A CASE STUDY OF THE ROLE OF UNIVERSAL DESIGN FOR LEARNING IN IMPACTING TEACHER PROFESSIONAL DEVELOPMENT AND INSTRUCTIONAL DESIGN

by

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Dedication

This dissertation is dedicated to my family.
My parents, Anne and Tom, for their unconditional love and support.
My brother and his family, Mike, Jordan, Georgie, and Theo, despite the distance, they have always encouraged and believed in me.
My sister and her family, Annette, Steve, and Anna, who have been and are a constant source of energy and strength.

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ABSTRACT

A CASE STUDY OF THE ROLE OF UNIVERSAL DESIGN FOR LEARNING IN IMPACTING TEACHER PROFESSIONAL DEVELOPMENT AND INSTRUCTIONAL DESIGN

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Educators continue to try to address the many different learning styles, disabilities, and intelligences of the students who enter their classroom. With each new year, the ask of our teachers becomes greater. Consequently, designing instruction from the start that addresses the many differences found in a classroom is a challenge for educators. Therefore, professional development centered around creating a flexible learning environment that reaches many types of learners has become the new expectation. The purpose of this mixed method case study was to understand the impact of professional development using the Universal Design for Learning framework on changing teacher practices, and thereby increasing perceived student engagement at three local middle schools.

The findings of this study were analyzed through the lens of four data sources: Teacher Focus Groups, Teacher Lesson Plans, Teacher Formative Assessments - Understanding the Role of Lesson Design, and the Technology Usage Perception Survey. My study revealed the challenges that teachers had with identifying students' unique learning needs and shows the importance of schools having a systemic learning

framework. Teachers understood the importance of student engagement and good instructional design; however, designing the lessons to create a learner-centered classroom required them to completely rethink their lesson design process. This study concludes with recommendations for redesigning professional development, job embedded coaching, and systemic implementation of the UDL framework within a school district.

Keywords: Universal Design for Learning, teacher professional development, design thinking, lesson design, flexible learning, instructional design, systems thinking

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CHAPTER ONE

INTRODUCTION

Background

Designing instruction that meets the needs of all learners has become the ask of the classroom teacher. Now more than ever, there is greater access to digital technologies, mobile devices, and other technological advantages to support individualizing instruction for all students. Yet, educators still face challenges with designing curriculum and assessments that meet the needs of all learners (Rose and Meyer, 2002). We also ask teachers to be expert learners themselves, knowing that each teacher is continuously growing and changing (Rose, Meyer, & Gordon 2014). Designing instruction for large groups of students in one classroom was and is a design challenge. The most common approach has been to teach to the average. However, we know there is no such thing as the "average" student (Rose, Meyer, & Gordon 2014). Therefore, understanding and designing instruction from the start to address learner variability is the new challenge for educators. Professional development centered around creating a flexible learning environment that reaches many types of learners has become an expectation. Furthermore, in a time when high stakes testing can make or break a school district, educators need guidance and tools that help them critique whether the learning and teaching processes being used are achieving the intended learning outcomes. The importance of pedagogical design has never been more critical; consequently, there is simply no escaping the need to adopt a theory of learning (Mayes and de Freitas, 2004). Educators need to have a framework for teaching and learning that provides opportunities

for customization. Learners are not passive individuals, they are active participants who build content, knowledge, and skills through their experiences.

Students should not be "boxed" into a certain learning type, but rather assimilate their learning based upon a more learner centered approach to their education. As Rose, Meyer, & Gordon (2014) note:

> We are steadily moving away from the vision of the normal curve, where "average students" can be counted upon to experience curriculum and to act in an "average" way. We now know that variability is the rule both within and between all individuals. (p. 45)

Many teachers have been constrained by the four walls of the classroom and a teacher-directed instructional model. The data indicate that most teachers are placing a significant majority of classroom emphasis (47%) on teacher-centered instruction that can be generally categorized as lecture, practice, and review (Marzano and Toth, 2014). Klem and Connell (2004) have reported that "by high school as many as 40% to 60% of students become chronically disengaged from school – urban, suburban, and rural – not counting those who already dropped out" (p. 262). We know that each student comes to the classroom with unique learning needs and has different ways in which he/she is engaged in learning. Teachers need a framework to improve pedagogy within the classroom. This case study will examine the impact of teacher professional development when implementing Universal Design for Learning principles/framework to change teacher practices and improve perceived student engagement.

In an effort to design curriculum from the start or be adapted after implementation, many educators have applied the Universal Design for Learning (UDL) framework for designing curriculum, materials, and content. The theoretical framework behind

Universal Design for Learning comes from the design principles found in architecture and the research applied from behavioral, cognitive, constructivist, and social learning theories.

Defining Universal Design for Learning

As defined by researchers at CAST, the "universal" in Universal Design for Learning (UDL) does not mean one perfect solution for everyone, but instead points out the need for inherently flexible, customizable content, assignments and activities, and assessments. UDL is a set of principles for designing curriculum that provides all individuals with equal opportunities to learn (Rose & Meyer, 2002, Preface). The Center for Applied Special Technology (CAST) defines Universal Design for Learning as an educational approach with three primary principles:

- Multiple means of representation, to give diverse learners options for acquiring information and knowledge,
- Multiple means of action and expression, to provide learners options for demonstrating what they know,
- Multiple means of engagement, to tap into learners' interests, offer appropriate challenges, and increase motivation. (Rose and Meyer, 2002, p.75)

Furthermore, with advanced technology comes the leverage educators need to access the multiple means of representation, expression, and engagement.

As Edyburn (2010) noted:

> The reason why UDL is possible today as opposed to the 1950s or 1970s is that digital technologies provide a high degree of flexibility. Paper-based instructional technologies (e.g., worksheets, textbooks) commit information to fixed formats and cannot match the array and flexibility of supports provided in a digital environment (e.g., alter the font size, color contrast, text to speech, hyperlinks for explanatory aids, agents that offer strategy suggestions, movies that supplement text. (p.7)

In the past, designing instruction that met these three principles effectively had been a challenge. Educators did not have easy access or even the ability to provide their students with multiple means of representation, expression, and engagement. However, the internet and low-cost technologies are enabling schools to rethink their instructional design. By understanding behavioral, cognitive, constructivist, and social learning theories, teachers are now building lessons that embed numerous opportunities for students to receive the content in multiple formats, show what they know in different ways, and experience higher levels of engagement by leveraging the 21st century technologies. Not only do the learning theories play a critical role in this redesign effort, but also key theoretical frameworks from architect provide the foundations for understanding Universal Design for Learning.

Universal Design for Learning and Architectural Theory

Universal Design for Learning has borrowed upon the design theories from architecture, specifically the work of Ron Mace at North Carolina State University. Mace (Center for Universal Design 1997) stated that, "the idea behind universal design in architecture is to create structures that are conceived, designed, and constructed to accommodate the widest spectrum of users, including those with disabilities, without the need for subsequent adoption or specialized design" (as cited in Rose and Meyer, 2002, p.70). The seven principles that guide universal design include:

> PRINCIPLE ONE: Equitable Use
> The design is useful and marketable to people with diverse abilities.
> PRINCIPLE TWO: Flexibility in Use
> The design accommodates a wide range of individual preferences and abilities.
> PRINCIPLE THREE: Simple and Intuitive Use
> Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

> PRINCIPLE FOUR: Perceptible Information
> The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
> PRINCIPLE FIVE: Tolerance for Error
> The design minimizes hazards and the adverse consequences of accidental or unintended actions.
> PRINCIPLE SIX: Low Physical Effort
> The design can be used efficiently and comfortably and with a minimum of fatigue.
> PRINCIPLE SEVEN: Size and Space for Approach and Use
> Appropriate size and space is provided for approach, reach, manipulation, and use regardless of the user's body size, posture, or mobility. (Story, Mueller, & Mace, 2008)

Everyone benefits from curb cuts, automatic doors, and escalators. The design is flexible enough to meet the varied needs of many different types of people. Similarly, the UDL framework provides an opportunity for educators to rethink the goals, methods, assessments, and materials used in classroom instruction so that the needs of different students can be met with that same flexibility. While universal design focuses on architecture and building products, universal design for learning focuses on actual learning.

Rose and Meyer (2002) extended the principles of architecture and applied the same standards to learning, thereby, creating a framework for UDL. These three principles were identified:

> ***Multiple means of representation***, to give diverse learners options for acquiring information and knowledge;
> ***Multiple means of action and expression***, to provide learners options for demonstrating what they know;
> ***Multiple means of engagement***, to tap into learners' interests, offer appropriate challenges, and increase motivation. (Rose & Meyer, 2002, p.75)

The above framework shares one common similarity: providing all students with options and increased student engagement (Rose & Meyer, 2002, p. 74). Also, this framework

becomes the outline for UDL implementation. Since 2002, these three principles have continued to evolve. The changes reflect recent research on the learning brain, significant developments in technology, and experiences in classrooms. Rose, Meyer, & Gordon, (2014) with input from the field:

> has also expanded the three principles by developing nine guidelines, each with multiple checkpoints offering specific approaches to implementation. These checkpoints are researched and applied in classrooms around the world, and this information is helping us refine and enhance the framework. Those guidelines became a foundational piece for much of the further theoretical research being done in the area of UDL. (p. 4)

This is reflective of learning being less about knowledge acquisition and more about students becoming expert learners.

Over the past 20 years, the three core principles of the UDL framework articulate the basic UDL premise: to provide equitable opportunities, to reach high standards and meet the needs of all learners. What continues to remain dynamic is the theory and practice of UDL, changes in the environment of UDL, and changes in the media used to convey UDL (Rose, Meyer, & Gordon, 2014, p.4). UDL is a process, just like learning that continues over time.

Behavioral Learning Theory

Definition

Student attitude and engagement plays an important role in learning, and when students are actively engaged in their learning, they are more likely to own that learning. When people like something, they typically react in a positive way, in contrast when they don't like something, they may react negatively. (Syomwene, 2013). Kochhar (1992) states that the child's readiness to learn is determined by his/her attitudes to school and

school subjects. Attitudes are defined as the predispositions that individuals have toward something. Behavioral learning theory involves adjustments or modifications in behavior, and it emphasizes the learners' active engagement, reinforcements and rewards that encourage continuing effort over time (Ornstein, Behar-Horenstein, and Pajak, 2003). Behaviorists believe that the environment influences what one learns. Therefore, the way in which educators design the learning environment, both physically and emotionally, can impact student learning and the attitude that the student has toward the learning. According to Katz (2013), "Students are said to be academically engaged when they demonstrate engaged behaviors" (p.160). By designing lessons with multiple opportunities for students to connect actively with their learning, academic experiences for students become richer and improve student achievement.

Access to technologies allow teachers to design opportunities and different styles of engagement to students since the learning is no longer restricted just to the inside of the classroom. The learning environment is far more personalized and designed to meet the students' individual learning preferences and attitudes rather than targeting the middle of the group. One aspect of personalization is allowing for the learner to "have the option to choose learning content based on their interest" (Al-Hmouz et al., 2010); with access to technology and the internet, both the student and teacher can change the look and feel of the content (Stanton and Ophoff, 2013) thereby customizing the environment to influence student learning and achievement.

Main Theorists

The proponents of behavioral learning theories include Thorndike and Skinner. Thorndike (1931) believed that there is a relationship between the environmental

stimulus in a learning situation and the response to such stimulus and that repeated connection or pairing of the environmental stimulus and the response embeds the skill so learned in the learner's mind. Thorndike established the importance that practice improves student learning. Behaviorists believe that reinforcement, both positive and negative, play a key role in the learning process. In Skinner's research, (1972) cited in Parkay and Hass (2000), he concluded, "that pleasant experiences (such as rewards or praise) are positive reinforcers. They cause learners to make desired connections between stimuli and responses. Also, unpleasant experiences (such as punishment) are negative reinforcers. They cause learners to avoid undesirable responses to stimuli" (Syomwene, 2013, p. 175). Furthermore, constant reinforcement increases the rate of learning. Teacher's use of praise in the classroom reinforces learners (Wiles, 2005; Ornstein, Behar-Horenstein and Pajak, 2003).

Therefore, student engagement becomes a critical component in designing lessons that provide students with different opportunities to experience and explore the content through multiple experiences. Students need choice and different experiences as they begin to learn about a concept or skill, and the experience the teacher provides the student to learn this content can greatly impact the results of student achievement. Rodriguez (2013) pointed out that "complex teaching is not a one-way street but an interactive human behavior. A teacher has to sense all the factors that may affect the learning interaction and compare them to all the feedback contributed by students and themselves" (p.9). The teacher must be able to react to the data collected regarding student learning and design or redesign instruction to meet the changing needs of the many learners in the

classroom. By leveraging technology, teachers are able to manage these needs and react to the changing behaviors of the classroom.

Main Beliefs

According to Syomwene (2013), “curriculum planners should understand the influence of the learners’ past experiences, attitudes, and values in order to plan and provide appropriate curriculum experiences for specific groups of learners" (p. 176). Based upon the thinking of behaviorists, teachers should connect learning to positive past experiences; therefore, the rate of learning should increase. The belief that the physical and emotional environments play a key role in learning provides educators with important insights to designing a positive learning environment within the classroom.

Leveraging the physical and emotional environment to impact learning has been a challenge. Now, with mobile learning devices and technology, educators “are able to move beyond the classroom, both taking the classroom with them while being removed from that context” (Stanton and Ophoff, 2013, p. 509). Teachers can design an educational environment that caters to the learning style of the student. Within this learning environment, designers and teachers have great influence over the student learning since they are able to point students to the right environment that can lend to the students’ strength and positive learning environment.

