is cause it was tweaking. I felt like it was tweaking more than like totally doing something brand new. Tweaking instead of overhauling." Given that the teacher participants already had some levels of implementing UDL checkpoints during baseline (i.e., business as usual), it is understandable that their perception of implementing the UDL framework, comprehensively, was not that difficult. When asked would

you recommend UDL to other teachers, Evelyn stated, "I would recommend it, but I don't know how well it would be received." She further elaborated that the challenges may be in the designing process (lesson planning) when the district provides a scripted curriculum that teachers follow, and she projected that teachers might not want to "take the time and go back again and breakdown a lesson and be thoughtful about types of learners."

Finding 3. Satisfaction: teachers liked what they observed in themselves and in the students. Geraldine had observed this in her shift to creating different ways for students to demonstrate their learning and using a rubric to assess mastery of content and skills standards. She commented, "The rubric that I used was focused and goal oriented. This really helped because kids really *do* want to meet expectations." Evelyn implemented both individual and class-wide supports. For example, the student with dis/abilities Evelyn photocopied text and highlighted the sight words and focus words for decoding. By highlighting the text, it signaled to the student what was important. Class-wide she instituted a self-check where students had to fill out a checklist of the activities they had selected during choice time and then reflect on what they had chosen and what they will try next. She commented, "Students were learning how to be self-managers." For Mary, her students had the weekly exercise of journal responses by making explicit connections between lived experience and learning about new experiences (i.e., text-to-self). For her student with a dis/ability, handwriting was challenging, resulting in an uptick in behaviors when approaching this assignment. Mary and the special education teacher had arranged for the student to use speech-to-text software to remove the handwriting obstacle and facilitate text-to-self learning task. Additionally, Mary noted that other students were struggling with this activity and created a journal checklist that was glued into the notebooks and served as

a guide on the goal of the activity and how students could engage in the activity (i.e., pictures and drawings with five sentences). Mary reflected on her efforts to increase student independence by providing explicit instruction around the goal, and she stated, "When they had a clear goal, they were able to work towards something that had meaning to them, and they could feel successful."

CHAPTER 5

DISCUSSION

The UDL framework is built upon previous research of effective instructional practices and provides educators with guidance on how to implement those strategies for diverse learners in inclusive classrooms. The limited research of UDL in the classroom has limited the application of the UDL framework (Smith et al., 2019). This study contributes to the research base by advancing effective professional development activities to support implementation and efficacy of UDL. To date, this study is the first study to examine the effects of a teacher training package on the implementation of the UDL framework (i.e., principles, guidelines, checkpoints) and the impact of these improved literacy lessons with UDL on student outcomes. The promising results from this mixed-methods study indicate a teacher training package that explicitly uses data-based decision making, modeling and feedback as active ingredients produced increased teacher implementation of UDL literacy lessons and increased student progress.

The theory of change guiding this study was developed from Dunst et al. (2013) revised definition of implementation to include professional activities. The two-part teacher training package (general overview and re-design workshop) implemented in this study facilitated teacher learning and implementation of the UDL framework (design and delivery). The active ingredients of the professional learning activities were providing teachers with evidence (data) on their areas of strength and areas for improvement, demonstrating how to design a lesson plan through modelling, providing specific feedback, and on-going collaboration. These features

align with the professional development literatures as being effective components and will be discussed in relation to the research the research questions guiding this study.

Effective Teacher Training

Across the literatures, professional development activities are broadly understood as the mechanisms to change teacher practice for the purpose of increasing student outcomes. This study created a professional development training using the core components that support teacher learning. The active ingredients, within these core components, were identified as: data-based decision making, modelling, and feedback which further strengthened teacher learning and resulted in change of teacher practices. The following sections discuss the changes in teacher practices in relationship to designing and delivering UDL literacy lessons and the impacts on student learning.

Lesson designing. Lesson plans are the tool that guides instruction and assessment, organizes materials and time, and facilitates reflection on student learning. Lesson plans are often referred to as blueprints, roadmaps, or game plan and take many forms; "it can be as simple as a mental checklist or as complex as a detailed two-page typed lesson plan that follows a prescribed format." (Jensen, 2001, p.403). Teacher preparation programs provide teachers with knowledge on the importance of planning and the skills on how to design lessons, however, in-service teachers lesson planning can take many forms (Danielson & McGreal, 2000). Regardless of the format of the lesson plan, proactive and intentional instructional planning addresses student learning profiles and facilitates the use flexible instructional approaches, materials, and assessments (Hall, Vue, Strangman, & Meyer, 2004). Similarly, CAST and the literature on UDL is clear, that both lesson designing and lesson implementation are important. In fact, to date, the

majority of the previous research on UDL professional development activities has been limited to examining the effects of a teacher training on the UDL lesson planning process (Spooner, Baker, Harris, Ahlgrim, Delzell, & Browder, 2007). One might assume that lesson designing is critical in order for lesson implementation to occur, particularly when teachers are focused on building more complex lessons to meet the needs of all learners.

Significant changes were observed in the lesson planning across all three teachers. Prior to the UDL training, the teacher participants' lesson plans were informal and served as more of a mental checklist for when the teacher actually taught the lesson. For example, Evelyn and Mary's lesson planning for the literacy block was guided by a scripted curriculum that outlined daily lessons including long- and short-term learning goals that aligned with the CCSS. The district-wide adopted curriculum prescribed adaptations for diverse learners and measures for assessing learning (e.g., text-to-self activities for comprehension, word lists for sight word and decoding mastery). Following the UDL training, the teachers used the materials in the workshop (e.g., UDL Checkpoint Checklist and the UDL Lesson Design Template) to guide their proactively designing instruction. The teachers change in how they designed lessons were then observed during intervention and noted in their interviews. Each participant increased their percentage of lesson designing components. In addition, as noted in Evelyn's interview, she discussed how daily lesson plans, during the early part of her career, were a requirement. She noted the new trend is for teachers to rely upon scripted curriculum. She stated, "Back in the day we had to do formal lesson plans, where we typed everything out and had to say what the objective was, the strategies we were using, and how we were going to assess learning…we are not in a district where we have to do this now because the curriculum does it for you." She

further elaborated that the lesson planning process was not unfamiliar and the absence of it was problematic as the curriculum is designed for "the average kid during the average lesson…it's [curriculum] not for the highly capable kids or your struggling readers who have other needs."

Lesson delivery. In general, the results of this study indicate the teacher training increased the number of checkpoint categories teacher implemented when delivering the literacy lesson. Given that the UDL framework can be applied in "variable amounts and ways" the existing research on implementation fidelity of UDL practices is fragmented and has failed to inform us on how to effectively implement the UDL framework as a whole (Ok et al., 2016; Smith et al, 2019). As noted in Chapter 2, how researchers describe the interventions used as a part of UDL has varied and often veered away from the UDL language. In a personnel communication with Jenna Gravel, Director of Research and Curriculum for Professional Learning, at CAST she indicated that there is no formula and that the learning goal and composition of learners determines which guideline/checkpoint is relevant and applicable. While this is an important aspect of teacher efficiency and meeting the needs of the learners in the classroom, it may cause confusion when trying to measure or determine if UDL was implemented in the classroom or when attempting to prepare teachers to implement in the classroom. While there is no consensus on what would it mean to implement UDL with fidelity, this study used the checkpoints as a measure of implementation fidelity, that is, the degree to which the UDL framework is delivered as intended (Carroll et al., 2007). This study focused on a comprehensive implementation of UDL: across design and delivery; all three principles; and multiple checkpoints.

Designing UDL lessons is the prerequisite to delivering UDL lessons. Instructional practices were selected based on the UDL lesson designing process that targeted specific areas for growth and were then implemented during literacy lessons. Designing UDL lesson plans, with targeted learning goals and targeted instructional practices, provided teachers with an action plan for instructional delivery; by having a proactive, intentional planning teacher's instructional behavior changed with an observed increase of UDL checkpoints from baseline to intervention phase.

Active Ingredients

Modelling. Joyce & Showers (2002) identify modelling as one of the key features in successful professional learning. By providing a model, teachers are able to more deeply understand the concepts or skills behind a strategy. It then follows that learning a new skill will transfer into classroom practice (Joyce & Showers, 2002).

Modelling was present at several points in time during the teacher training. First, in the general training, various UDL components were modeled during the presentation. For example, when defining multiple methods of presentation, several different methods were provided such as video links, verbal descriptions, and paper descriptions. Second, during the "re-design" training, a model of a UDL lesson plan was provided for each teacher based on the learning activities, context, and learners. Contextualizing the lesson plan was purposeful as it bolstered relevancy, accessibility, and meaning. For Evelyn and Mary, lesson planning for literacy learning was guided by a scripted curriculum that outlined daily lessons that provided long- and short-term learning goals that aligned with the CCSS. Their lesson planning consisted of reviewing the upcoming weekly lessons and accompanying curriculum materials. The district-

wide adopted curriculum had prescribed measures for assessing learning (e.g., text-to-self activities for comprehension, word lists for sight word and decoding mastery). Both teachers elected to omit specific lessons, activities, or materials based on their review and conclusions about the fit (appropriate for the learners) and balancing of time. Their modeled lesson plans included language from the curriculum and emphasized barriers in the curriculum (e.g., reliancy on print language) and learner variability (e.g., how to represent information using a variety of formats). The modeled UDL lesson plan provided to the teachers and the UDL Lesson Design template used during intervention, served as an example and a visual support to guide teachers through the planning process. These visual models (i.e., visual supports) likely served to effectively communicate structure, routine, and sequence and increase learning (e.g., Hogdon, 2000; Janzen, 1996; Kluth & Darmondy-Latham, 2003). This was substantiated by the interview data when Geraldine commented on how the modeled lesson plans supported her independent designing process and engaged her thinking on the types of classroom learning (social, emotional, and academic). She recalled, "When I looked at what you [researcher] had done [modeled lesson plan], and I had looked at the resources and websites you gave me…it was forcing me in a good way to think about representation, engagement, and action and expression and it made me think of the entire range of my classroom and not just in terms of reading level or academic content, but also behaviorally and emotionally."

Data-based decision making. Data-based decision making (DBDM) has historically been a part of how teachers learn to design and tailor instruction for their learners. It then follows that professional development should also implement data-based decision making to tailor instruction for teachers or the participant of that professional development. DBDM is described as, “the

systematic collection, analysis, examination, and interpretation of data to inform practice" (Mandinach, 2012, p. 71). The data collected during baseline on the teacher performance served to inform teachers on the areas that needed further development. For example, baseline data indicated that in Geraldine's instructional routine she consistently made connections between the students' lived experiences to the new learning. This was identified as UDL principle Engagement, guideline 7 (recruiting interest), checkpoint 7.2 (making learning relevant and valuable). However, in the principle Action and Expression, Geraldine had limited means of how students responded to their learning (guideline 4: options for physical action and guideline 5: provide options for expressive skills and fluency). Thus, during the individualized re-design workshop this data were provided to Geraldine to help her identify opportunity for change.

For example, Geraldine used the data and considered the ways to change her instruction to target the principles of Engagement and Action and Expression. In her design process, she explicitly mapped her instruction onto the checkpoints that corresponded with these principles. Specifically, Geraldine changed the methods for assessing student learning and designed outcome measures (i.e., rubric) that allowed for students to demonstrate mastery in a variety of formats. The students were provided with options to demonstrate their learning which facilitated increased engagement. The checkpoints that align with Geraldine's (Engagement: checkpoint 7.1) supporting relevancy in learning (Engagement: checkpoint 7.2) and providing explicit connections between the learning goal and process (Engagement: checkpoint 8.1). This was observed during a classroom observation where the students were learning about opinion writing supported by points of view and citing the informational text.

Sustainability and Social Validity

While the focus of this study was to increase the implementation of UDL in a literacy lesson, the interview data provide us with data that address not only the implementation of UDL but also the social validity. During the interview when asked if they would consider applying UDL framework to other content areas, Geraldine and Evelyn reported they had already begun to implement new methods and materials in different areas outside of literacy, as they were thinking about how to increase representation and engagement. Interestingly, the teachers cited math instruction as the area in which they were experimenting with using the UDL framework. Evelyn provided the example of designing a math activity by bringing "crafts" into math work and providing students with different ways to engage with math concepts. She described building analog clocks using paper plates and brass brads and concluded, "…that way they [students] are not just doing the curriculum or a worksheet, they are actually building- and that way it is more hands-on." It might be logical to assume that one measure of implementation and potential for sustainability is the generalized use of a practice to another situation.

In addition, while the single-case design provides us with limited quantitative data on the long-term use of UDL design and delivery by the participants, there are several references in the interviews to sustained use of these practices. Mary made several references to instructional designing and planning for the next year. In the context of learning about designing using the UDL framework, Mary reported, "already has me thinking towards next year, like what are some things I can have in place at the beginning of the year where everybody has access to all these different kinds of learning, and then they can choose routes that works best for them."

Responses from all three participants has implications for social validity. As mentioned by Schwartz and Baer (1991), social validity ascertains the "acceptability or viability" of a program or intervention as well as "how acceptable [the intervention] will be to their relevant audience" (p.189,191). In relation to assessing satisfaction, the authors posit that correlating observable behaviors with assessment measures further strengthens social validity (Schwartz & Baer, 1991).

Student Outcomes

Student outcomes are the means to better understand the efficacy of a practice as well as the efficacy professional learning activities. Developing evidence of how the UDL framework meets the needs of all students in a general education context is vital to establishing the efficacy of UDL (Smith et al., 2019). This study evaluated student outcomes for students with and without dis/abilities to examine the impact of UDL on learner outcomes. The study showed academic progress for all six participants. The student's with dis/abilities made the most significant gains as their learning opportunities were more accessible than during the baseline phase. Accessing the learning goals led to increased opportunities to participate and demonstration of learning. Additionally, flexible assessment strategies, employed by Geraldine and Mary, allowed for all students to provide evidence of learning. The causal relationship between implementation of the UDL framework and student outcomes further suggests that UDL, when implemented with high fidelity, can reach all learners.

Limitations

There are several limitations in this study that are important to discuss. First, baseline data shows that the teacher participants instructional practices aligned with several of the UDL

checkpoints. For example, use of peer supports was observed at different points in time across all three classrooms. This EBP is embedded in UDL checkpoint (8.3): support collaboration and communication with peers. Given the universal nature of UDL practices we would expect that some practices would be present. However, the teachers were selected for this study based on classroom composition (i.e., including students with dis/abilities) and building administrator nomination. The two elementary school principals had identified the teacher participants as teachers willing to stretch and strengthen their instructional practices. Both the presence of UDL checkpoints during baseline and the principal nominations suggest that the teacher participants had in place instructional qualities that may have attributed to the observed change in design and delivery during the intervention phase.

Additionally, teacher's willingness to change may have also been influenced by the relationship the researcher had with the school district. The lead researcher had previously worked for the school district as an autism specialist. While having a had a previous professional relationship with the special educators, the researcher had not worked directly with the teacher participants prior to the study.

Data collection in the design component of the study is also a limitation. During baseline, there was an absence of formal designing daily lesson plans across the three teachers. The teachers had informal planning practices that looked more like mental lists than detailed plans. After receiving the teacher training, a UDL lesson plan template and UDL Checklist was modeled to demonstrate how to account for potential barriers, learner variability, and strengthen connections between instructional planning and delivery by clearly identifying the checkpoints that would be utilized in the lesson. Independent UDL lesson planning looked different across

the teachers. For Evelyn and Mary, they filled out the UDL Checkpoint Checklist mapping their instructional practices observed in baseline and then identifying the new checkpoints that were implemented during the intervention phase. They connected the evidence of checkpoints being employed in their practices to their daily UDL lesson plans, which included curriculum language. Their designing process was more reflective of identifying barriers in both the curriculum and learning and targeting those areas to change their instruction. The curriculum both Evelyn and Mary used had some embedded information (i.e., short- and long-term goals, differentiation, and use of EBPs)- so their UDL lessons drew from the language provided in the curriculum and was enhanced by their identification of checkpoints. This indicates that lesson designing for Evelyn and Mary was not as intensive as Geraldine's lesson designing process. Geraldine's lesson planning was more reflective of traditional lesson planning as she had to independently identify all the design components (short- and long-term objectives, learning goal, potential barriers, learning variability, instructional methods and materials, instructional sequence, multiple means of representation, multiple means of engagement, and multiple means of action and expression). Understanding the intensity (i.e., amount of time and location of resources) of the lesson planning process is important as it may influence teacher's willingness to change.