Applications to Universal Design for Learning

One of the key tenets of Universal Design for Learning is multiple means of engagement. Teachers who are able to tap into the learner’s interest and offer appropriate challenges can increase the motivation of the student in his/her learning (Rose and Meyer, 2002). Teachers who are able to connect positive past experiences and utilize

praise in their lesson design are able to increase student engagement within the lesson. Yet every student brings a different set of values, experiences, and attitudes to the classroom. Therefore, leveraging new technologies to capture these many differences that students bring to the classroom environment are critical. Teachers are at an advantage when they use principles of good design to better understand the student's readiness to learn. If teachers are able to pinpoint each child's attitude to school and interest in the subject, they are able to make adjustments not only to optimize the external learning environment, but also modify student behavior to maximize achievement.

Bringing in the learner's personal context within a situational context brings a different perspective into a student's educational experience. The learning becomes personalized to the student since the environment is customized to create an experience that is positive and engaging. The instruction is purposefully designed to lead to active learning, and it encourages the learner to take responsibility for his/her learning. In creating a Universal Design for Learning environment, student engagement is a key pillar. Therefore, the opportunity to personalize the environment to provide maximum student engagement becomes crucial when designing student instruction.

Social Learning Theory

Definition

Not only do students need to experience success at their target-learning zone, they need to have learning experiences with other students in a social context. According to social learning theory, behavior is learned before it is performed (Bandura, 1971). The observation identificatory event (the occurrence of similarity between the behavior of a model and another person under conditions where the model's behavior has served as the

determinative cue for the matching responses) plays a major role in student learning (Bandura, 1971). This identification process continues over time, as Bandura (1971) states, "new responses are acquired and existing repertoires of behavior are modified in some extent as a function of both direct and vicarious experiences with a wide variety of actual or symbolic models, whose attitude, values, and social responses are exemplified behaviorally, or in verbally coded forms" (p. 255). Therefore, educators understanding the importance of providing an identificatory event that clearly illustrates the expected learning target can support student learning.

On a theoretical level, students who are socially engaged, typically interact positively with their peers, have a positive self-image, and feel a sense of belonging in the classroom (Katz, 2013). Katz and Porath (2011) define *Social and Emotional Learning*, as building compassionate learning communities. This type of learning is modeled in the classroom both by the student and the teacher, and it is learned before it is performed. Teachers who strategically build opportunities for students to be highly engaged at school, learn more, get higher grades, and more often pursue higher education (Park, Holloway, Arendtsz, Bempechat, and Li, 2012). Consequently, giving students opportunities to develop their social and academic engagement in diverse, inclusive classrooms from K-12 is critical (Katz, 2013).

Main Theorists

Albert Bandura is one of the main theorists in Social Learning Theory. Bandura (1971) believed that behavior was learned through modeling. Under this premise, the modeling phenomena is governed by four interrelated sub-processes (Bandura, 1971):

Table 2.1: Bandura's Modeling Process

Process	Definition
Attention process	A person cannot learn much by observation if he does not attend to or recognize the essential features of the model's behavior.
Retention process	A person cannot be much influenced by observation of a model's behavior if he has no memory of it.
Motoric reproduction processes	To achieve behavioral reproduction, a learner must put together a given set of responses according to the model patterns.
Reinforcement and motivational processes.	A person can acquire, retain, and possess the capabilities for skillful execution of modeled behavior, but the learner may rarely be activated into overt performance if it is negatively sanctioned or unfavorably received.

These processes that Bandura describes will not automatically create certain patterns of behavior. However, his identification and belief in these sub-processes help the teacher understand the critical elements that are needed for modeling to occur within the relevant activity.

Main Beliefs

Social learning theorists believe that behavior is learned before it happens. As Bandura (1971) notes, "Man's capacity to learn by observation enables him to acquire large, integrated units of behavior by example without having to build up the patterns gradually by tedious trial and error" (p.2). Every day students learn from their peers, teachers, and community members. Therefore, even the best-designed curriculum must take into consideration the social aspect of learning. Learning is social, but it also requires motivation.

In addition, Bandura's self-efficacy theory focuses on expectancy for success. Bandura distinguished:

> between two kinds of expectancy beliefs: *outcome expectations* - beliefs that certain behaviors will lead to certain outcomes (e.g., the belief that practicing will improve one's performance) - and *efficacy expectations* - beliefs about whether one can effectively perform the behaviors necessary to produce the outcome (e.g., "I can practice sufficiently hard to win the next tennis match"). (Eccles and Wigfield, 2002, p. 111)

These two kinds of expectancies beliefs can impact student learning and motivation. Both the teacher and the student need to have self-efficacy for their learning. Student efficacy influences their goal setting, activity choice, effort, and determination (Eccles and Wigfield, 2002). Designing instruction that takes into consideration student efficacy can provide opportunities for increased engagement and sustained student interest and persistence.

Application to Universal Design for Learning

One of the major reasons that Universal Design for Learning is becoming more of an educational reality is the vast and ever improving technologies that are continually changing and improving the learning environment. Educators have easy access to tools that allow students to access information and content in a far more efficient and seamless manner. Much of this learning now occurs online and through video content. Gaming and internet resources are highly interactive, and the social interaction students now have with learning has added a new dynamic to the classroom. Universal Design for Learning capitalizes on the opportunity technology provides students to engage and collaborate with other learners on a whole new level. As Stanton and Ophoff (2013) illustrate, technology allows for, "a social platform that creates environments for communication,

understanding, and transfer of information. Its ability to cater to varying learning styles through various features, its link to communication and its social context make it a very attractive tool for learning" (p.9). Students are naturally drawn to the personalization and interaction it provides. However, it is important that this type of learning exists within the parameters of a learning framework, and the principles of Universal Design for Learning can guide the design of not only the learning, but also support the social context of the new learning environment.

Thereby, social learning theories have a major impact on how students gather and process content. Learning does not just occur from simply obtaining information from one source. Instead, it is perceived as the product of individual experience as constructed from immersion in a culture (Schenker & Scadden, 2002). As Myhill (2007) states, "The ability to create a knowledge structure, to define problems, and locate needed information to address those problems are more valuable skills for students than learning a static database of information. The teacher is no longer the repository and source of information" (p. 10). Student learning is not just about obtaining and filing information, but rather how that information is used within the learning environment.

Cognitive Psychology

Definition

Clearly, the external learning environment plays a critical role in a student's learning process. However, the internal thinking of the student is just as important to understand when designing good instruction. Cognitive psychologists focus on uncovering and measuring the internal cognitive processes of the individual (Brown, 2007.) This provides useful information for teachers as they attempt to design lessons. Rollins-Hines and

Runnels (2009) note, “accessing multiple cognitive levels is a necessity if students are to gain true understanding of what they are learning in the classroom” (p. 51). Cognitive psychologists define brain processes using input, storage, and retrieval processes. This is similar to the way one might describe a computer’s “thought” process (Brown, 2007). Using this model, cognitive psychologists can predict, describe, and explain the thinking occurring within the brain.

Main Theorist

One of the main theorists in cognitive psychology was Swiss developmental psychologist Jean Piaget. Piaget's approach is key to the school of cognitive theory known as "cognitive constructivism." Piaget (1969) proposed “that children's thinking does not develop entirely smoothly; instead, there are certain points at which it ‘takes off’ and moves into completely new areas and capabilities” (Atherton, 2011). Piaget (1969) developed the stages of cognitive development and designed the four stages through which all learners move. Piaget’s work has impacted the way in which school curriculum has been developed with regards to grade levels and course content. His child-centered approach considered both age as well as the importance of social interactions in a child’s development (Atherton, 2011). He did not simply consider age, but rather looked at stages of child development.

Main Beliefs

Some educators have taken Piaget’s work to mean that before these ages, students are not capable (no matter how smart) of learning things in certain ways, and it has been used as the basis for scheduling the school curriculum (Atherton 2011). However, even though Piaget “suggested age stages, he measured the highest level of intellectual function by

Table 2.2: Piaget's Stages of Cognitive Development

Stage	Characterized by
Sensori-motor (Birth-2 yrs)	Differentiates self from objects
	Recognizes self as agent of action and begins to act intentionally: e.g. pulls a string to set mobile in motion or shakes a rattle to make a noise
	Achieves object permanence: realizes that things continue to exist even when no longer present to the sense (pace Bishop Berkeley)
Pre-operational (2-7 years)	Learns to use language and to represent objects by images and words
	Thinking is still egocentric: has difficulty taking the viewpoint of others
	Classifies objects by a single feature: e.g. groups together all the red blocks regardless of shape or all the square blocks regardless of color
Concrete operational (7-11 years)	Can think logically about objects and events
	Achieves conservation of number (age 6), mass (age 7), and weight (age 9)
	Classifies objects according to several features and can order them in series along a single dimension such as size.
Formal operational (11 years and up)	Can think logically about abstract propositions and test hypotheses systematically
	Becomes concerned with the hypothetical, the future, and ideological problems

what a child was in and not by chronological age" (Garguilo and Metcalf, 2010, p.186). Instruction should be designed to meet the child where he/she is in his/her learning and not be age-based.

Select terms from cognitive psychology play a key role in designing instruction that would be considered effective universally designed lessons. The key terms that can be considered are illustrated in the table below:

Table 2.3: Select Terms and Themes of Cognitive Psychology

Term	Definition
Chunking	knowledge made up of smaller pieces of information
Gestalt psychology	the idea that cognitions involve active, rather than passive, processing of information
Rehearsal	processing involves the repetition of material that has already been analyzed
Schema	a building block of knowledge about people, events, and the world that is stored in long-term memory
Semantics	links between meaningful concepts

Note: From "Cognitive Psychology" by C. Brown, 2007. Copyright 2007 by Sage Publications, Ltd.

These terms reflect specific strategies and tasks that teachers use in the classroom to design instruction, and they also are methods used to meet the needs of individual student learning styles. The teacher uses these critical elements to design lessons of instruction that can meet the needs of the various learners within the classroom. The learners need to understand clearly the learning target, and the teacher's method of *chunking* information provides various ways for the students to retrieve the knowledge for application. Through the critical element of *gestalt psychology,* the learners actively engage in processing the information. Multiple means of engagement can occur through tapping a

student's prior knowledge and by strategically connecting a student's *schema* to the content. By making meaningful connections to other concepts related to the material, the teacher uses *semantics* to link information together. Lastly, the teacher designs lessons that allow for *rehearsal* so that a student has multiple opportunities to practice applying the information.

Using multiple means of action and expression to provide learners options for demonstrating what they know is a key requirement of the task creation process. As Leigton and Gokiert (2005) state, "it is the continual investigation of how students think about and respond to specific task features" (p. 13). Students need multiple opportunities and methods to practice the above terms. In researching, modern theories of the brain and cognitive science stress the process over content. Dolan (2013) provides the following example:

> Whereas memory was formerly conceived in terms of physical objects or content (a bucket or long-term storage device where there are memory traces), memory is now understood much more dynamically as a process—or more accurately processes—by which the brain changes itself. The same areas of the brain responsible for perception are the ones responsible for memory; these two functions share the same processes and the same anatomy. (p.25)

Universal Design for Learning, therefore, becomes a powerful approach to teaching and learning since it provides a framework toward understanding instruction and the processes that students use to understand, strategize, and evaluate tasks (Dolan 2013). Understanding the way in which the brain processes information provides insight into designing activities that allow for a strategic process for learning and processing content.

Applications to Universal Design for Learning

Universal Design for Learning integrates the stages of cognitive development as part of the multiple options for demonstrating learning. For example, in the sensorimotor stage, Piaget describes that using sensory motor activities to receive information is important. At this age, a child traditionally begins to repeat, name, and recall objects from the environment. This fits with the recognition system of Universal Design for Learning (Garguilo and Metcalf, 2010).

In addition, as Rollins-Hines and Runnels (2009) state, "The Theory of Cognitive Psychology has no better practical match than that of Universal Design for Learning. As a theoretical perspective that focuses on human perception, thought, and memory as they pertain to learning, cognitive psychology recognizes that learners construct knowledge" (p. 55). Every day teachers watch, evaluate, and adjust to meet the needs of their students. This type of instruction and approach to learning changes the role of the teacher. Rollins-Hines and Runnels (2009) illustrate:

> As teachers access the students' prior knowledge and experiences, universal design provides an opportunity for each student to benefit from and contribute to the lesson in an individualized, though equally meaningful way. Teachers then observe, coach, and facilitate learning. This differs greatly from the teacher-dominated perspective that simply transmits knowledge to students. (p. 55)

The role of the teacher is not to transfer knowledge, but rather, assess what the student brings to the learning and guide the learning process. Understanding these frameworks allows "for teachers to access diverse learning styles in ways that allow students who learn differently to retain their dignity and contribute positively to their own and others' learning" (Rollins-Hines and Runnels, 2009, p. 56). In addition, these frameworks

provide foundational theoretical knowledge for understanding the principles of Universal Design for Learning and are a part of the Constructivist Learning Theory.

Constructivist Learning Theory

Definition

Constructivism theory proposes that "knowledge is being actively constructed by the individual and knowing is an adaptive process, which organizes the individual's experiential world" (Mayer, 1992, p. 406). Not only knowing what knowledge the learner brings to the content, but understanding the way in which students learn best, provides teachers a place to begin when designing instruction. Constructivist teachers see learning as an active process, and students construct their understanding of knowledge. Technology plays a role in the learning since the teachers are acting as guiding partners (Keengwe, Pearson, and Smart, 2009). This type of active learning is intended to give students multiple tracks to meet the learning target. The teacher often works as a guide or coach to assist and facilitate student learning. However, the design of the pedagogy and practice is fundamental to the success of a constructivist approach to learning.

Main Theorists

Lev Vvgotsky was a Soviet educational psychologist (1896-1934) whose research and theory pointed to new ideas of how children can learn (Carter 2005). One of Vygotsky's important ideas was 'the Zone of Proximal Development' (Vygotsky 1978). According to Carter (2005):

> Educators have been (and are even more so now) interested in what pupils can achieve. In an effort to 'measure' this achievement objectively it has always been assumed that the most important aspect of that measurement is that which the pupil can do completely independently. It is obvious that pupils can generally perform above this level if they work with the teacher or another (sometimes, but

> not always) more able pupil. The difference between these two levels Vygotsky called the ZPD. Now this difference of levels must be obvious to any teacher, but what Vygotsky pointed out was that this difference or zone is vitally important. It is important because it points the way to the course future learning should take. (p.9)

The Zone of Proximal Development is often different for each student in a classroom. To this day, educators try to meet the needs of the various students in the classroom knowing that it is vital to reach students at the correct ZPD, but they also realize the challenge of trying to diversify instruction with limited resources.

Main Beliefs

One of the major goals in constructivism is providing learners with a rich learning environment (Lefoe 1998). Reeves (1994) states, "emphasis is placed on identifying the unique interests, styles, motivations, and capabilities of individual learners so that learning environments can be tailored to them. Instead of an empty vessel, the learner is regarded as an individual replete with pre-existing knowledge, aptitudes, motivations, and other characteristics that are difficult to assess, much less accommodate." Constructivists believe that the learning environment needs to be reflective of the needs of the individual learner. In addition, students are not just learning content from the technology but rather the technology is supporting thinking in a meaningful way (Keengwe, Pearson, and Smart, 2009).

Applications to Universal Design for Learning

The core UDL principles of multiple means of representation, expression, and engagement come from studying the human brain. Rose and Meyer (2002) describe the learning brain as having three networks: recognition, strategic, and affective. The activities of these networks "parallel the work the three prerequisites for learning

described by the Russian psychologist Lev Vygotsky (1962): recognition of the information to be learned; application of strategies to process that information; and engagement with the learning task" (Rose and Meyer, 2002, p. 12).

Concisely put:

> *Recognition networks* are specialized to sense and assign meaning to patterns we see; they enable us to identify and understand information, ideas, and concepts. *Strategic networks* are specialized to generate and oversee mental and motor patterns. They enable us to plan, execute, and monitor actions and skills. *Affective networks* are specialized to evaluate patterns and assign them emotional significance; they enable us to engage with tasks and learning and with the world around us. (p. 12-13)

With the understanding that learning occurs through the interconnectedness of all three networks, learners have degrees of strengths and weaknesses. Students are also deeply connected to learning by their level of emotional engagement. Through the appreciation of the three networks, educators can begin to design instruction that meets the needs of the complex learner brain. Moreover, this correlates with Vygotsky's learning theory. As Jarimillo (1996) states: "Vygotsky noted that individuals interact with one another in social situations to socially negotiate meaning. To learn, he emphasized the importance of problem solving in this process, which was reflected in his notion of learning by doing" (p. 133). The UDL framework provides opportunities for students to problem solve and learn to make meaning at the appropriate level. The multiple opportunities for representation, expression, and engagement allow for a variety of student interactions in the classroom and different learning opportunities to create meaning of new content.

The more strategic a teacher can be in the classroom, the better opportunities for increased student learning and engagement. As Kameenui and Carnine (1998) note, "The importance of designing educational strategies to match students' zone of proximal

development is critical to ensuring that students benefit from instruction and that the instructional experiences enhance the student's self-esteem" (p. 109). When students feel good about their learning and experience success, they are much more likely to maintain engagement. However, educators need to develop a curriculum that is flexible enough to meet the many different students' zone of proximal development.

Statement of Purpose

Examining the theoretical frameworks of Universal Design for Learning illustrates the enormous need for change to occur in teacher instructional practice. Educators continue to implement and explore areas of best practice to improve student achievement. For that reason, in order to best understand the impact of Universal Design for Learning, it is critical not only to understand but also implement these learning theories into instructional design, classroom application, and teacher professional development. By applying the theoretical framework behind Universal Design for Learning from the design principles found in architecture and the research applied from behavioral, cognitive, constructivist, and social learning theories, teachers can continue to play a significant role in education. Technology should allow educators to have the ability to harness 21st Century technologies in a much more efficient manner and be able to apply the theories of student learning in a systematic and seamless design practice.

By training teachers in a more student-centered approach, the teacher's role begins to change. Each student comes to the classroom with unique learning needs and has different ways in which he/she is engaged in learning. Consequently, designing instruction that addresses the many differences found in a classroom with limited resources remains the challenge. The principles of Universal Design maximize

instructional resources to benefit all students. As defined by Rose and Meyer (2002), the "universal" in Universal Design for Learning (UDL) does not mean one perfect solution for everyone, but instead points out the need for inherently flexible, customizable content, assignments and activities, and assessments.

Research Question

This was an explanatory case study that addresses the question: How does the implementation of the Universal Design for Learning Professional Development Framework impact changes in teacher practices and increases in perceived student engagement at three local middle schools?

Explanation of the Case Study

This type of case study is being used to answer a question that sought to explain the presumed causal links in real-life interventions that are too complex for the survey or experimental strategies. In evaluation language, the explanations would link program implementation with program effects (Yin, 2003). The case study examines a specific group of teachers (by grade level and content area). Using a specific district where the teachers experienced a specific professional development around the framework and practices of Universal Design for Learning binds the study. Teachers experienced a Blended Model of Professional Development:

- Face to Face Professional Development
- Online Professional Development

Teachers experienced the Online Learning Modules by Topic: http://e3t.org/on-line-modules.html.

Significance of Study

Teacher reliance on traditional teaching methods such as lecture and textbooks have a significant impact on student self-efficacy (Klem & Connell, 2004). Oftentimes, school is the only place students are compelled to learn information in such a low-tech, passive manner. The research at the Learning Sciences Marzano Center, completed an analysis on specific classroom instructional strategies, indicates that even today, with the increased focus on rigor and technology, the great majority of teachers still devote the highest frequency of classroom instruction to introducing and practicing new knowledge, activities which are at the lower levels of Bloom's (1956), Webb's (2002), and Marzano's (2001) taxonomies of educational objectives (Marzano and Toth, 2014).

This case study raises several questions that are relevant for subsequent research; namely, to examine which traditional teaching methods are most harmful and which best enhance student self-efficacy. Strategically collecting data not only on technology delivery but perceptions of use and the impact that technology has on the learning environment could be useful. Likewise, it also would be valuable to examine the effects of traditional teaching methods on other academic indicators such as student achievement, advanced course selection, and degree attainment. Lastly, an investigation into what factors lead teachers to rely heavily on traditional teaching methods would be important to ascertain what part of teacher preparation needs to be reformed. Macomb's E3T project holds potential for changing teacher instructional practice as well as increasing student achievement. This case study could possibly demonstrate that Universal Design for Learning professional development can change teacher practice and improve student engagement towards school.

CHAPTER 2

LITERATURE REVIEW

Theoretical Framework

Educators continue to implement and explore areas of best practice to improve student achievement and engagement. Every year, as part of the recertification process, professional development is required for teachers to retain a teaching certificate. The type and focus of professional development a teacher selects varies from district to district each year, just as the long-term impact of the professional development on both teachers and students varies. John Hattie shares, "…supportive and great systems are needed to support and nurture great leaders" (Hattie, 2015 p. 29). Therefore, having a framework and system for teaching and learning can provide a clear roadmap for quality instruction. Clearly articulating that framework of teaching and learning to all stakeholders is critical. Universal Design for Learning is one framework that provides a way of thinking about teaching and learning. This framework provides a flexible design structure where learners are able to access material, engage with it, and show what they know in a variety of ways. The framework can also be applied to professional development. Educators need the same opportunities for choice and voice in their learning thereby embedding the new practices into their lesson design framework. For the purpose of this literature review, understanding the literature that discusses the **Universal Design for Learning framework and theory** was essential as it provides the foundation for **UDL professional development and classroom implementation**.

Keyword searches were conducted using the words: universal design for learning, teacher professional development, self-efficacy, design thinking, instructional technology, and CAST (Center for Applied Special Technology). Leveraging Oakland University's library databases, I was able to access both peer reviewed and open-source resources. I first started my research using Oakland University's OneSearch database to begin my literature review. Specifically, the JSTOR database provided extensive research using the keyword search of universal design for learning. Initially articles were reviewed to include post-secondary UDL studies. Searches were then narrowed to specifically examining research articles that focused on secondary and K-12 education. The literature was then organized by major themes: (1) UDL theory and definition, (2) UDL and professional development and (3) UDL classroom implementation and teacher self-efficacy.

Theory and Definition of Universal Design for Learning

Founded in 1984 as the Center for Applied Special Technology, CAST is a nonprofit research and development organization that works to expand learning opportunities for all individuals, especially those with disabilities, through Universal Design for Learning. CAST partners with colleges and universities, corporations, government agencies, national and regional organizations, and international organizations. CAST collects and posts many research articles from the National Center on Accessing the General Curriculum that presents data that supports strategies and tools for implementing Universal Design for Learning (Center for Applied Special Technology, Web Site). As Stage and Manning noted, research of previous work and "published studies conducted on similar topics to the research question provide a wealth of information about methods

and techniques used to get results and answers to research questions" (2003, p. 29), and they are resources that will not only support UDL research, but they also offer ideas in how to collect data and find further research.

Consequently, the partnerships built as a result of CAST provided a starting point of resources to narrow the literature review. In examining the many publications and articles found on the CAST website, a consistent list of key researchers and educators who wrote about Universal Design for Learning and Differentiating Instruction became evident, and those authors became a basis for the literature review. One of the most critical texts CAST provided includes Rose and Meyer's (2002) book *Teaching Every Student in the Digital Age: Universal Design for Learning*. This book has become the underpinning for the work CAST does on Universal Design for Learning. This source illustrates the concept of Universal Design for Learning to utilize 21st technologies and addresses the practical application of UDL in the classroom. Published by the ASCD (Association for Supervision and Curriculum Development). Rose and Meyer's text supplies the initial foundation of literature that studied the scientific research, definition, and wide-scale implementation of UDL.

Rose and Meyer (2002) convey the theory and concept behind Universal Design for Learning. In Chapter 2, "What Brain Research Tells Us about Learner Differences," Rose and Meyer present the research foundation for Universal Design for Learning. By studying the human brain, connections can be made between the classroom and science. Rose and Meyer describe the learning brain as having three networks: recognition, strategic, and affective. The activities of these networks "parallel the work the three prerequisites for learning described by the Russian psychologist Lev Vygotsky (1962):

recognition of the information to be learned; application of strategies to process that information; and engagement with the learning task" (Rose & Meyer, 2002, p. 12). Concisely put:

> *Recognition networks* are specialized to sense and assign meaning to patterns we see; they enable us to identify and understand information, ideas, and concepts. *Strategic networks* are specialized to generate and oversee mental and motor patterns. They enable us to plan, execute, and monitor actions and skills. *Affective networks* are specialized to evaluate patterns and assign them emotional significance; they enable us to engage with tasks and learning and with the world around us. (p. 12-13)

With the understanding that learning occurs through the interconnectedness of all three networks, learners have degrees of strengths and weaknesses. Through the appreciation of the three networks, educators can begin to design instruction that meets the needs of the complex learning brain.

Over time, the work of Rose and Meyer continues to grow, and the book *Universal Design for Learning: Theory & Practice* (2014) provides a modern lens of how these three networks are influenced by neuroscience: "instead of seeing the brain as a collection of discrete structures with specific functions, modern neuroscience views the brain as a complex web of integrated and overlapping networks. And learning is seen as changes in the connections within and between these networks" (Rose, Meyer, & Gordon, 2014, p.30). The three networks, recognition, strategic, and affective are divisions found in the anatomy of every animal with a central nervous system:

> When anatomists look at the most basic levels of the central nervous system, they differentiate three types of neurons: receptive or sensory neurons that bring information into the nervous system, motor or effector neurons that carry information out of the nervous system to stimulate muscles into action, and interneurons that represent the current state or "values" of the organism. Everywhere we look in the nervous system, we can see the same three kinds of

> differentiation. And these all play a key role in any act of learning. (Rose, Meyer, & Gordon, 2014, p.31)

These three networks are studied separately in order to better understand how the networks work together as learners. As Rose, Meyer, & Gordon state, "By dividing types of networks and studying the functions for which they are specialized, we can gain insights about how students learn and how they vary" (p. 32). These three networks provide a structure to better understand learner variability.