Finally, the measurement of student outcome data across the course of the curriculum provided some challenges and limitation. Typically, in a single case design, the dependent variable would be defined in a way that the measurement was consistent at each repeated measurement point. The applied research literature most often uses "engagement" as a proxy for student outcomes. While a more consistent measure of student outcomes would have been to use

"engagement" it did not really tell us how UDL influence progress as it would be defined by school personnel. In this study, student outcomes were measured based on percentage correct. However, it is important to note that for Geraldine, the curriculum-based assessment changed considerably between baseline and intervention phase; it is difficult to compare the baseline measures to the intervention phase measures as the assessment changed.

Future Implications

Results from this study in combination with the literatures on effective professional development and implementation strategies demonstrated the positive effects of a teacher training on the UDL framework across three teachers and increased student learning outcomes for students with and without dis/abilities. The areas this study addressed (i.e., professional learning, implementation, and student outcomes) were areas identified in the UDL-IRN research committee. UDL-IRN partnered with CAST to address concerns related to extant research on UDL interventions and implementation. The inconsistencies across the empirical evidence stimulated the research group to guide future research efforts (Smith et al., 2019). Among the key issues, measurement of UDL and professional development and preparation to implement UDL were identified as areas to be addressed. The UDL framework is comprehensive and requires effective professional development that supports teachers in enriching and enhancing their instructional practices. Contextualized, small scale training provides the opportunity to understand better how teachers interact with new knowledge and how that translates to practice (Guskey & Yoon, 2009).

Additionally, providing coaching to individual teachers provides the opportunity for tailored feedback, acknowledges individual learning levels and styles, and builds expertise in

new skills and supporting the practice of the new skills (Joyce & Showers, 2002). Furthermore, developing consistent implementation fidelity measures will aid in understanding implementation barriers. Extending the research on professional development and professional learning activities and developing consistent measures connected to student outcomes will contribute to the evidence of UDL reaching all learners.

Summary

This study employed a non-concurrent, multiple baseline design, and the qualitative measure of semi-structured interviews to examine the effects of a teacher training on the implementation of the UDL total framework and how that impacted student outcomes. The teacher training drew on established effective professional learning practices and implementation strategies to enrich three teachers understanding of the UDL framework and enhance instructional practices implementing the UDL framework. The results of the experimental and qualitative show that the teachers were high implementers, and they found the UDL framework acceptable, useful, and relevant to their instructional practices and diverse learner needs. Furthermore, the study connected the learning and implementation activities to student learning outcomes; student outcome data showed an increase in learning for students with and without dis/abilities. The findings of this study suggest that the UDL total framework is useful in guiding instructional design and delivery and can effectively address learner variability.

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Appendix A

UDL Checkpoints Operationalized

	Example	Non-Example
Guideline 1: Provide options for perception *Checkpoint 1.1 – Offer ways of customizing the display of information:* • Display information in a flexible format so that the following perceptual features can be varied: o The size of text, images, graphs, tables, or other visual content o The contrast between background and text or image o The color used for information or emphasis o The volume or rate of speech or sound o The speed or timing of video, animation, sound, simulations, etc. o The layout of visual or other elements o The font used for print materials	High-tech: Using Smart Board to project the daily lesson Low-tech: highlighting key words in printed text	Providing lecture or instruction in only a verbal format.
Checkpoint 1.2 - Offer alternatives for auditory information • Use text equivalents in the form of captions or automated speech-to-text (voice recognition) for spoken language • Provide visual diagrams, charts, notations of music or sound • Provide written transcripts for videos or auditory clips • Provide American Sign Language (ASL) for spoken English • Use visual analogues to represent emphasis and prosody • Provide visual or tactile equivalents for sound effects or alerts • Provide visual and/or emotional description for musical interpretation	High-tech: use speech-to-text to allow for seeing verbal or auditory information. Low-tech: providing outline or lecture notes	Providing information in only an auditory format.

Checkpoint 1.3 - Offer alternatives for visual information • Provide descriptions (text or spoken) for all images, graphics, video, or animations • Use touch equivalents (tactile graphics or objects of reference) for key visuals that represent concepts • Provide physical objects and spatial models to convey perspective or interaction • Provide auditory cues for key concepts and transitions in visual information • Allow for a competent aide, partner, or "intervener" to read text aloud • Provide access to text-to-speech software	High-tech: providing text in a digital text-to-speech. Low-tech: Text provided with images or graphics.	Providing information using images, graphics, animation without text or auditory cues.
Guideline 2: Provide options for language, mathematical expressions, and symbols *Checkpoint 2.1 - Clarify vocabulary and symbols* • Pre-teach vocabulary and symbols, especially in ways that promote connection to the learners' experience and prior knowledge • Provide graphic symbols with alternative text descriptions • Highlight how complex terms, expressions, or equations are composed of simpler words or symbols • Embed support for vocabulary and symbols within the text (e.g., hyperlinks or footnotes to definitions, explanations, illustrations, previous coverage, translations) • Embed support for unfamiliar references within the text (e.g., domain specific notation, lesser known properties and theorems, idioms, academic language, figurative language, mathematical language, jargon, archaic language, colloquialism, and dialect)	High-tech: embedding hyperlinks in text to support vocabulary learning. Low-tech: pre-teach vocabulary by providing a word list with definitions.	Providing text with unfamiliar or unlearned vocabulary.
Checkpoint 2.2 - Clarify syntax and structure	High-tech: Using a Smart Board	Providing printed text that does not

• Clarify unfamiliar syntax (in language or in math formulas) or underlying structure (in diagrams, graphs, illustrations, extended expositions or narratives) through alternatives that: o Highlight structural relations or make them more explicit o Make connections to previously learned structures o Make relationships between elements explicit (e.g., highlighting the transition words in an essay, links between ideas in a concept map, etc.)	highlighting ending sounds (e.g., -ed). Low-tech: In printed text highlighting the ending sounds (e.g., -ed).	emphasize ending sounds.
Checkpoint 2.3 - Support decoding of text, mathematical notation, and symbols • Allow the use of Text-to-Speech • Use automatic voicing with digital mathematical notation (Math ML) • Use digital text with an accompanying human voice recording (e.g., Daisy Talking Books) • Allow for flexibility and easy access to multiple representations of notation where appropriate (e.g., formulas, word problems, graphs) • Offer clarification of notation through lists of key terms	High-tech: Using Bookshare© which highlights text while reading it aloud. Low-tech: Model reading a passage for students before independently reading text.	Providing students with text without any support.
Checkpoint 2.4 - Promote understanding across languages • Make all key information in the dominant language (e.g., English) also available in first languages (e.g., Spanish) for learners with limited-English proficiency and in ASL for learners who are deaf • Link key vocabulary words to definitions and pronunciations in both dominant and heritage languages • Define domain-specific vocabulary (e.g., "map key" in social studies) using both domain-specific and common terms	High-tech: Provide hyperlinks to a dictionary in digital text that provide access to alternative language. Low-tech: Provide visual information to support access to text.	Providing text or key information in English language only.

• Provide electronic translation tools or links to multilingual glossaries on the web • Embed visual, non-linguistic supports for vocabulary clarification (pictures, videos, etc.)		
Checkpoint 2.5 - Illustrate through multiple media • Present key concepts in one form of symbolic representation (e.g., an expository text or a math equation) with an alternative form (e.g., an illustration, dance/movement, diagram, table, model, video, comic strip, storyboard, photograph, animation, physical or virtual manipulative) • Make explicit links between information provided in texts and any accompanying representation of that information in illustrations, equations, charts, or diagrams	High-tech: Providing demonstrations by accessing YouTube and projecting on Smart Board or another media projection. Low-tech: Model learning concept through action.	Providing learning concept in isolation without an alternative form.
Guideline 3: Provide options for comprehension *Checkpoint 3.1 - Activate or supply background knowledge* • Anchor instruction by linking to and activating relevant prior knowledge (e.g., using visual imagery, concept anchoring, or concept mastery routines) • Use advanced organizers (e.g., KWL methods, concept maps) • Pre-teach critical prerequisite concepts through demonstration or models • Bridge concepts with relevant analogies and metaphors • Make explicit cross-curricular connections (e.g., teaching literacy strategies in the social studies classroom)	High-tech: Using Smart Board and google sheets, drawing connections between types of text (e.g., informational and opinion). Low-tech: Providing opportunities for student to make self-to-connections in a journal writing activity.	Presenting students with an informational text and an opinion piece in a lecture without guiding students through making connections.
Checkpoint 3.2 - Highlight patterns, critical features, big ideas, and relationships • Highlight or emphasize key elements in text, graphics, diagrams, formulas • Use outlines, graphic organizers, unit organizer routines, concept organizer routines,	High-tech: Using mind mapping software to make connections between concepts.	Providing information on concepts that are connected without