Taking the concept of understanding structure and design within architecture is another underpinning of Universal Design for Learning. Even though the process of building structures is very different from educational pedagogy, designing structures with equitable access in mind has been generalized to the more abstract idea of teaching and learning with equality of learning in mind (Hall, Meyer, & Rose, 2012). The literature shows a difference in key word searches for Universal Design for Learning and Universal Design. The concept of Universal Design looks at structure and comes from understanding the importance of having good design within architectural structures. In Chapter 4, "What is Universal Design for Learning," of *Teaching Every Student in the Digital Age: Universal Design for Learning,* Rose and Meyer (2002) apply the concept of universal design found in architectural structures. It is based upon the work of Ron Mace at North Carolina State University, "the idea behind universal design in architecture is to create structures that are conceived, designed, and constructed to accommodate the widest spectrum of users, including those with disabilities, without the need for subsequent adoption or specialized design" (Rose & Meyer, 2002, p.70). His work reflects that everyone benefits from curb cuts, automatic doors, and escalators. By taking

the architectural concept and applying it to learning and curriculum all students benefit – special needs, gifted and talented.

Rose and Meyer extended the principles of architecture and apply the same standards to learning. By creating a framework for UDL, three principles were identified:

- Multiple means of representation, to give diverse learners options for acquiring information and knowledge;
- Multiple means of action and expression, to provide learners options for demonstrating what they know;
- Multiple means of engagement, to tap into learners' interests, offer appropriate challenges, and increase motivation. (Rose & Meyer, 2002, p.75)

The above framework shares one common similarity: providing all students with options (Rose & Meyer, 2002, p. 74). These three principles align with Carol Ann Tomlinson's three elements of the curriculum that can be differentiated: Content, Process, and Products. (2001). Jiménez, Graf, & Rose (2007), illustrate how Tomlinson's instructional methods and definition support the principles of UDL:

- Multiple means of representation (Content)
- Multiple means of engagement (Process),
- Multiple means of action and expression (Product).

This framework becomes the outline for Universal Design for Learning implementation. Rose and Meyer developed the role of applied neuroscience and the role of digital media in implementing UDL. Those guidelines became a foundational piece for much of the further research being done in the area of UDL.

In the final chapter, “Making Universal Design for Learning a Reality” (Chapter 8), Rose and Meyer (2002) detailed the methods of application and implementation of UDL. This chapter was critical in narrowing the articles to review for classroom application.

The research provided on national models and resources demonstrated what educators are doing on a national scale. Their research suggests that in order to bring about change, they need to build awareness. Teachers need to know that alternatives exist in teaching the core curriculum, and teachers have to have support in finding those materials. Administrators must advocate for flexible materials and technology from educational companies. Parents need to understand the concept of UDL and seek alternatives to traditional curriculum. Lastly, publishers need guidelines and expectations in providing digital media to schools (Rose & Meyer, 2002, p. 170-171).

This early literature on implementation of UDL has grown. More examples of teacher practice and implementation are being researched and documented. In Chapter 7, "Learning From the Field," Rose, Meyer, & Gordon (2014) share the importance of designing instruction from the start that considers the diversity of learners. Reflective stories are shared in this chapter and lay out concrete examples of UDL implementation within the field. Rose, Meyer, & Gordon (2014) explain:

> The contexts and practices discussed are disparate—necessarily so, since education is a process which, involving highly variable people with variable needs and circumstances is necessarily diverse, even messy. However, as we have emphasized throughout this book, such variability and diversity is an asset—not a liability—in building strong educational environments as long as we design those environments and curricula to leverage these strengths (p. 97)

These smaller vignettes of teacher application of UDL are complemented by larger scale implementation research.

The Concord Model was one early large-scale example of implementation. The evidence Rose and Meyer (2002) provided in making UDL work in practice was

illustrated in the Concord Model. The research conducted in Concord, New Hampshire, public school system took shape during the 1990s and demonstrates the necessary support elements for successful UDL implementation (Rose & Meyer, 2002). They acknowledge that considerable technological advances have occurred; however, specific components emerged that have become the foundation of UDL implementation. The Concord Model developed seven key components for UDL implementation: Technology Infrastructure and Support, Administrative Support, Teacher Training and Support, Redefined Roles for Special and Regular Education Teachers, Collaborative Curriculum Planning, Parent and Community Involvement, and Creative Funding (Rose & Meyer, 2002, p. 160). The research done in Concord has presented important considerations for other studies, and the work of Rose and Meyer has become a roadmap for other UDL studies in schools.

Another model of large-scale Universal Design for Learning implementation was studied in Bartholomew Consolidated School Corporation (BCSC). This BCSC UDL model was implemented with a deep commitment to providing PD and training to teachers over time. Rose, Meyer, & Gordon (2014) described:

> The essential part of building a UDL culture is providing effective professional development and training so that staff can grow as a team in their knowledge of and experience with UDL. Rather than "one size fits all" professional development—or "one-off" workshops—the best professional development approaches foster the kinds of sustained and vibrant communities of practice discussed in the opening paragraphs of this chapter. (p.95)

The BCSC UDL model illustrates the impact of having professional development implemented systematically with opportunities for coaching and administrative feedback. It was implemented on-site with teams of teachers working together and reflecting on their learning.

Professional Development and Universal Design for Learning

A review of the professional development in successful efforts to implement UDL allows us to look at the strategies and design structures teachers developed. Building on the work of Rose and Meyer (2002), Grace Meo, Director - Professional Development & Outreach Services, developed a case study based upon the PAL model (Planning for All learners), a process for developing and delivering lessons based on UDL (Meo, 2008). The study included 12 high school content teachers and special educators. The composite case study represented an 18-month professional development project designed to improve students' understanding of core curriculum content by bringing together principles of UDL, the PAL process, and research-based reading comprehension practices. (Meo, 2008, p. 25). Meo's research focused mainly on participant experiences and the PAL process. However, this particular article provided a wealth of additional resources to explore based upon the references Meo used.

Meo's (2008) study included relevant findings regarding the benefits of recognizing curriculum barriers and developing tools to eliminate learning barriers. Many of the tools used were using technology to enhance the curriculum. Teachers learned how to use text to speech software and other audio enhancements to support reading comprehension (Meo, 2008). Also, teachers appreciated the collaboration between general and special education teachers. The teachers had a change in understanding and realized the advantage of using research-based strategies. Meo (2008) also noted that the teachers began to adopt a common language, and "More important than their adoption of the program's language, however, was their growing adoption of UDL principles and effective strategies in their teaching (p. 27). The study done by Meo reaffirmed the work

of Rose and Meyer (2002). All three principles of UDL must be put into curriculum planning in order to customize curriculum for diverse learners. Furthermore, the PAL process builds on the work of Rose and Meyer, since it provides a process for both general and special educators to develop curriculum. Meo noted that this process can be used with all content areas, but her focus for this study was in the area of high school reading and comprehension (2008, p. 23). However, it is important to note that the PAL model can be replicated in other content areas.

Another source of information regarding UDL application in a school setting comes from a case study done by Dymond, Renzaglia, and Rosenstein (2006) at University of Illinois at Urbana-Champaign. This case study was done in a high school science class and reflected similar elements of Meo's (2008) work. However, unlike Meo, Dymond's et al. (2006) research methodology was a combination of a participatory action research (PAR) approach to examine the process of redesigning one high school science course to incorporate the principles of Universal Design for Learning (UDL) and instructional technology to promote access to the general curriculum. The participants included one general education teacher and two special education teachers. A range of students with disabilities were in the course. The redesign process involved changes to the course in the areas of curriculum, instructional delivery/organization of learning environments, student participation, materials, assessment, and technology. Over one school year, they collected data through documents, interviews, and focus groups and were analyzed qualitatively using a constant comparative method (Dymond et al., 2006, p. 293). It is important to note that the technology provides one facet of the redesign process. The overall redesign of the course impacted the change in the learning environment.

In comparison, both the studies of Meo (2008) and Dymond et al. (2006) showed that through collaboration the relationship between the general and special education teacher changed. In interviews with the teachers, they saw their "role broadening to include more planning with the general education teacher before actual instruction occurred, as opposed to adapting materials before actual instruction occurred" (Dymond et al., 2006, p. 299). Also, the UDL strategies increased student engagement, and the teachers commented on how the strategies supported all students. Dymond's et al. (2006) study used a content analysis procedure to analyze and organize the data. The researchers then used a constant comparative method to develop categories within the data sets. Lastly, triangulation of the data was finished through using several sources of data (i.e., interviews, focus groups, documents) and multiple researchers in the analysis process (Dymond et al., 2006, p. 298).

Dymond's et al. study suggests that the roles and responsibilities of a co-taught class need to be clearly defined and discussed before implementation. Also, the increased options for learning provided to students showed increased student engagement. However, the study described drawbacks in providing too many options: "Some students 'crumbled' with the number of choices and became 'overwhelmed.' Teachers discovered that choice making does not come naturally to all students" (Dymond et al, 2006, p. 301). A similar observation occurred in Meo's (2008) study as well. The teachers observed one method of assessment was not suitable for all learners and increased choice led to increased student engagement. In the Dymond et al. study, the teachers responded by limiting the choices to just two or three options for students. However, the most significant outcome of the Dymond et al. (2006) study was "the impact of UDL on

relationships and interactions among students with SCD (significant cognitive disabilities) and other students in the class" (p. 293). Using the UDL principles, improved social skills and increased student engagement developed.

In addition, these two studies addressed similar concerns regarding the time needed for implementation. Both in the Dymond et al. (2006) and Meo (2008) case study, teachers need extended time to plan and work together in order to make the work successful. In particular, Dymond's (2006) study required more time than was initially projected, and the researchers believe that if the study occurred over multiple years an even better understanding of the process could be developed" (p. 307). Regardless of the content area, UDL implementation takes time and teacher training, and both studies illustrate the intense professional development and planning necessary to change teacher instructional practice. Therefore, the literature investigation shifted direction to the area of teacher training. Since the two case studies, Meo (2006) and Dymond et al. (2008), demonstrated improved student achievement and engagement, and the theory of Universal Design for Learning is entrenched in brain research and best practice, teacher training and professional development must embed these practices into classroom instruction. Teachers need to have training not only in instructional design, but in the use and application of the technology they need for changing the learning environment.

The process for researching literature on Universal Design for Learning and Teacher Training started with examining research from the *College Student Journal*. Nelson's research provides convincing statistics on the changing K-12 student and supports the need for continued technology training for K-12 educators. Nelson (2006) provides compelling evidence for the need to increase teacher training and professional

development in UDL and technology implementation. Nelson (2006) studied the statistical data of the changing students in general K-12 education classrooms. This data illustrates the growing trend of students with special needs in general education classrooms. Teachers face the challenge of designing effective curriculum that will address the needs of many different types of learners. Consequently, veteran and new teachers must be trained with the assistive technology tools and best practice to assure student achievement.

The National Center for Education Statistics reports from school year 2009–10 through 2019–20, the number of students ages 3–21 who received special education services under IDEA increased from 6.5 million, or 13 percent of total public school enrollment, to 7.3 million, or 14 percent of total public school enrollment. The overall trend indicates a progressive increase of least restrictive environment placements for students with disabilities, with elementary students being more likely to be served in the regular classroom than secondary students. (National Center for Education Statistics 2022; B. Nelson, 2006, p. 486) Nelson refers to the Interstate New Teacher Assessment and Support Consortium (INTASC) standards to guide the training and development of teachers in Universal Design for Learning. These standards imbed the practice of using technology, multiple materials, and approaches, and providing students with multiple assessments.

UDL Classroom Practice and Self-Efficacy for Change

Professional learning is just one piece of implementing UDL. Embedding these practices into the classroom requires teachers to implement the UDL framework and design for learner variability while also leveraging technology to enhance instruction.

Nelson (2006) reported that technology skills must be embedded in classroom instruction. Schools of education must prepare teachers for working with all students, and the study reports they can best support teachers by providing them with the knowledge and skills of Assistive Technology and Universal Design for Learning. Once teachers have developed that knowledge, they need support to embed and increase the practice into their instruction. Nelson (2006) refers to CAST regarding the leadership they have provided educators in implementing UDL in classroom instruction. Moreover, in examining the UDL tools and resources, Nelson (2006) lists many of the same resources that were referred to in the theory and history of UDL.

Further evidence and research done by the National Center on Accessing the General Curriculum, supports the professional development of veteran teachers in embedding UDL in classroom practice. Jackson's et al. (2001) study supports the need to find time to plan:

> There is a need for professional development that would help teachers from both special and general education to clarify roles, responsibilities, and beliefs about the inclusion of students with disabilities. Teachers need time to learn new skills, but more importantly they need opportunity to identify mutual and complementary skills. They need to feel empowered, so that all teachers come to this new, shared responsibility from a stance of real purpose and commitment. (p. 5)

According to Jackson et al. (2001), not only do teachers need time to collaborate, but they also need training to prepare them to work with a diverse student population. Throughout the study, they reported teachers lacked the education and time to plan appropriately and prepare, and these deficiencies led to increased teacher frustration. The answer to dealing with this frustration in Jackson's et al (2001) study supports the need to find time to plan instructional routines, support teachers in finding appropriate media and curriculum, and

design activities around the individual learner. The answer supports the primary principles of UDL: multiple means of representation, multiple means of engagement, and multiple means of expression. (Jackson et al, 2001, p.13)

On a larger scale, Abel (2005) conducted a qualitative study to examine large-scale implementation of Universal Design for Learning and text reader software in the state of Kentucky. The study embedded teacher professional development and technology training as part of the process. Based upon the premise that teacher professional development is critical to the success of UDL implementation, the teachers worked closely with support staff and received professional development in the area of technology and implementation. This also included locating and distributing accessible digital curriculum materials, school-wide availability and use of technology supports (e.g., text reader tools), and accessible online assessment.

The researchers collected both qualitative and quantitative data during the statewide implementation of UDL-based practices. They utilized surveys, teacher and student comments, and material usage charts to analyze the success of the project. They identified four professional development issues that need to be considered in UDL implementation: district support for text reader software, digital text, district technical support, and building a state support network. The results of this research revealed not only the importance of strong professional development, but the importance of strong leadership and vision. Abel (2005) stressed the importance of strong administrative leadership during the five-year project. A sustained commitment of state and local fiscal resources allowed the project components to become best practice. The leadership team

also allowed other states to learn from Kentucky's experiences by sharing resources and knowledge.

In addition to providing job embedded UDL practices, teachers need to believe in the work and have the support of district leadership in order to recognize that change is necessary. Makoeele and Van Der Merwe (2014) "Educational Change and Inclusion: Lessons from A Collaborative Action Research" studies the complexity of change occurring in schools. While schools work hard to create planned routines and activities:

> when policies have to be implemented or changes effected, the school is an unpredictable environment. It is for this reason that the complexity approach becomes important for the process of educational change. Change is dependent on the capacity of teachers to create knowledge with the purpose of learning new ideas. (p. 170)

Furthermore, school leadership must be ready to address resistance, listen to stakeholders, seek to understand, and incorporate feedback through the change process. Specifically, "The teachers and the leadership should engage with one another in shaping and exchanging knowledge and ideas" (Makoeele and Van Der Merwe, 2014, p.171). This piece of change implementation is often missing when designing any type of professional development. Teachers have to be supported in the process of UDL implementation. Just like the students, teachers need to be motivated in order for them to redesign their teaching and learning framework.

Chapter Summary

The review of this particular body of literature illustrates the importance of studying the theory and history of UDL, the classroom applications of Universal Design for Learning, and the key elements of teacher professional development. The literature tells a story that professional learning for teachers needs to be collaborative, supported by

leadership, and most importantly provide teachers with ownership of their learning. These stories of UDL implementation within school districts are often narrative in nature. Additional literature is needed on UDL implementation and data collection. Most studies did not provide evidence of improved student achievement and student engagement. Studies that provide a model for collecting this type of data would be helpful for future research. Further understanding of how change leadership impacts systemic implementation of UDL in a school setting is another layer in the UDL literature that could be explored. Many of the articles reviewed looked at just teacher practice and lesson design and did not discuss the impact of school leadership. In addition, implementation research specific to the UDL framework may provide additional understanding of how best to improve the fidelity of UDL implementation.

Those gaps in research make for a compelling case study. Specifically, studying the impact the Universal Design for Learning framework has on teacher pedagogy through targeted professional development. This case study that tells the story of the Engage, Expand, and Encompass Teacher Professional Development Series, applies the UDL framework to all learners, both to the student and the classroom teacher. Looking at the pedagogy of UDL through the lens of both the student and teacher is important for this case study. If we want teachers to leverage the UDL framework and intentional instructional design of lessons for their students, these same practices should be embedded in their own professional learning. Therefore, as educators continue to implement and design instruction using the Universal Design for Learning framework, research and data collection must reflect evidence of student achievement as well as

continuing to design opportunities for teacher professional development that embeds the UDL principles.

CHAPTER THREE

METHODS

Description of Study

This case study examined the impact of the Macomb County Intermediate School Districts - Engage, Expand, and Encompass Teacher Professional Development Series. The study specifically looked at the influence of implementing the Universal Design for Learning principles/framework to change teacher practice and improve perceived student engagement and self-efficacy. The project, Engage, Expand and Encompass through Technology, has been fostering middle and high school teams of educators who work together to minimize learning barriers and create UDL curriculum that increases the opportunity for all students to learn. These teams focused on designing instruction that reaches, supports, engages, and motivates all students, ensuring that every student has an opportunity to make progress in the general education curriculum.

In the E3T project, training was delivered in a hybrid model. Teams learned via a combination of on-going, intense professional development workshops, team-centered, personalized school-based support, and online learning modules. The topics for the online learning modules included: Students in the Margins, Introduction to UDL, Framing the learning, Developing a Web Presence, Lesson Opener, Supporting (Augmenting) Text, Strategic Lecture, Supportive Notes, Extended Practice, and Structured Vocabulary. These modules and additional teacher resources can be found on the website, www.E3T.org. E3T teams learned to create flexible curriculum designed to meet the needs of a wide range of students including gifted students, struggling students, students

for whom English is a second language, and disengaged students, in short, the range of the students in all classrooms.

E3T Goals:

To create teams of educators who are proficient at working together to minimize barriers to the curriculum in order to increase opportunities for learning for all students. These teams will:

- Provide opportunities for all students to make progress in the general curriculum.
- Create learning environments that support, engage, motivate, and teach all students.

E3T Methods:

- On-going, intense professional development workshops
- On-going, team-centered, personalized school-based support
- Virtual learning communities
- Online learning modules

E3T Materials:

- Web-based resources
- Web 2.0 collaborative tools
- Online learning modules

E3T Assessments:

- Pre and post teacher/student surveys
- Classroom based formative assessments
- Lesson planning tools using the UDL Framework
- Teachers

Research Question

How does the implementation of the Universal Design for Learning Professional Development Framework impact changes in teacher practice? And does this framework result in increases in perceived student engagement at three local middle schools?

Explanation of the Case Study

This was an explanatory case study. This type of study was selected in order to seek answers to a question that sought to explain the presumed causal links in real-life interventions that are too complex for the survey or experimental strategies. In evaluation language, the explanations would link program implementation with program effects (Yin, 2003). The case study examined a specific group of teachers (by grade level and content area). Twenty-two teachers participated in the case study. All of the teachers were tenured, and they taught in the same school district. They all were middle school teachers who taught English, science, or social studies. The district selected these teachers for professional development, and the training was completed during the school day. Using a specific district where the teachers were experiencing a specific professional development around the framework and practices of Universal Design for Learning binded the study. Teachers experienced a blended model of professional development:

- Face to Face Professional Development
- Online Professional Development

Teachers experienced their professional development through both face-to-face and online Learning Modules by Topic: http://e3t.org/on-line-modules.html.

Data Collection

The data collection process had four parts: (1) Teacher Focus Groups, (2) Lesson Plan

Analysis, (3) Formative Assessments of Professional Development, and (4) Technology Usage Perception Survey (TUPS).

Part I: Teacher Focus Groups

Focused discussion groups provided the participants an opportunity to reconstruct his or her experiences within teaching and pedagogy. Eight teachers explored how the professional development experiences they had helped them to understand their role as a teacher. Two focus groups were conducted at the end of the professional development series (April/May 2017). The focus group was done using a Hybrid approach (Theory-building focus) group. The chart below provides a Descriptive Framework for the Focus Group Design (Ryan, 2014). These focus groups provided opportunities to unearth contradictions in participants' opinions about the complexity of changing teaching pedagogy and classroom instruction. In combination with relevant artifacts collected (lesson plans), survey information (TUPS), and assessments, the focus group provided an opportunity to hear narratives from the participants on the impact of the implementation of the Universal Design for Learning Professional Development. Specifically, these focus groups provided data as it relates to changes in their teacher practice and increases in perceived student engagement.

Table 3.1: Teacher Focus Groups - Hybrid Approach (Theory-Building Focus)

Key Elements	Approach
Theoretical Perspective	Mixed
Purpose or use	Build mid-range theory, constructs
Type of Information	Mixed-opinion/experiences
Role of Participant Interaction	Generate mix of personal opinion and collective experiences
Structure	Mixed with semi structured conversation
Evaluator stance/role	Empathic interviewer with authority
Data Analysis	May mix or merge interaction with content; grounded theory analysis
Evidence	Rich description preliminary program/policy theory

During the focus group interviews, two groups of teachers were interviewed. These interviews were recorded on an iPad and then transcribed. Group number one had three teachers and group number two had five teachers.

They were asked the following questions (in the order outlined below):

Driving Question:

1) How has the professional development experiences they have had, helped them understand their role as a teacher?

Sub-Questions:

2) Describe your own educational experiences in middle school.

3) Describe other professional development experiences that you have had. How is this experience different from your E3T experience?

Each focus group lasted approximately a half hour to forty minutes. These discussions were held at the Macomb Intermediate Schools District during the last professional development session. Over the past two years, we had many opportunities to connect with these participants. This included spending time with them during the professional development sessions

Part II: Teacher Lesson Plans

In addition to focus groups, teachers shared completed lesson plan templates using a Universal Design for Learning lesson plan template. Twelve teachers provided lesson plans detailing a UDL lesson that they introduced into their classrooms.

They were given a pre-designed Universal Design for Learning Lesson Plan Template where they demonstrated their understanding of pedagogy and practice around the three frames of Universal Design for Learning.

Universal Design for Learning Planning Template

This template was coded to the three principles of UDL: Representation (Input - The "What?" of learning), Action/Expression (Output - The "How?" of learning) and, Engagement (Connection - The "Why?" of learning). These three areas could then be patterned to identify the three UDL Principles:

- Multiple Means of Engagement (Affective)
- Multiple Means of Representation (Recognition)
- Multiple Means of Action and Expression (Strategic)

In addition, teachers were given a UDL Lesson Plan Bookmark (Appendix A) to guide their planning process.

Table 3.2: Teacher Grade Level Lesson Plans

Grade Level	Subject and Title of Lesson
7th Grade	Language Arts - “We Need a Timeline”
7th Grade	Life Science - “The Cell as a System”
8th Grade	Earth Science - “Exploring the Rock Cycle - Rock Cycle Cookie Bars”
6th Grade	Social Studies - “How people and ideas move in the European Union”
7th Grade	Life Science - “Cells and Cells Organelles”
8th Grade	Social Studies - “Andrew Jackson”
6th Grade	World Geography - “Population Dilemmas of Europe”
7th Grade	Life Science - “Osmosis and Diffusion”
8th Grade	Social Studies - “George Washington's Presidency”
6th Grade	Earth Science - “Mass Movement Station Activity”
7th Grade	Social Studies - “Hinduism”
8th Grade	Social Studies - “Andrew Jackson, Trail of Tears”

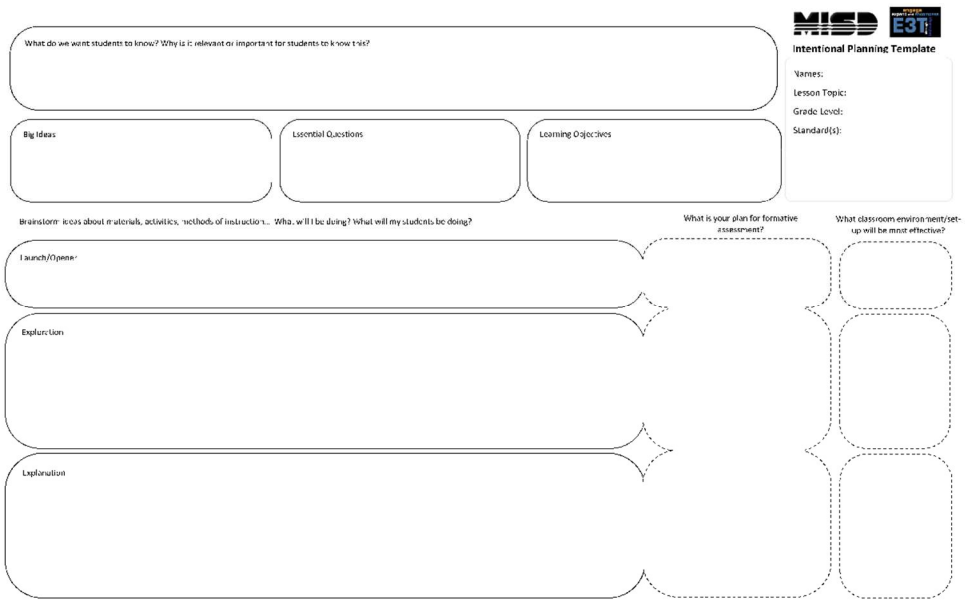

Figure 3.1. Lesson Plan Template Macomb Intermediate School District, 2011

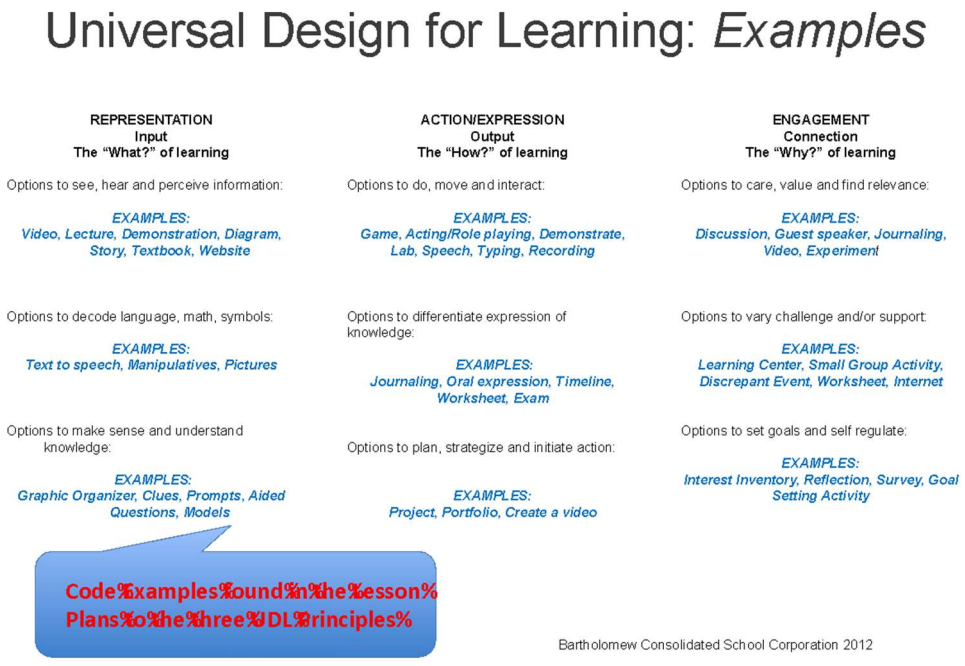

Figure 3.2. UDL Template Bartholomew Consolidated Schools Corporation, 2012

Bartholomew Consolidated School District has developed a protocol that provides UDL examples within each principle that could be used to code the teacher lesson-planning template (See Figure 3.2). By coding the activities, assignments, and assessments, patterns of implementation can begin to be identified.