and concept mastery routines to emphasize key ideas and relationships • Use multiple examples and non-examples to emphasize critical features • Use cues and prompts to draw attention to critical features • Highlight previously learned skills that can be used to solve unfamiliar problems	Low-tech: Using a Venn diagram to show where concepts intersect.	showing the relationship.
Checkpoint 3.3 - Guide information processing, visualization, and manipulation • Give explicit prompts for each step in a sequential process • Provide options for organizational methods and approaches (tables and algorithms for processing mathematical operations) • Provide interactive models that guide exploration and new understandings • Introduce graduated scaffolds that support information processing strategies • Provide multiple entry points to a lesson and optional pathways through content (e.g., exploring big ideas through dramatic works, arts and literature, film and media) • "Chunk" information into smaller elements • Progressively release information (e.g., sequential highlighting) • Remove unnecessary distractions unless they are essential to the instructional goal	High-tech: Using a Smart Board, show a video of steps in a process. Low-tech: Demonstrate steps in process by modeling the steps for the students.	Providing a whole concept in a single format.
Checkpoint 3.4 - Maximize transfer and generalization • Provide checklists, organizers, sticky notes, electronic reminders • Prompt the use of mnemonic strategies and devices (e.g., visual imagery, paraphrasing strategies, method of loci, etc.) • Incorporate explicit opportunities for review and practice • Provide templates, graphic organizers, concept maps to support note-taking	High-tech: Using a Smart Board demonstrate filling out a t-chart to organize information. Low-tech: Provide students with a pre-made t-chart and guide them through	Providing students with a whole learning concept in isolation.

• Provide scaffolds that connect new information to prior knowledge (e.g., word webs, half-full concept maps) • Embed new ideas in familiar ideas and contexts (e.g., use of analogy, metaphor, drama, music, film, etc.) • Provide explicit, supported opportunities to generalize learning to new situations (e.g., different types of problems that can be solved with linear equations, using physics principles to build a playground) • Offer opportunities over time to revisit key ideas and linkages between ideas	how to use it to organize information.	
Guideline 4: Provide options for physical action *Checkpoint 4.1 - Vary the methods for response and navigation* • Provide alternatives in the requirements for rate, timing, speed, and range of motor action required to interact with instructional materials, physical manipulatives, and technologies • Provide alternatives for physically responding or indicating selections (e.g., alternatives to marking with pen and pencil, alternatives to mouse control) • Provide alternatives for physically interacting with materials by hand, voice, single switch, joystick, keyboard, or adapted keyboard	High-tech: Use of clicker technology to respond to questions. Low-tech: Use of hand signals to respond to questions.	Response options are limited to paper-and-pencil.
Checkpoint 4.2 - Optimize access to tools and assistive technologies • Provide alternate keyboard commands for mouse action • Build switch and scanning options for increased independent access and keyboard alternatives • Provide access to alternative keyboards • Customize overlays for touch screens and keyboards • Select software that works seamlessly with keyboard alternatives and alt keys	High-tech: Using iPad technology that allows for touch-screen. Low-tech: Placing color-coded stickers on keyboard to direct learner for finger placement.	Simply providing access to technology (i.e., chrome book, laptop) without any additional supports or consideration of the user.

Guideline 5: Provide options for expression and communication *Checkpoint 5.1 - Use multiple media for communication* • Compose in multiple media such as text, speech, drawing, illustration, design, film, music, dance/movement, visual art, sculpture or video • Use physical manipulatives (e.g., blocks, 3D models, base-ten blocks) • Use social media and interactive web tools (e.g., discussion forums, chats, web design, annotation tools, storyboards, comic strips, animation presentations) • Compose in multiple media such as text, speech, drawing, illustration, comics, storyboards, design, film, music, visual art, sculpture, or video • Solve problems using a variety of strategies	High-tech: Allowing students access speech-to-text software to support expression of knowledge. Low-tech: Allow for students to draw or illustrate to express knowledge.	Providing a single method for students to express knowledge (e.g., paper-and-pencil task.
Checkpoint 5.2 - Use multiple tools for construction and composition • Provide spellcheckers, grammar checkers, word prediction software • Provide Text-To-Speech software (voice recognition), human dictation, recording • Provide calculators, graphing calculators, geometric sketchpads, or pre-formatted graph paper • Provide sentence starters or sentence strips • Use story webs, outlining tools, or concept mapping tools • Provide Computer-Aided-Design (CAD), music notation (writing) software, or mathematical notation software • Provide virtual or concrete mathematics manipulatives (e.g., base-10 blocks, algebra blocks) • Use web applications (e.g., wikis, animation, presentation)	High-tech: Students accessing Read & Write application to access word prediction. Low-tech: Provide student with sentence starters or word lists.	Students are provided with an assignment and required to work on independently without scaffolds or support.
Checkpoint 5.3 - Build fluencies with graduated levels of support for practice and performance		

• Provide differentiated models to emulate (i.e. models that demonstrate the same outcomes but use differing approaches, strategies, skills, etc.) • Provide differentiated mentors (i.e., teachers/tutors who use different approaches to motivate, guide, feedback or inform) • Provide scaffolds that can be gradually released with increasing independence and skills (e.g., embedded into digital reading and writing software) • Provide differentiated feedback (e.g., feedback that is accessible because it can be customized to individual learners) • Provide multiple examples of novel solutions to authentic problems	High-tech: Provide templates in a Google Classroom document to guide composition writing. Low-tech: Provide students with color-coded writing prompts (i.e., topic sentence, details, conclusion).	Requiring students to engage in writing assignment without models or scaffolds.
Guideline 6: Provide options for executive functions Checkpoint 6.1 - Guide appropriate goal-setting • Provide prompts and scaffolds to estimate effort, resources, and difficulty • Provide models or examples of the process and product of goal-setting • Provide guides and checklists for scaffolding goal-setting • Post goals, objectives, and schedules in an obvious place	High-tech: Using Google Classroom, teacher provides student with calendar of activities for a long-range project. Low-tech: Teacher posts on classroom calendar steps to long-range project.	Teacher provides a handout with assignment description and due date.
Checkpoint 6.2 - Support planning and strategy development • Embed prompts to "stop and think" before acting as well as adequate space • Embed prompts to "show and explain your work" (e.g., portfolio review, art critiques) • Provide checklists and project planning templates for understanding the problem, setting up prioritization, sequences, and schedules of steps • Embed coaches or mentors that model think-aloud of the process • Provide guides for breaking long-term goals into reachable short-term objectives	Teacher provides students with embedded prompts in a learning task, such as marking the stop point at the end of a reading passage and a graphic organizer to jot down main ideas.	Teacher provides a task with a "trial and error" strategy and without scaffolds or support; teacher assigns a reading without any breaks, prompts, or mechanisms to engage reflection.

Checkpoint 6.3 - Facilitate managing information and resources • Provide graphic organizers and templates for data collection and organizing information • Embed prompts for categorizing and systematizing • Provide checklists and guides for note-taking	High-tech: Teacher shows student how to use One Note. Low-tech: Teacher shows student how to take two-sided notes.	Teacher instructs students to take notes without examples or models.
Checkpoint 6.4 - Enhance capacity for monitoring progress • Ask questions to guide self-monitoring and reflection • Show representations of progress (e.g., before and after photos, graphs and charts showing progress over time, process portfolios) • Prompt learners to identify the type of feedback or advice that they are seeking • Use templates that guide self-reflection on quality and completeness • Provide differentiated models of self-assessment strategies (e.g., role-playing, video reviews, peer feedback) • Use of assessment checklists, scoring rubrics, and multiple examples of annotated student work/performance examples	High-tech: Teacher has student fill out a Google survey that is in the form of a self-assessment. Low-tech: Teacher provides students with a checklist to reflect on progress.	Teacher asks students to comment on their progress without engaging reflection.
Guideline 7: Provide options for recruiting interest *Checkpoint 7.1 - Optimize individual choice and autonomy* • Provide learners with as much discretion and autonomy as possible by providing choices in such things as: o The level of perceived challenge o The type of rewards or recognition available o The context or content used for practicing and assessing skills o The tools used for information gathering or production o The color, design, or graphics or layouts, etc. o The sequence or timing for	High-tech: Students are provided with choice to access reading materials on-line or print. Low-tech: Students are provided with choice of reading materials.	Teacher provides students with single reading material.