Part III: Teacher Formative Assessments - Understanding the Role of Lesson Design

In addition to the interviews, lesson plan artifacts were collected, and the TUPS survey was given twice. The teachers also provided responses to formative assessments throughout the professional development sessions. The formative assessments addressed two specific components of the Universal Design for Learning Lesson Plan template (Appendix A): explanation and exploration.

EXPLANATION: Information delivered so that students develop a mastery of the objectives. Includes explicit learning strategies, multiple representations of info provided, frequent opportunities for response and practice and a variety of student-centered learning activities.

All the assessments followed a similar pattern.

EXPLORATION: Activities that help students make discoveries related to big idea(s) and promote student inquiry.

The UDL Lesson Plan Bookmark (Appendix A) provided the definition and model to apply to their learning.

Formative Assessment Structure:

1. Teachers were asked to select a Universal Design for Learning focus area (exploration, explanation, and assessment).

2. Teachers were asked to define the focus area components.
3. Teachers were asked to describe implementation using the question stem: This means that I will. . .
4. Teachers reflected on how they would implement the focus area within a lesson cycle.

These open-ended questions provided narrative data that assessed the learning of teachers during professional development. Teachers were asked what they know about the topic prior to the training and at the close of the training explained what they had learned, and how they would apply it in the classroom. Twenty- one teachers participated in the formative assessment process of the professional development series.

Part IV: Technology Usage Perception Survey

The Technology Use and Perception Survey (TUPS) was given to the participants in the professional development series. The Technology Use and Perception Survey (TUPS) was produced by the Florida Center for Technology based out of the University of South Florida's College of Education. The survey was used to examine how well-prepared teachers were able to integrate technology in meaningful ways and analyze and identify the technology professional development topics that teachers wanted and needed. It also identified patterns of growth and decline in teacher perception data. Results from this survey helped identify professional development needs at the teacher, school, or larger aggregate levels. The survey includes 200 items in ten categories using a likert scale of 1 to 5. (See Appendix B for individual sections and statements).

Survey sections included:

- Technology Access and Support

- Preparation for Technology Use
- Perceptions of Technology Use
- Confidence and Comfort Using Technology
- Technology Integration
- Teacher & Student Use of Technology
- Technology Skills and Usefulness

The survey data was developed to target the professional development efforts to meet the needs of teachers in a school or district.

This resource and survey tool provided additional case study data that supported the Professional Development model of E3T project and allowed for data to be analyzed to show growth in technology use in the classroom. Twenty-two surveys were analyzed along with a subgroup of four classroom teachers. One of the major goals of the project was to create learning environments that support, engage, motivate, and teach all students. Therefore, collecting data on the level of technology integration in the classroom as well as studying the meaningfulness of the learning environment aligns with core principles of Universal Design for Learning. The TUPS survey focused on both teacher and student efficacy toward technology. The grade levels taught by the teachers who took the survey included Grades 6, 7, and 8th Grade.

Chapter Summary

This Universal Design for Learning professional development case study was a two-year study. Data was strategically collected not only on technology delivery but perceptions of use and the impact that technology had on the learning environment. The Technology Perception Survey was given during the Professional Development Series.

The teacher focus groups were conducted at the end of the Professional Development Series. Lesson Plans were collected at the end of the series. The formative assessments were conducted during the professional development sessions.

CHAPTER 4

RESULTS

Introduction

Using a mixed methods approach, I collected qualitative data with two focused discussion groups, teacher lesson plan analysis, and short formative assessments, and quantitative data using Technology Usage and Perception Survey. This method perspective, from the research of Greene, Caracelli, and Graham (1989), defined mixed methods designs as "those that include at least one quantitative method (designed to collect numbers) and one qualitative method (designed to collect words)" (p. 256). Through analysis of these four layers of data, both numbers and words, a story unfolded. The results below describe the impact of implementing professional development using the Universal Design for Learning framework to impact teacher pedagogy. The qualitative data revealed examples of how teacher pedagogy changed and demonstrated a belief in increased student engagement. The quantitative data provided an overview of teachers' perceptions towards educational technology to improve teacher practice.

Qualitative Results

Part I: Teacher Focus Groups

In order to better understand how the professional development experiences impacted the teachers, I conducted two focused discussion groups. These focus groups provided the teachers an opportunity to reconstruct his or her experiences within teaching and pedagogy. During these discussions, the teachers had an opportunity to unearth

contradictions in their own opinions about the complexity of changing teaching pedagogy and classroom instruction. Specifically, these focus groups provided data that demonstrated how their past school experiences influenced them as a teacher as well as how this professional development experience led to changes in their own teacher practices and increases in perceived student engagement.

Personal Middle School Experiences as it Impacts Student Learning

Although the groups were not fully representative of the total participants, the results do paint a picture of similar experiences toward their personal experiences in school. Below are the responses from focus group participants to questions designed to address their own educational experiences in middle school. The focus group interviews demonstrated similar experiences in middle school. Participants were asked the question: Can you talk a little bit about your own experiences as a student in middle school that influenced you being a teacher from your own experiences that influenced HOW you are teaching students today? All but one of the participants described their own learning experiences in middle school as traditional. For example, Teacher #3a stated,

> Well, I feel like I was always a traditional learner, like I could always read the book and answer the questions and do all the tests, you know, earning B's with very little effort. I tried to make sure that I remembered. I don't know, I guess um, that not everybody learns like that.

The word traditional resonated with many of the participants. While discussing their experiences, traditional learning seemed to also connect with student success as well. However, one Teacher (Teacher #1a) shared:

> I mean I graduated with just under 110 students. So, like everybody knew everybody. All the teachers knew all the teachers, so everybody knew

> everybody, so everybody was kind of looking out for everybody in helping each other. So like, even though we were building relationships with students that you should have. Um, I find that is something that is extremely important because, you don't know, you might see that kid out of a situation before more develops, or you may need to get them to come out for a sport when they have never been interested in sports. Or trying to broaden … you know … school is not just academics only. You know, try to engage them and create them into being social people of the future … not just on their iPads or their phones.

This teacher seemed to value relationships and engagement. His comment regarding the size of his graduation class reflected the importance of being able to connect with not only his teachers but to the other classmates. His reflection on what his learning experience was like did not include the word traditional as the other participants shared. Rather, his comments were on making connections and connecting with students.

Professional Development Experiences and Impact Teacher Pedagogy

The professional development experience lasted over a two-year period. Many of the teachers felt this continuous learning was an important part of the experience. Teacher #2 shared:

> But there are lots of ISD trainings, and they just sat there and they present stuff, and you may have some activities too, but you didn't develop 'em. They meant nothing to me. At least go back and try and work with.

Teachers felt having a connected experience that allowed for time to reflect and implement between sessions was helpful. One theme that emerged was teachers typically had professional development sessions that were one time experiences and did not have opportunities for application during the session. They appreciated the time between sessions and the continuation of work. This seemed to be a different experience for most of the teachers. They also shared a lack of accountability in having to implement past professional development experiences within their classroom. Teacher #1A shared "You

did those things that … you followed through on those things that you started here, whereas other PDs … if you can use this, it's great … if you don't, whatever." This two-year experience provided them with opportunities to try new things with an expectation that they would need to report back to the group. Unlike other professional development experiences, they were held accountable for implementing new learning. They also valued the opportunity to go back over an idea that was discussed at a previous session.

However, the influence and connection UDL had on their classroom instructional practices were described by Teacher #3 as: " Actually, I was not rocked by all this stuff because … well, we're already learning this through CTIW, but this stuff teaches us to go a step further." Many of the teachers commented that this learning was not new to them, but rather "For me it was more like a refresher" (Teacher #4). The concept of "meshing" their UDL professional development into an existing teaching framework was shared. There was a continuous thread of trying to layer their new learning into their current instructional framework. The thinking that UDL is not a new thing, but rather a framework that can fit into a traditional instructional model and provide improvements.

The actual professional development that was devoted to pedagogy did not resonate to the same level as the new technology professional development. Teacher #3 went on to say: "I do like in the technology piece that they taught us a lot of resources that we can use and we try to take 'em back, like the next day, and that was a great thing." All of them shared similar comments regarding technology being used as a positive addition. They saw the technology used as a separate piece of the training. It supported student engagement. Teacher #3 described the impact the technology professional development had as:

> I mean, like my kids, like, connected to it in terms of review. And we've got the quizzes and we've got the other, and there's a lot of them, we've got the apps and a lot of websites that are really helpful that I didn't get from other pd sessions.

Her comment illustrated a pattern of technology being a way to engage students. The connection of using the technology to content showed how she felt it could be brought back into the lesson planning template. Technology was seen as engaging, but teachers were also hesitant to rely on it due to the distractions and instability it could bring into the classroom. As noted by Teacher #3, "They bring a phone in and get their Wifi so slow that they cannot … and they get frustrated …. and they can't connect anymore. They've lost all connections and , yeah, they become disengaged, and they're talking." There was concern around losing control of the classroom if the technology failed, and that hesitancy led some teachers to feel that it might not be worth the risk to try out certain technologies even though it could provide alternative options for student engagement.

Connecting UDL Professional Development to Student Engagement

Throughout the interviews, the word engage appeared six times within our conversations. Teachers shared thoughts of both engagement and disengagement of students. Teacher #2a described her technique for observing engagement: "So I kind of tried to look for other ways that I could see kids engaging like the nodding of their head or the things that I used to do to know that they are engaged without putting them on the spot or things like that." Throughout the professional development, engagement was explained as "the why of learning" and helping to recruit interest in the learning. However, the teachers seemed to feel that they needed to look for engagement by the comments that they made during their interviews.

Part II: Teacher Lesson Plans

The E3T professional development included explicit instruction on the understanding of the key components of a UDL Lesson plan. The following tenant was critical in assessing the UDL framework within these plans: lesson opener, exploration, check for understanding, explanation, check for understanding, summative assessment, and extended practice.

Understanding of Key Lesson Plan Elements

Each teacher developed and executed a UDL lesson. These lessons reflected the UDL tenets they were trained on during their professional development. They were given the E3T UDL Lesson Plan Creator Template to universally design their curriculum. UDL Lesson Plan Bookmark (Appendix A).

These elements were explicitly taught using the lesson plan template and modeled during the professional development. The lesson design process began with each teacher identifying specific standards from the Michigan Standards that aligned to the content area which was taught. Two key elements of lesson design that all teachers first addressed included essential questions and big ideas. These elements are defined as:

- BIG IDEAS: The concepts or principles central to the lesson that anchor or connect the smaller ideas.
- ESSENTIAL QUESTIONS: Questions that help students probe for deeper meaning.

Key Element: Big Ideas

All lesson plans submitted provided examples of big ideas of essential questions. However, the level of depth of understanding in each area varied among the teachers. The big ideas that the teachers shared within their lessons had three major types: (1)

represented a big idea of the lesson topic, (2) compared/contrasted the lesson topic, or (3) defined the lesson topic. For example, the 7th Grade Language Arts Teacher described the big idea of the lesson as "Big assignments and projects do not have to be overwhelming if you create personalized goals that are attainable and work towards the end result." This concept anchors the lesson and connects to a smaller idea of understanding why creating a timeline can support a student in executing the steps necessary to complete a research project. This example aligned to the definition and examples provided throughout the professional development. In contrast, the 7th Grade Science Teacher described the big idea of the lesson as "Cells have different parts that serve different functions inside the cell just like organs serve different functions inside your body." This example of a big idea provides students with a compare/contrast example and does not reflect the big idea of the lesson. Rather, it gives students a context to make a personal connection to understanding cell parts within the function of their own body. Other teachers provided a definition of the topic. The 8th Grade Earth Science Teacher defined the big idea of her lesson as "The rock cycle is a process that is constantly recycling and reforming material within the earth. There are three main types of rocks, and one type of rock can change into any other type of rock or even back into itself. There are basic processes that rocks go through (weathering, erosion, heat, pressure, etc.) when changing (rock cycle)." This definition of the rocks and the rock cycle does not connect to a bigger concept.

Key Element: Essential Questions

The depth of understanding demonstrated in sharing with the students the big idea of their lesson impacted the types of essential questions the teachers asked their students.

Essential questions were meant to be open-ended and provide students an opportunity to probe for deeper meaning with the big ideas of the lesson. They should allow for multiple answers and be open ended. For example, the 7th grade ELA teacher asked the essential question: "How will you keep yourself on track when completing the research project?" Students could provide a variety of responses to this question.