completion of subcomponents of tasks • Allow learners to participate in the design of classroom activities and academic tasks • Involve learners, where and whenever possible, in setting their own personal academic and behavioral goals		
Checkpoint 7.2 - Optimize relevance, value, and authenticity • Vary activities and sources of information so that they can be: o Personalized and contextualized to learners' lives o Culturally relevant and responsive o Socially relevant o Age and ability appropriate o Appropriate for different racial, cultural, ethnic, and gender groups • Design activities so that learning outcomes are authentic, communicate to real audiences, and reflect a purpose that is clear to the participants • Provide tasks that allow for active participation, exploration and experimentation • Invite personal response, evaluation and self-reflection to content and activities • Include activities that foster the use of imagination to solve novel and relevant problems, or make sense of complex ideas in creative ways	For poetry study, teacher assigns students to study poetry forms from a variety of cultures and share with the classroom.	For a poetry study, Teacher provides a few examples and students read aloud.
Checkpoint 7.3 - Minimize threats and distractions • Create an accepting and supportive classroom climate • Vary the level of novelty or risk o Charts, calendars, schedules, visible timers, cues, etc. that can increase the predictability of daily activities and transitions o Creation of class routines o Alerts and previews that can help learners anticipate and prepare for	Teacher provides a verbal, visual, and auditory cue (e.g., chime paired with verbal warning) during each transition.	Teacher expects students to independently follow rules and routines.

changes in activities, schedules, and novel events o Options that can, in contrast to the above, maximize the unexpected, surprising, or novel in highly routinized activities • Vary the level of sensory stimulation o Variation in the presence of background noise or visual stimulation, noise buffers, number of features or items presented at a time o Variation in pace of work, length of work sessions, availability of breaks or time-outs, or timing or sequence of activities • Vary the social demands required for learning or performance, the perceived level of support and protection and the requirements for public display and evaluation Involve all participants in whole class discussions		
Guideline 8: Provide options for sustaining effort and persistence *Checkpoint 8.1 - Heighten salience of goals and objectives* • Prompt or require learners to explicitly formulate or restate goal • Display the goal in multiple ways • Encourage division of long-term goals into short-term objectives • Demonstrate the use of hand-held or computer-based scheduling tools • Use prompts or scaffolds for visualizing desired outcome • Engage learners in assessment discussions of what constitutes excellence and generate relevant examples that connect to their cultural background and interests	High-tech: Teacher uses Smart Board to project the learning goal that is embedded in a Google document. Low-tech: Teacher posts on the wall the learning goal with short-term objectives to make clear connections throughout learning process	Teacher provides instruction and does not anchor learning goal to learning activities.

Checkpoint 8.2 - Vary demands and resources to optimize challenge • Differentiate the degree of difficulty or complexity within which core activities can be completed • Provide alternatives in the permissible tools and scaffolds • Vary the degrees of freedom for acceptable performance • Emphasize process, effort, improvement in meeting standards as alternatives to external evaluation and competition	High-tech: Allow students to access Read&Write to support writing conventions. Low-tech: Teacher provides scaffolds (e.g., graphic organizer, writing prompts) to support writing process.	Teacher assigns a writing activity.
Checkpoint 8.3 - Foster collaboration and community • Create cooperative learning groups with clear goals, roles, and responsibilities • Create school-wide programs of positive behavior support with differentiated objectives and supports • Provide prompts that guide learners in when and how to ask peers and/or teachers for help • Encourage and support opportunities for peer interactions and supports (e.g., peer-tutors) • Construct communities of learners engaged in common interests or activities • Create expectations for group work (e.g., rubrics, norms, etc.)	Teacher assigns students to cooperative learning groups or peer tutors.	Students only work independently.
Checkpoint 8.4 - Increase mastery-oriented feedback • Provide feedback that encourages perseverance, focuses on development of efficacy and self- awareness, and encourages the use of specific supports and strategies in the face of challenge • Provide feedback that emphasizes effort, improvement, and achieving a standard rather than on relative performance • Provide feedback that is frequent, timely, and specific	Teacher provides regularly scheduled mini-conferences to provide feedback.	Students receive feedback based on their grade.

• Provide feedback that is substantive and informative rather than comparative or competitive • Provide feedback that models how to incorporate evaluation, including identifying patterns of errors and wrong answers, into positive strategies for future success		
Guideline 9: Provide options for self-regulation *Checkpoint 9.1 - Promote expectations and beliefs that optimize motivation* • Provide prompts, reminders, guides, rubrics, checklists that focus on: o Self-regulatory goals like reducing the frequency of aggressive outbursts in response to frustration o Increasing the length of on-task orientation in the face of distractions o Elevating the frequency of self-reflection and self-reinforcements • Provide coaches, mentors, or agents that model the process of setting personally appropriate goals that consider both strengths and weaknesses • Support activities that encourage self-reflection and identification of personal goals	Teacher guides students through a weekly mindfulness activity that requires students to reflect on themselves.	Teacher has posted expected and unexpected behaviors but does not refer to these when unexpected behavior is observed.
Checkpoint 9.2 - Facilitate personal coping skills and strategies • Provide differentiated models, scaffolds and feedback for: o Managing frustration o Seeking external emotional support o Developing internal controls and coping skills o Appropriately handling subject specific phobias and judgments of "natural" aptitude (e.g., "how can I improve on the areas I am struggling in?" rather than "I am not good at math") Use real life	Teacher uses an on-going self-regulation strategy, class-wide.	Teacher provides consequences for interfering or disruptive behavior.

situations or simulations to demonstrate coping skills		
Checkpoint 9.3 - Develop self-assessment and reflection • Offer devices, aids, or charts to assist individuals in learning to collect, chart and display data from their own behavior for the purpose of monitoring changes in those behaviors • Use activities that include a means by which learners get feedback and have access to alternative scaffolds (e.g., charts, templates, feedback displays) that support understanding progress in a manner that is understandable and timely	Teacher provides student with ways to "rate" their behavior such as graphing how often they are on-task. Graphing could look like paper-pencil or using stackable manipulatives to show on-task behavior.	Teacher uses negative consequences to inform students of their behavior.

Note: UDL Guidelines version 2.2 retrieved from http://udlguidelines.cast.org (CAST, 2018)

Appendix B

UDL Intervention Studies

Reference	Research Design	Population	RQ (s)	IV/ Intervention	DV	Outcomes/ Effect Sizes
Studies Using Technology						
Basham, Meyer, & Perry (2010)	Qualitative Case Study DBR	9-11th Grade N=35 Disability Category: 11 LD	What equipment, environmental, and instructional factors contributed to the outcome of the design cycle? Should the factors be modified to obtain the desired outcome, and if so, how?	Use of a **Digital Backpack** to be applied across school and museum settings increase learning outcomes.	Knowledge of the concept of Freedom (observation, field notes, surveys, interviews, student generated artifacts)	Supported diverse students in access and engagement.
Coyne, Pisha, Dalton, Zeph and Smith (2012)	Quasi-experimental Group: non-equivalent intervention and control group; pre/post test Expression	K-2nd Grade Disability Category: ID N=16	For children in grades K-2 with significant intellectual disabilities, what effect does a UDL technology-based reading approach (Literacy by Design) versus traditional reading instruction have on students' reading comprehension, fluency, phonemic awareness, phonics, and vocabulary development?	**Literacy By Design (LBD)** (technologically-based UDL aligned approach to literacy instruction which included scaffolded eBooks	WJ-III assessment measures: Letter-word id; understanding directions; passage comprehension; word attack; picture vocabulary; oral comprehension; sound awareness.	Controlled for pre/post-test differences; LBD group mean scores were greater than means for control group. Effect size varied from small to large across the assessment measurements.
Dalton, Proctor, Uccelli, Mo, and Snow (2011)	Quasi-experimental design: Presentation	Grade: 5th N = 106 Disability Category: NR Target Group: Bi-	What is the effect of Improving Comprehension On-line (ICON) condition (comprehension strategy vs. vocabulary vs. combination) on fifth grade students' comprehension and vocabulary learning within the ICON scaffolded digital reading (SDR)? What is the effect on students; standardized reading achievement test performance?	**ICON** with three different types of supports embedded: Comprehension strategy (CS), Vocabulary (VOC),and CS + VOC combined. Scaffolded Digital Reading (SDR)	Reading achievement levels measured using the Gates-MacGinitie Reading Test Vocabulary and Comprehension assessment	Effect sizes varied across the measurements from near zero to large. Pre to post-test effect size gain for all students on GMRT comprehension and vocabulary was small.

		Lingual and ELL	Do ICON condition effects by language status?			
Dolan, Hall, Banerjee, Chun, and Strangman (2005)	Mixed Methods: Quasi-experimental	11th & 12th grade Disability Category: LD *N*=9	Is Computer-based testing with text-to-speech (CBT-TTS) effective? What aspects of CBT-TTS make it effective for students with LD? Would students use CBT-TTS in the real-world?	**CBT-TTS** Vs. Paper-and-Pencil Testing (PPT)	Test scores under CBT-TTS condition and PPT condition Other measurements: student survey, structured interviews, usage tracking, and field observations to measure preference, performance, and pattern of use	Quantitative: Large and Statistically significant increase in scores for reading passages greater than 100 words. Qualitative: Student preference for CBT-TTS
Hall, Cohen, Vue, and Ganley (2015)	Quasi-experimental/ Mixed Methods; pre/post-test change; UDL vs. Non UDL; Likert-scale; teacher interview	6-8th graders N=284 Disability Category: 64 LD; 11 ADHD; 8 OHI	Is the implementation of CBM-UDL more efficient and effective for teachers and students than a more traditional offline implementation of CBM when using a UDL reading environment? Is the technology-based approach to monitor student performance in reading more effective in improving student performance on standards-based measures of reading comprehension? Does implementing technology-based CBM in a UDL reading environment facilitate teachers' use of CBM to inform instruction central to state standards?	**Strategic Reader** tool to improve reading comprehension with an online CBM	Gains in vocabulary and comprehension as measured by the Gates-MacGinitie Reading Test Vocabulary and Comprehension assessment	Quantitative: Students with LD had greater gains in the online condition, however, students with LD also made gains in the offline condition. Teachers in the online condition viewed and designed interventions over 3 times more frequently than the offline condition.
Kennedy, Thomas, Meyer, Alves &	Quasi-experimental without random assignment to	16 yrs. old N=141 Disability Category: 27	To what extent to adolescents with and without dis/abilities improve vocabulary performance following the use of CAPs versus no CAPS	**Content Acquisition Podcast (CAP)** to increase vocabulary (historical definitions) for high school students with and without dis/abilities.	Pre/Posttest and CBM on World History vocabulary	Students in the CAP condition scored higher on Post-tests and CBM; Effect Size was large

Lloyd (2014)	condition and control.	LD, 3 BD, 2 ID				
*King-Sears, Johnson, Berkeley, Weiss, Petters-Burton, Evmenova, Menditto, & Hursh (2015)	Quasi-experimental with random assignment to UDL vs. non-UDL conditions; intact classes	10-12th Grades N=60 Disability Category: 19 HID; 10 LD; 5 OHI; 1 ED; 2 ASD; 1 SLI	Are students with and without HID taught using a UDL treatment better able to solve one- and two-step mole conversation problems than students taught using comparison instruction (BAU)? Do these students maintain performance after a 4-week delay?	UDL treatment condition included 10 video clips. 3 videos provided an overview of the **UDL Mole Module** materials; 1 video clip demonstrated the IDEAS self-management strategy and how to solve two problems; 2 videos on how to solve one-step mole problems; 3 video clips on how to solve two step mole problems; 1 video clip on how to solve both one and two step problems (mixed problems).	Chemistry Test on calculating mole.	Students increased their scores from pre/post-test. Post-test scores were similar in UDL and non-UDL conditions presenting with a small effect size. Students with disabilities had higher post-test scores in UDL condition.
Marino (2009)	Quantitative: Correlational Study	6-8th grade N=1153 Disability Category: 205 poor readers	Is there a relationship between students' reading ability, use of use of cognitive tools, and their comprehension of scientific concepts and processes?	Use of a **technology-based curriculum-Alien Rescue**- to increase knowledge of scientific concepts, processes, and vocabulary.	Pre- and post-test: paper and pencil 25 item multiple-choice.	Small effect size
*Marino, Gotch, Israel, Vasquez, Basham, & Becht (2014)	Mixed Methods Quantitative: quasi-experimental design using repeated measures factorial	10-14 yrs. old N=341 Disability Category: 57 LD	Is there a relationship between the use of video games, alternative text, and the level of engagement of students with LD in inclusive middle school science classrooms? Are there differences in performance on paper and pencil posttests when students with LD participate in video game and alternative text enhanced	UDL-enhanced units including **four life science video games** and a UDL-aligned supplementary print-based textbook for struggling readers. Reading Ability/Disability Status	Students' performance on paper-and-pencil posttest, students' video game play statistics, and students' reported levels of engagement during the learning activities.	Engagement measured qualitatively, Pre/posttest of UDL vs. non-UDL had small Effect size.

	analysis and multiple regression Qualitative: semi-structured focus group interviews of students, with and without dis/abilities		units compared with traditional instruction units? Are there differences in performance during UDL-enhanced units on the paper and pencil tests when students with LD are compared to students in other reading ability groups? Is there a relationship between students with LD use of UDL scaffolds in the game and their performance on the paper-and-pencil tests?	"Two aspects of learner variability that are tracked in every school in the US are students' reading ability and dis/ability status." P. 88		
Rappolt-Schlichtmann, Daley, Lim, Lapinski, Robinson, & Johnson (2013)	Mixed-methods Quantitative: quasi-experimental; RCT assigned to experimental condition or control treatment; multi-level modeling used to analyze student outcomes. Qualitative: content analysis of teacher interviews	4th Grade N=621 Disability Category: NS; 10% with IEP or 504 Plan	RQ1(overall impact): On average, do students in classrooms using support-rich, UDL science notebooks learn and understand more about science than similar students in similar classrooms using traditional paper-and-pencil science notebooks? RQ2 (Differential Impact): On average, is the impact of the UDSN the same for students at various reading and motivation levels? RQ3 (Use): Do students use the UDSN in ways that would indicate productive science notebook use? RQ4 (Differential use) Do students whose teachers have more professional experience and students who more frequently use the contextual process-focused supports in the UDSN tend to engage in more	**UDL Science Notebook (UDSN)** which included text-to-speech features, terms with illustrations, prompts and scaffolds during activities, and multi-media response options.	ASK Survey (Ferguson, Long, and Kennedy, 2009). Assesses the potential impact of a web-based science notebook to support improved content knowledge outcomes as compared to traditional paper-and-pencil science notebooks	ES= Large Controlled for reading levels, prior knowledge, and motivation- tx group scored higher on ASK posttest. Qualitative: high rates of reporting preference for USDN

	and student focus groups.		productive notebook learning behaviors? RQ5 (Perceptions): What are the students' and teachers' perceptions of the usefulness of the UDSN in science learning?			
Studies Using UDL Instructional Strategies/Support						
*Browder, Mims, Spooner, Ahlgrim-Delzell, and Lee (2009)	SCRD: Multiple-probe across participants	7 & 10 yr. old Disability Category: ID *N*=3	The purpose of this study was to demonstrate a method for planning and implementing shared stories for students with the multiple disabilities that incorporated both **task analytic instruction and team planning using principles of UDL.**	Adapted picture books that included student's name as main character	Task analysis: number of independent student responses during the story read aloud (out of 16 possible steps).	Student Engagement increase during UDL Intervention; Large Effect Size calculated by PAND and Phi
*Lieber, Horn, Palmer, & Fleming (2008)	Descriptive case study	4.5 yrs. old N=58 Disability Category: 29 SLI, 19 DD, 1 ED, 1 OHI, 1 ID, 1 ASD	To determine if the preschool children with disabilities who received the CSS curriculum changed significantly in their social and academic skills.	Children's School Success Which included **flexible grouping, environmental arrangements, and peer supports.**	Academic: multiple measures of literacy and math Social Skills Rating System	Effect size across measure ranged from small to large for reading; moderate to large for math; small for social skills. Authors report that the CSS curriculum improved learning outcomes in academic and social areas.
UDL Explorations at Classroom Level and Building Level						
Dymond, Renzaglia Rosenstein, Chun, Banks, Niswander,	Qualitative Case Study/Participatory Action Research	High School N=101 Disability category:	The purpose of the case study was to describe the experiences of school personnel involved with **redesigning one inclusive high school science course.**	Redesign of a high school science course by employing the principles of UDL (changes to material, student participation, instructional delivery, assessment, and curriculum)	Emergent themes that identified change, shifts, and progress.	Special Ed teacher reported a shift in role as being more involved in planning and less modifying during class time. Para educators struggled with the newly developed

and Gilson (2006)		25 Mild Disabilities; 8 ID		by means of team meetings and lesson planning that was guided by questions and problem solving.		role of providing support to small groups and not 1:1. Students with IEPs made gains on their annual goals
Katz (2013)	Quasi-experimental Pre-posttest design	1st-12th grades N=631 Disability Categories: NR, noted students with dis/abilities	a. Is there a significant difference in students' academic engagement? following the implementation of an instructional pedagogy based on the Three Block Model of Universal Design for Learning? b. Is there a significant difference in students' social engagement? following the implementation of an instructional pedagogy based on the Three Block Model of Universal Design for Learning?	Three-Block Model of UDL: 1. SE Learning **2.** Inclusive Instructional Practices which include PD on EBP (cited as: **Understanding by Design, DI, Curriculum Integration, Inquiry,& Assessment for Learning** 3. Student Engagement/Autonomy	Measures of engagement, social interactions, and instructional practices.	Engagement: large ES for students in UDL classroom. Social: near zero ES Instructional practices: increase in varying materials, grouping, and decrease in whole group instruction and paper and pencil tasks.

Appendix C

Student Assent

ASSENT FORM

UNIVERSITY OF WASHINGTON
ASSENT TO RESEARCH

Access, Participation, and Progress: Universal Design for Learning Advancing Literacy Instruction and Learning for All

Researcher: Elizabeth Hartwell Saliba, M.Ed.
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Special Education
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Faculty Advisor: Dr. Carol Ann Davis
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(206) 221-5043

Researcher's statement:
My name is Liz Saliba and I am going to be working with your teacher. I am student, like you, and I studying teaching and learning.

All students are different and special. Because of that, students learn in different ways. To help you learn, I'm going to work with your teacher to provide you with choices so you can pick activities that will work best for you.

I am asking if you would be part of my study to help me learn more.

If you agree to be in this study you will have the chance to try different ways of learning and different ways of showing your teacher what you know.

This study may be a little different from how your teacher usually teaches. Your teacher may be trying new things out.

Because it's a little different than what you are used to it may be confusing or feel a little strange at first. Your teacher will work with the whole class and with you individually to help you out if get stuck or confused.

The cool part about this study is that you will hopefully find new ways in which you can learn and new ways to show what you know.
We have let your parents know about this study and we hope that you can talk this over with your parents before you decide whether or not to do this.

We will also ask your parents if it is okay for you to be in this study. But even if your parents say "yes" you can still decide not to do this. It's your choice.

If you don't want to be in the study, you don't have to participate- it's as simple as that. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop.

You can ask any questions about the study. If you have a question later you can ask your parent/guardian to call me or ask me next time I am in your class.

_____ _____

Researcher's signature **Date**

Your statement:
This research has been explained to me. I agree to take part in this study. I have had a chance to ask questions. If I have more questions, I can ask the doctor or researcher.

_____ _____

Student Name/Response: verbal or gestural (circle one) **Date**

Copies to: Elizabeth H. Saliba

Appendix D

UDL Lesson Design Checklist

Design Components		
	0	1
Long Term Objective		
Short Term Objective		
Potential Barriers		
Learner Variability		
Instructional Methods/Materials		
Instructional Sequence		
Multiple Means of Presentation		
Multiple Means of Engagement		
Multiple Means of Expression		
Assessment Strategies		
Total: /10		%

Operational Definitions: Design

Component	Definition	Example	Non-Example
Long-Term Objective	Provides a statement that makes a connection to the skill and concept(s) for the long term learning goal	Demonstrate Understanding of spoken words, syllables, and sounds.	Phonological Awareness
Short-Term Objective	Provides a brief statement of that connects concepts to skills for the short-term learning goal.	Using a note-taking strategy and a graphic organizer as needed, students will compose a first-draft opinion piece on [topic of choice] supporting a point of view with at least two reasons.	Draft opinion writing assignment
Potential Barriers	Identifies barriers and solutions within the learning activity or	Print text: have XX student access books on tape for independent reading	Reading challenges

	curriculum based on student profiles		
Learner Variability	Identify strategies or interventions to address how to increase access, participation, and progress across a range of learners	Differentiation for struggling learners: pre-teach text (print out a copy and highlight focal words) daily before small group lesson	Pre-teaching
Instructional methods/materials	Identifies the instructional methods and materials to be used to ensure access, participation, and progress	For collaborative structures provide cards with clearly stated role and pair with visual/icon to distinguish between roles.	Collaborative grouping
Instructional Sequence	Identifies the sequence of instruction that connects to materials, methods, and checks for understanding.	Introduction of new book: Ask students to look at pictures in book. Follow with what do you think the book might be about?	New Book
Multiple Means of Presentation	Teacher makes explicit connection between checkpoint and activity or instruction	*2.1 Access to Key Vocabulary:* Sight word: decode part of word using boxes and underlines; use hearts for sound switches, etc.; introduction of new book have students take a highlighter and mark words that are unfamiliar	Use pictures and words
Multiple Means of Engagement	Teacher makes explicit connection between checkpoint and activity or instruction	*8.1 Strengthen connections between goals and objectives:* Review reading with fluency and expression how it sounds and how it feels. Provide example, ask for student volunteer. Explain that tone and pace of reading is important for comprehension	Re-read for fluency and expression
Multiple Means of Action/Expression	Teacher makes explicit connection between checkpoint and activity or instruction	*4.1 Vary physical response:* Use playdough and letter stamps to have students practice word work	Use manipulatives

Assessment	Teacher identifies methods for students to demonstrate their learning	Embed comprehension questions during small group reading to assess for understanding of text.	Ask questions.

Appendix E

UDL Checkpoint Checklist

Educator_____ Observer_____ Date/Day/Time of Observation_____ Interval Length_____

UDL Classroom Observation Checkpoints

Start Time	Representation (What of Learning)	Engagement (Why of Learning)	Action/Expression (How of Learning)
Instructional Grouping Whole Gp Sm. Gp Partner Indep. 1:1 Other Notes:	**1 Perception** Vary ways to display information (visual information: size, contrast, color, layout; Auditory information: speed, timing, amplification) Observed Evidence:_____ _____ Alternatives for Auditory Information (Text provided for spoken language, use of visual diagrams or charts, visual symbols for emphasis, provides tactile equivalents) Observed Evidence:_____ _____ Alternatives for Visual Information (Text or spoken equivalents for graphics/video/animation) Observed Evidence:_____ _____ **2 Language/Symbols** Access to key vocabulary/language (Pre-teach vocabulary & symbols, highlight components of complex words, embed vocabulary supports in text – hyperlinks, footnotes, definitions, etc.; promote connection to prior knowledge) Observed Evidence:_____ _____ Clarify lang. structure/rules (Make rules & relationships explicit, clarify links between concepts, use less complex vocabulary or language structures, etc.) Observed Evidence:_____ _____	**7 Recruiting Interest** Support choice & autonomy (Challenge levels, vary content or context for learning, choice of information tools, design of products, timing & sequence of tasks, allow students to participate in design of activities or tasks) Observed Evidence:_____ _____ Making learning relevant and valuable (Activities personalized to students' lives, socially relevant, age & ability appropriate, culturally & racially appropriate, allow for active participation, authentic & purposeful outcomes, use of self-reflection, allow for use of imagination to solve problems) Observed Evidence:_____ _____ Reduce distractions and threats (Vary novelty & risk-taking in activities & transitions-charts, calendars, schedules, visual timers, cues to alert for change/transition- increase predictability, scheduling, routines, novel events; vary sensory stimulation levels-background noise, # of items; vary pace & length of work sessions, vary social demands required for activities) Observed Evidence:_____ _____ **8 Sustaining Effort & Persistence** Strengthen connections between goals and objectives (Develop explicit goals, restate goals for clarity, clearly display goals, develop sort-term objectives for long-term goals, use prompts to visualize & clarify outcomes, etc.)	**4 Provide options for physical action** Vary physical response vary rate, timing, amplitude, range-of-motion, materials, manipulatives, & technologies, allow response alternatives from standard means (e.g. computer response vs paper & pencil), etc. Observed Evidence:_____ _____ Vary ways to interact with materials Use multiple means of navigating materials (e.g. by hand, by voice, by switch, by keyboard, etc.) Observed Evidence:_____ _____ Use of assistive technologies to access learning Determine appropriate technologies (physical, sensory, cognitive, communication) needed to access instruction, integrate training to support & enhance learning and goal achievement, etc. Observed Evidence:_____ _____ **5 Provide options for expressive skills & fluency** Vary choices for expression of knowledge Choices may include text, speech, illustration, physical models, film, video, pictures, music, art, etc. Observed Evidence:_____ _____

	Alternatives for Text (tapes, DVD, digital text, text-to-speech) Provides connections across different languages Uses non-language alternatives Present complementary representations (e.g. text with animation/graphics, etc.), link illustrations and verbal enhancements, make text-to-chart or diagram links explicit, etc. Observed Evidence:_____ _____ **3 Comprehension** Access background knowledge (Activate prior knowledge with imagery, concepts, etc., use organizers- KWL, concept maps, etc.; pre-teach concepts, "bridge" ideas with analogies & metaphors, etc.) Observed Evidence:_____ _____ Highlight essential information and "big ideas" (Emphasize key elements, use organizer, prompts & cues to identify & connect key elements, use multiple examples and non-examples, reduce extraneous elements, etc.) Observed Evidence:_____ _____ Guide information selection and processing (explicit prompts and scaffolds, develop multiple points-of-entry & pathways for content, chunk information, release information progressively, etc.) Observed Evidence:_____ _____ Support memory and knowledge transfer (Checklists, sticky notes, electronic reminders, mnemonic devices, space out reviews, organizers for note-taking, connect new information & prior knowledge, embed analogies & metaphors, etc.) Observed Evidence:_____ _____	Observed Evidence:_____ Vary levels of challenge and support (Vary difficulty in core activities, use tools & scaffolds to provide alternatives, use collaboration, vary ranges for acceptable work, emphasize process, effort & improvement, etc.) Observed Evidence:_____ _____ Support collaboration and communication with peers Cooperative learning groups, clarify roles & responsibilities, positive behavioral supports, differentiated supports, peer tutoring & support systems, connect to virtual communities, etc. Observed Evidence:_____ _____ Focus feedback on effort, practice, and mastery Encourage perseverance, self-awareness & self-efficacy, emphasize effort & improvement, give frequent, on-going, & substantive feedback, model evaluation strategies, etc. Observed Evidence:_____ _____ **9 Options for Self-Regulation** Guide and support personal goal setting Model goal-setting process, coach or mentor students in goal-setting, use prompts, rubrics, checklists, etc. to support self-regulatory goals, on-task behaviors, and self-reinforcements, etc. Observed Evidence:_____ _____ Develop individualized coping skills Use differentiated models & feedback to develop skills e.g. managing frustration, seeking emotional support, and developing internal controls, etc. Observed Evidence:_____ _____ Support self-monitoring & self-assessment Use tools & models to collect & determine own behaviors (e.g. charts, recording devices, peers, etc.), build student self- awareness (and reduce scaffolds) over time, etc. Observed Evidence:_____ _____	Vary tools for composition and problem solving (Choices may include spell checks, grammar checks, word prediction, speech-to-text software, dictation, recording, sentence starters, story webs, concept webs, outlining tools, calculators, graphing calculators, software for problem solving skills) Observed Evidence:_____ _____ Vary ways to support practice and evidence of learning Differentiated approaches, strategies, skills to achieve same outcomes, use diverse mentors to guide differentiation processes, gradual release of supports to increase independence, etc. Observed Evidence:_____ _____ **6 Provide options for Executive Functions** Guide and support goal setting Use a variety of tools (e.g. prompts, scaffolds, models, guides, checklists) to support process of individualized and appropriate goal-setting, etc. Observed Evidence:_____ _____ Support goal planning and strategy development Use "stop & think" prompts, use checklists and templates to prioritize & sequence, model "think- aloud" process, guide transition from long-term goals to short-term objectives, etc. Observed Evidence:_____ _____ Use tools to manage information and resources Keep information organized and accessible with graphic organizers, templates, embedded prompts, checklists, note-taking guides, software tools, etc. Observed Evidence:_____ _____ Enhance self-monitoring Develop self-monitoring through guided questions, frequent representations of progress, self-reflection templates, differentiated self-assessment strategies, etc. Observed Evidence:_____ _____

Note: UDL Guidelines and Checkpoints, version 2.2. retrieved from http://udlguidelines.cast.org (CAST, 2018)

Appendix F

UDL Literacy Lesson Design Template

Teacher: **Grade:** **Support:** **Date:**		
Literacy Instruction		
Long Term Objective:		
Short Term Objective:		
Potential Barriers to Curriculum		
Checks for Understanding/Assessment:		
Teaching Methods/Materials		
Learner Variability		
Learner Variability (identify strategies or interventions to address how to increase access, participation, and progress across a range of learners):		
Instructional Sequence:		
Anticipatory Set **Teacher Actions:**	**Student Actions:**	**UDL Strategies:** **Presentation** **Engagement** **Action/Expression**
Instruction		
Activity		
		UDL Strategies: **Presentation**

		Engagement **Action/Expression**
○ **Reflections:**		

Appendix G

UDL Teacher Training Procedural Fidelity Checklist

General Overview	Addressed	Not Addressed
History of UDL • Describes why CAST applied the architectural concept of Universal Design to develop means to support accessibility; • Describes how learner variability has been demonstrated through neuroscience and the alignment to UDL practices; • Connects instructional practices that address the what, why, and how of learning.		
Research and Educational Policy • Briefly reviews the empirical evidence and outlines the educational policy (IDEA, 2004; HEOA, 2008; ESSA, 2016).		
Understanding the three guiding principles, guidelines, and checkpoints • Reviewed the connection between what, why, and how-to engagement, representation, and expression; described the nine guidelines and how to develop options; • Described the 31 checkpoints which demonstrate means to achieving the guidelines; • Provided high-tech and low-tech examples of the principles in applied settings.		
Re-design		
Review Baseline Data • Discussed checkpoints observed and checkpoints not observed		
Modeled UDL Lesson Plan • Provided with a modeled UDL lesson plan		
Guided Practice • Collaborative lesson planning • Reviewed targeted principles		
Percent Agreement:		

Appendix H

Semi-Structured Interview Protocol**:** Social Validity and Implementation Factors

1. ***Thinking about learner variability….***
   - 1.1. Do you think that the UDL framework addresses learner variability? (Listen for identified learner differences- absence or presence.)
   - 1.2. Do you think that the UDL framework is an acceptable instruction framework to address learner variability? (Listen for examples in which UDL was or was not effective in reaching all learners.)
   - 1.3. Would you recommend the UDL framework to your colleagues? (Listen for negative or positive statements.)
   - 1.4. Was the UDL framework applicable to your classroom? (Listen for reaching a range of learners or a select few).
2. ***Thinking about designing and delivering literacy lesson through a UDL framework….***
   - 2.1. Did you notice a change in how your students interacted with the material? (Listen for identification of specific students; listen for whole class; listen for no change observed).
   - 2.2. Did you notice a change in how your students interacted with one another? (Listen for examples of group work, partner work).
   - 2.3. Did you notice differences in your student's participation between how you provided instruction (prior to the training) and how you changed instruction? (Listen for comments related to pre- UDL training and post-UDL implementation).
3. ***In thinking about implementing UDL literacy lessons…***
   - 3.1. If someone were to ask you about UDL, what would you say? (Listen for negative or positive based comments.)
   - 3.2. Did you feel confident implementing UDL? (Listen for: areas that were difficult or easy).
   - 3.3. How did the concept of UDL change your teaching? (Listen for: teacher reflection)
   - 3.4. In regard to UDL, what are your strengths as a teacher?
   - 3.5. In regard to UDL, what teaching skills do you need to continue working on.
   - 3.6. Can you identify a training, PD, or specific type of support to address the skills you would like to develop or continue working on? (Listen for reflection on the training received and recommendations for future training.)
   - 3.7. What aspects of UDL were the easiest to implement? (Listen for examples connected to representation, engagement, and expression.)
   - 3.8. What was the most challenging to implement? (Listen for examples connected to representation, engagement, and expression.)
   - 3.9. What did you notice about your teaching using the UDL framework? (Listen for discourse that reflects change or no change.)
   - 3.10. Will you continue to use UDL in your lesson planning for literacy?
     - 3.10.1. If not, why?
   - 3.11. Do you think you will apply UDL to other content areas? (Listen for ideas or thought that indicate reflection.)