The 7th Grade Science teacher asked, "What is a cell organelle? What are the different levels of organization? What are some different types of cells? 8th Grade Earth Science teacher asked, "(1) What are the processes responsible for recycling rock materials? (2) How can one type of rock be changed into the other two types of rock?" These questions require a specific answer and do not have an open-ended response. They asked content specific questions and did not probe for deeper meaning. The essential questions that were developed by Science teachers reflected a content specific response. This is important to note because we provided science teachers with examples of potential essential questions and models that were open ended. Specifically, teachers were provided examples of how to create a culture of inquiry which included:

- Encourage students to try different ideas (it is ok to be wrong)
- Support student risk taking by focusing on student thinking and not "right answers" (exploration is about student learning)
- Be patient, this is new for students, and it will take time for them to become better intellectual risk takers

Yet, when asked to provide students with similar opportunities to respond to open ended questions, science teachers defaulted back to content specific questions. In contrast, English Language Arts and Social Studies teachers used more open-ended questions. For

example, 8th Grade Social Studies teachers shared, “Was Andrew Jackson a hero or a villain?” and “Was the Trail of Tears comparable to the ‘final solution’ in Germany?” with the opportunity to share their thinking on the decision. These are content specific questions but allow for students to provide a more open-ended response that does not have a right or wrong answer.

Application of Technology to Lesson Design

Internet access was the technology that was most requested by all the teachers. Therefore, when the internet was not working or perceived as unreliable, teachers shared frustrations of having to change their lesson design at the last minute. Many of the lessons had a backup paper version of the activity on paper or a resource that was copied in addition to having digital access. Having solid wi-fi access was an important indicator for successful technology application. In the materials section of the lesson template key phases included: internet access, online textbook access (social studies), YouTube videos, and access to google documents. All teachers did have access to Smart Boards; however, they were only mentioned once in the lesson design templates.

Common Examples of Student Engagement with Lesson Design

Increasing student engagement was a priority throughout the professional development experience for the teachers. Two specific areas that were targeted included lesson openers and summative assessments. These elements are defined as:

- LESSON OPENING: Lesson openers establish a purpose, are engaging and activate prior knowledge
- SUMMATIVE ASSESSMENT: Provide a choice of topics (when appropriate) and multiple options of means for completing the assessment to support different

learning needs/preferences. Include an explicit description of the criteria for quality work.

Teachers provided evidence of these elements in their shared lessons.

Key Element: Lesson Opening

It was evident that teachers understood the importance of engaging students with a lesson opener. Many of these lesson openers did not involve any technology but engaged students through movement and novelty. For example, a 6th Grade Social Studies teacher had students create a classroom size map of Europe that portrayed the size of each country. She divided the students into eight groups and had them sit in the designated areas before the labels were placed on each country. Students were able to explore and discuss what they noticed regarding how population affects a country and why they may want to go to another country close by. They were also able to discuss what the advantages and disadvantages are based on the physical size and population size of the various countries.

Key Element: Summative Assessments

Summative Assessments varied widely in the lesson plans that were collected from the teachers. Three main forms of assessment were collected: (1) test/quiz, (2) essay, and (3) project. Tests or quizzes were used for most of the summative assessments. All the teachers, except for four, gave a test at the end of the unit. Three Social Studies teachers responded with very similar answers that included:

> Students will be given a study guide before the day of the assessment to help them focus on the learning objectives for the unit. The test will have multiple forms of assessment that cover multiple choice, analysis of the European cartogram, and short answer. Students will take a formal multiple-choice exam on the whole Andrew Jackson chapter. Students will take a quiz on this material. The quiz will

be made up of multiple choice and short answer items.

Despite the training and discussion that the teachers received in providing choice with summative assessments, teachers provided examples that provided little choice and no opportunity for a retake or reassessment. This theme emerged throughout the examples of assessment. One Social Studies teacher remarked, "Students will take a formal test at the end of the unit. All students who do not receive an 80% will be prompted to fix all incorrect answers and turn it back in for a few extra points." This is the only example of an opportunity to improve or reteach the learning.

The other types of Summative Assessments that were provided to students were divided into two categories: (1) essay and (2) project. A traditional five paragraph essay was assigned to the students in their 8th Grade Social Studies Class. 8th Grade Social Studies Teacher described the assignment: "Students will write a five (5) paragraph argumentative essay in which they will take a stand for or against the Indian Removal Act and the Trail of Tears. The contents of this essay will be concrete proof that they have grasped both sides of the issue and that they are able to take a stand on one side or the other." The teacher leveraged the graphic organizer that the students developed during the explanation portion of the lesson to support the essay writing process. The essay summative assessment also did not include a rubric or retake opportunity.

The 8th grade science assessment allowed for group work and an opportunity for students to apply their learning to a real-life situation. This was the strongest example of a summative assessment. The teacher described the assessment as:

> This summative assessment is a group project that involves the students creating an analogy for the cell similar to the cell city. Students work in small groups to create an analogy for how the cell parts work as a whole to keep the cell alive.

> Students show examples using the videos and projects that previous students have created as well. Give students a planning document to include all the cell organelles required. Models should include type of cell, organelles and functions labeled on a key. Project also includes the "story" of the analogy similar to the Cell City Analogy worksheet. Assignment will include a rubric.

In this example, the teacher addressed the importance of providing examples of past work, modeling, and including a rubric. In addition, the teacher included an explicit description of the criteria for quality work.

Part III: Teacher Formative Assessments - Understanding the Role of Lesson Design

Throughout the professional development experience, teachers were given short formative assessment opportunities to reflect on their lesson design understanding. They were asked to select a focus area of the lesson design template, define the component in their own words, reflect on how they would implement that area, and describe implementation within the lesson cycle. The UDL Lesson Plan Bookmark (Appendix A) provided the definition and model to apply to their learning. The areas of lesson design that were selected for reflection included explanation and exploration.

Key Element: Explanation

In analyzing the formative assessments on the role of explanation in the lesson design process, teachers were to understand the importance of providing students multiple ways of receiving the content. Explanation of content, also described as the "what" of learning was a key principle for the teachers. This element was defined as:

- EXPLANATION: Information delivered so that students develop a mastery of the objectives. Includes explicit learning strategies, multiple representations of info provided, frequent opportunities for response and practice and a variety of

student-centered learning activities.

This was by far the most important piece teachers reflected on as part of their formative assessment work. Seventy-one percent of the teachers focused on this lesson design element. A theme that emerged from the teachers when defining the explanation component in their own words included providing content at multiple levels. They noted specific strategies they were using in their lesson to improve explanation. Teachers described that content could be explained through illustrations, multimedia, and images, etc. This response was frequently seen in the formative assessment responses. For example, a 6th grade science teacher noted, "Provide guided notes with varying levels of support. Provide text at multiple reading levels." They also noted that providing the same content at different reading levels could be another way for students to access content.

Technology was seen as an opportunity to support student engagement within the explanation process. For example, science teachers described the importance of adding video clips within their PowerPoint notes. The technology was web-based and included the use of video and images. It was partnered with other classroom strategies. Those strategies included the use of graphic organizers, guided notes, rubrics with specific learning targets, and the use of pre and post assessments. Teachers were given a checklist which included the following suggestions: Include multiple ways of representing new ideas e.g., images, graphic organizer, model concept maps, demonstration, audio/video, and manipulatives. Those examples were clearly incorporated into their reflections of improving explanation of content within the classroom.

Key Element: Exploration

Exploration activities supported increased student engagement. In analyzing the teachers' formative assessment responses, this design element was one that provided students with choice and opportunities to engage in the content to better understand the "why" of learning. This element is defined as:

- EXPLORATION: Activities that help students make discoveries related to big idea(s) and promote student inquiry.

Teachers also noted that that exploration should include opportunities for alternative ways of exploring the content. 7th grade language arts teacher noted the importance of "Find(ing) ways to bring kinesthetic activities into the classroom to help them explore." Teachers shared the concept explore without risk and provided opportunities to discover content. However, this type of exploration was not included in the overall summative assessment process.

Quantitative Results

Part IV: Technology Usage Perception Survey

As part of the teachers' professional development, they completed a pre- and post-survey of the Technology Usage Perception Survey. This online survey provided baseline information about the current teacher/student use and perceptions of technology. The TUPS examined teachers' beliefs about the role of technology in the classroom, as well as their comfort and confidence with technology in general, with pedagogy of technology, with a variety of different specific technologies. It also asked about the frequency that

they used those technologies and the frequency with which their students used those technologies. The survey includes 200 items in ten categories:

I. Technology Access and Support
II. Preparation for Technology Use (In School)
III. Preparation for Technology (Professional Development)
IV. Perceptions of Technology Use
V. Confidence and Comfort Using Technology
VI. Technology Integration
VII. Teacher Use of Technology
VIII. Student Use of Technology
IX. Technology Skills
X. Technology Usefulness

The qualitative data was analyzed at two levels. Data were analyzed (1) as a whole data set - 23 teachers and (2) specifically four individual content area teachers. The data was calculated with the averages for each above section for every teacher in the study, for 2014 and again for 2016. (See Appendix A for individual sections and statements).

A t-test was calculated for:

- 2014 to 2016 changes in the average domain responses for all participants for an average of all teachers
- 2014 to 2016 changes for a sample group of four classroom teachers (Three teachers were science teachers and one teacher taught English language arts and social studies).

Table 4.1

Results of Pre- and Post-TUP Survey for Full Sample

Scale	Pre-Survey		Post-Survey		*t*	*p*	
	M	*SD*	*M*	*SD*			
Access & Support	2.810	0.74	2.357	0.65	0.074	0.471	(ns)
Preparation Skills	2.622	0.33	2.563	0.60	0.399	0.351	(ns)
Preparation PD	3.413	0.50	3.300	0.80	0.362	0.364	(ns)
Perceptions	4.222	0.51	4.260	0.31	0.413	0.346	(ns)
Comfort	3.376	0.65	3.159	0.60	0.218	0.417	(ns)
Integration	2.721	0.77	2.813	0.52	0.368	0.362	(ns)
Teacher Use	2.629	0.37	2.836	0.43	0.135	0.448	(ns)
Student Use	1.723	0.47	1.586	0.45	0.251	0.405	(ns)
My Skill	3.360	0.42	3.828	0.75	0.067	0.474	(ns)
Usefulness	3.865	0.88	3.629	0.76	0.256	0.403	(ns)

Table 4.2

Results of Pre- and Post-TUP Survey for Focus Group Sample

Scale	Pre-Survey		Post-Survey		*t*	*p*	
	M	*SD*	*M*	*SD*			
Preparation Skills	2.500	0.72	2.500	0.45	0.500	0.326	(ns)
Preparation PD	3.000	0.49	3.300	0.26	0.166	0.439	(ns)
Perceptions	4.292	0.25	4.563	0.35	0.129	0.453	(ns)
Comfort	3.159	0.61	3.273	0.85	0.418	0.352	(ns)
Integration	2.500	0.33	2.328	0.71	0.340	0.378	(ns)
Teacher Use	2.625	0.38	2.430	0.22	0.207	0.425	(ns)
Student Use	1.320	0.27	1.234	0.12	0.292	0.395	(ns)
My Skill	4.055	0.32	3.508	0.33	0.028	0.490	(ns)
Usefulness	3.914	0.50	3.734	1.41	0.412	0.354	(ns)

In both sets, there was not a detectable statistically significant difference between participants' responses from the beginning vs. the end of the study. This quantitative data showed that teachers were fairly confident in their technology usage at the start of the professional development and the training that focused on improving those skills throughout their time did not change. The teachers also perceived the same with their students' use and skill level.

Conclusion

Quantitative data collected showed that improved teacher technology use was not a factor in increasing student engagement. The Technology Usage and Perception Survey showed no significant difference in the pre and post survey results. The teacher's perception and ability to use technology effectively in the classroom did not improve or grow in any significant way. This lack of growth is important. Teachers at the beginning of the study shared a level of confidence in not only their ability to use technology, but also their students' ability to use these tools in the classroom.

Qualitative data collected affirmed similar results of insignificant changes in teacher practices. Teacher interviews, lesson plans, and formative assessments on lesson design did not show changes in practice that modeled a Universal Design for Learning framework. The student summative assessments that were shared within the lesson plan template provided clear evidence of teachers reverting back to a traditional multiple-choice assessment. The summative assessment was the opportunity to showcase the full UDL framework, and the artifacts provided showed a lack of implementation of UDL pedagogy and practice. While there may have been points throughout the lesson design

process where pieces of the framework were applied, the summative examples did not provide evidence of full UDL application. In all four areas where data were collected:

- Part I: Teacher Focus Groups
- Part II: Teacher Lesson Plans
- Part III: Teacher Formative Assessments - Understanding the Role of Lesson Design
- Part IV: Technology Usage Perception Survey

evidence of UDL elements could be found in pockets; however, a full implementation of practice never formalized within the teacher pedagogy.

CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

Overview

In 2010, David Edyburn published a critique, "Would you recognize universal design for learning if you saw it? Ten propositions for new directions for the second decade of UDL." He outlined a number of fundamental challenges associated with operationalizing and measuring the outcomes of UDL. Over the past twelve years, UDL has made gains in both policy and implementation. It was written into policy with the Every Student Succeeds Act of 2015 (U.S. Department of Education, 2015) as well as the 2016 update of the National Technology Plan (CAST, 2016). Not only does UDL impact policy, but it has also become studied pedagogy in teacher prep and influenced assessment practices. As Edyburn notes:

> It is now a routine topic in pre-service teacher education (Lowrey et al., 2019) as well as in-service professional development (Craig et al., 2019). Publishers (UNICEF, 2020) and test developers (Rose et al., 2018) market products they claim were designed in accordance with UDL principles. Nonetheless, researchers continue to raise the question about how to define UDL (Capp, 2017; Crevecoeur et al., 2014; Ok et al., 2017), a fundamental issue that must be resolved prior to establishing the efficacy of UDL interventions. (p. 308)

For over 20 years, Edyburn has researched UDL implementation and the claim of whether UDL was on a pathway to becoming an educational fad (Edyburn, 2010, 2020). In his most recent "Ten Years Later: Would You Recognize Universal Design for Learning If You Saw It?" Edyburn describes:

> continuing problems with (a) definitional clarity about a UDL intervention; (b) inability to isolate the active ingredients thought to make UDL effective; (c) guidelines about the dosage of UDL intervention need to achieve access, engagement, and success; and (d) appropriate research methodologies relevant to

> the standard of evidence-based practice. Despite these concerns, I remain hopeful about the potential of UDL. (p. 308)

The challenges Edyburn describes "of isolating the active ingredients thought to make UDL effective" resonates with the research findings conducted within this case study.

Introduction

The purpose of this case study was to examine the impact the Universal Design for Learning Professional Development Framework had on teacher practice along with the potential for increases in perceived student engagement at three local middle schools. To this end, I collected qualitative data with two focused discussion groups, teacher lesson plan analysis, and short formative assessments, and quantitative data using the Technology Usage and Perception Survey. These four parts of data provided a story that describes the impact of implementing professional development using the Universal Design for Learning framework to impact teacher pedagogy.

Findings

Teacher Focus Groups

In analyzing the focus group interviews of the teachers' personal middle school learning, it provides evidence that the teachers were strongly influenced by their own school experiences. Their own self-efficacy on how they learned impacted the way in which they designed lessons for their students. Teachers described themselves as traditional learners who were, for the most part, successful in school. They learned through lecture, note-taking, and multiple-choice assessments. Even though the professional development was designed to provide educators with the tools to understand the importance of a students' personal context to engage in their learning, it became

evident that the teachers' personal learning experiences influenced their lesson design process. This supports the claim by Makoeele and Van Der Merwe (2014) that "educational change has to take into consideration teacher beliefs and attitudes which necessarily influence personal vision and mission, if it is to be successful" (p. 171). The personal beliefs that a teacher holds around their own learning experiences can have a profound effect on how they themselves present and deliver instruction to their students. Despite learning about providing students with opportunities to demonstrate their learning using multiple means of assessment, teachers pivoted back to what they experienced in middle school.

This might have been a result of the teachers' self-efficacy for not needing to change deeply their lesson design practices. The concept of self-efficacy was established by Bandura (1977) who defined it as a judgment of the capability to execute a given type of performance (Bandura, 2006b). Self-efficacy was grounded in the social cognitive theory, which claims that people are able to exercise some control over their self-development and life circumstances even though many things depend at least partly on chance (Bandura, 2006a). Theoretically, self-efficacy was constructed from four main sources: mastery experiences, vicarious experiences, social persuasion, and somatic and emotional states (Bandura, 1977; Tschannen- Moran & Woolfolk Hoy, 2007). Malinen & Savolainen et al (2013) discuss that mastery experiences:

> are commonly seen as the most powerful since they provide the most authentic evidence of whether one can do what it takes to succeed. Nevertheless, if people experience only easy success they may come to expect quick results and become quickly discouraged when they encounter difficulties. (p. 36)

The focus group teachers had positive experiences and success in their own personal school experiences. Their positive mastery experiences in school were through traditional lesson design models of lecture, closed response questions, and whole group instruction. Therefore, designing lessons that replicated that experience would make sense to continue as they themselves had personal evidence that these strategies produced successful learning experiences.

The focus groups also shared that Universal Design for Learning was not something new. They took the components of UDL that fit within their previous lesson design construct and added them into their traditional learning model. Rather than redesigning their lessons, teachers bolted on UDL strategies into their current schema of pedagogy. This finding supports Guskey's (2003) flow-through concept. The professional development that was provided to the teachers was impactful enough for them to try out the strategies; however, their self-efficacy internalizing these practices did not become evident. The research of Haney et al. (2002) conducted a research project on teacher motivation and their will to implement change. Haney notes, "Theory holds that people tend to act according to their beliefs. More accurately then, the beliefs that teachers hold regarding science reform ideas are truly at the core of educational change" (p. 171). The research indicated that the belief teachers have about themselves influences how they conceptualize change. This implies that if the teacher had successful experiences with a lecture, note-taking, and multiple-choice assessment education, they are influenced by that learning and internalize those strategies into their practice.

The third major theme that surfaced during the focus group interviews centered around student engagement. The teachers all expressed how important student

engagement was in student learning. They also shared that technology was able to increase student engagement. Those two components were often seen as complementary, and technology was not necessarily leveraged to provide multiple means of accessing content, but rather being used to increase student engagement during the initial introduction and exploration of content. In addition, teachers had apprehension in committing to the technology due to beliefs of poor connectivity and access. As Makoeele and Van Der Merwe (2014) point out, "Teacher beliefs are important because, together with their context, they shape how they will relate to the change process." (p. 171) The UDL professional development model attempted to change teacher practices and increase student engagement. However, the deep-rooted beliefs and attitudes the teachers brought into their pedagogical practices influenced their lesson design.

Teacher Lesson Plans

A second component of this case study included analyzing teacher lesson plans. Teachers were given training and instruction on how to use the UDL Lesson Plan Bookmark (Appendix A). This template included a checklist of the UDL principles to support and guide teachers as they were lesson planning. The first two elements of lesson design that were highlighted included:

- Understanding of Big Ideas
- Understanding of Essential Questions

Both of these elements were critical in anchoring both the lesson and unit of study. Teachers were provided models and collaborated with colleagues to develop model lessons for their own classrooms. Teachers provided these lessons as evidence of practice and UDL implementation.

The examples that the teachers provided for big ideas fell into three categories: (1) represented a big idea of the lesson topic, (2) compared/contrasted the lesson topic, or (3) defined the lesson topic. Based upon the examples that were analyzed, conceptual ideas were difficult for teachers to develop within their lessons of study. This may have been due to the fact that many of the tasks students were being asked to complete were content specific. The content area drove the instruction, and it created big ideas that were specific to the topic rather than connecting the topic to a universal concept. Teachers were given ample time to develop their lessons; however, the reflection that needed to occur once the lesson was completed needed to be more prescriptive. The professional development did not provide an opportunity for reflective questioning. As the literature states, both in the Dymond et al. (2006) and Meo (2008) case study, teachers needed extended time to plan and work together in order to make the work successful. In particular, Dymond's (2006) study required more time than was initially projected, and the researchers believed that if the study occurred over multiple years, an even better understanding of the process could be developed" (p. 307). The planning time was provided, but the reflection and feedback loop to provide an opportunity to reassess their work through a UDL lens was not included. Even if the opportunity had been available, the conversations would have been challenging. This is further supported by Makoeele and Van Der Merwe (2014) work on teacher change:

> The notion of how teachers change is a complex issue. Similarly, the way teachers conceptualize the notion of changing from a traditional to an inclusive teaching method is a difficult and ongoing process. It is significant for teachers to take the opportunity to reflect on the proposal for change by reviewing their values and beliefs and the manner in which these values affect their daily work. Teachers should allow themselves to think on their own about change rather than having change imposed on them. (p.171)

Teachers were provided the tools for changing their lesson design along with being asked to redesign their current lessons of study. However, the opportunity for reflection on how these changes aligned with their personal beliefs and time to process through the work after completion was not built into the professional development opportunity.

Therefore, when they were asked to move into the next step in the lesson design process of developing essential questions, the teacher's examples of essential questions were close-ended rather than the open-ended thinking that was discussed in the professional development sessions. Essential questions were meant to provide students an opportunity to probe for deeper meaning with the big ideas of the lesson. However, if the big ideas of the lesson were content driven, it was challenging to have an essential question that reflected an open-ended answer. The professional development sessions modeled the importance of beginning with the end in mind, developing big ideas and essential questions to create opportunities to experience the principles of UDL. Those are critical elements of professional learning that connect to Chapter 7, "Learning From the Field" Rose, Meyer, & Gordon (2014). They share the importance of designing instruction from the start that considers the diversity of learners.

In both lesson plan examples, big ideas and essential questions were explicitly taught and modeled; however, the internalization of the work was not evident. This was not due to the lack of instruction, but rather not having an opportunity for reflection and feedback after the lesson was implemented. The research supports the need to help teachers reflect critically on themselves. As Makoeele and Van Der Merwe (2014) share their research:

> One of the factors hindering the collaborative action-research process was the fact that teachers hardly disagreed with anything said or done by authority figures (a culture of being submissive). Consequently, it could be very difficult for anyone in a position of authority (in my case, as the researcher) to elicit an honest opinion from the teachers about anything, which could have jeopardized the trustworthiness of the research process. (p. 178)

In both cases, reflective conversations were not a part of the process, and without the opportunity to engage in meaningful discussion with critical feedback, teachers most likely did not recognize the gaps in their lesson design.

Teachers did provide evidence to support their value of student engagement, especially around lesson openers. Two additional specific instructional design elements were assessed within the UDL lesson plan template which included:

- Lesson openers
- Summative Assessments

Both elements were meant to provide students with opportunity for increased engagement and choice in demonstrating their learning. The examples teachers provided for Lesson Openers demonstrated their understanding and importance of student engagement. Evidence of engagement around lesson openers came in the form of both technology, movement in the classroom, and novelty activities the teachers shared in their lessons. However, when sharing the opportunities for summative assessments, the lesson plans provided examples that gave students little choice or voice in their learning. When the learning was more exploratory and not for a grade, the UDL lesson design components were more readily implemented. At the point of assigning students' summative assessments, where students would be graded, teachers gravitated back to a traditional assessment (essays and tests). This may be in part to the traditional beliefs that they held

regarding assessment. As noted by Makoeele and Van Der Merwe (2014), "Teacher beliefs are important because, together with their context, they shape how they will relate to the change process." (p. 171) Their belief systems influenced their selective implementation of parts of the UDL lesson design template.

Teacher Formative Assessments - Understanding the Role of Lesson Design

UDL Lesson Design drove the professional development model that was used throughout the teacher training. Including multiple ways to: engage students, represent big ideas and content, and multiple ways for students to show what they know (formative and summative assessments) guided each session that the teachers experienced. The framework (Rose & Meyer, 2002, p. 74).

shares one common similarity: providing all students with options. These three principles align with Carol Ann Tomlinson's three elements of the curriculum that can be differentiated: Content, Process, and Products. (2001). This framework outlined our process for professional development for Universal Design for Learning implementation. Those guidelines became the foundational piece for the teacher's professional learning experience.

While there was not an opportunity for reflection and feedback after the lesson implementation occurred, teachers were given short formative assessment opportunities to reflect on their lesson design understanding during the professional development time. Teachers were assessed on their ability to define the component in their own words, reflect on how they would implement that area, and describe implementation within the lesson cycle. The areas of lesson design that were selected for reflection included explanation and exploration. Teachers were able to define, reflect on how this might be

done in a classroom setting, but they never were expected to implement the practice. Rather, they described potential implementation strategies. The formative assessments showed that teachers understood the definitions and could take one piece of the UDL framework and look for ways to implement it into the lesson. More importantly, it showed that teachers needed the opportunity to identify mutual and complementary skills. They needed to feel empowered, so that all teachers came to this new, shared responsibility from a stance of real purpose and commitment. Jackson's et al. (2001,p. 5) Otherwise, we saw selective parts of the framework being used to retrofit their current lesson design practices.

Technology Usage Perception Survey

The Technology Usage Perception Survey provided data on what teachers believed about the role of technology in the classroom, as well as their comfort and confidence with technology in general, with pedagogy of technology, with a variety of different specific technologies. The survey also asked about the frequency that they use those technologies and the frequency with which their students use those technologies. In the two data sets that were analyzed:

- 2014 to 2016 changes in the average domain responses for all participants for an average of all teachers
- 2014 to 2016 changes for a sample group of four classroom teachers (Three teachers were science teachers and one teacher taught English language arts and social studies).

In both sets, there was not a statistically significant difference between participants' responses from the beginning vs. the end of the study. This may have been due to the structure of the survey. Teachers could have rated themselves lower based upon the new learning. The survey, including its design, may not have had the power to detect statistically significant differences in a pre-post survey design. Lastly, the sample size may not have been sufficient to demonstrate a significant difference before and after the professional development experience.

Furthermore, teachers demonstrated confidence in their personal use of technology, and they were often more concerned with the infrastructure not being able to support the work that they wanted to use the technology for within the lesson. Whether or not their skills reflected their impression was challenged by the lack of confidence we saw in trying out the technology in a systematic way. In an effort to provide students with choices, teachers consistently provided an alternative to using technology when completing lessons. This particular finding supported the need for schools to have technology infrastructure that are both stable and reliable The work of Abel (2005) reinforced this finding. His team identified four professional development issues that needed to be considered in UDL implementation: district support for text reader software, digital text, district technical support, and building a state support network. The results also showed districts need strong leadership and vision, and sustained commitment of state and local fiscal resources to allow the project components to become best practice. Without teachers having the confidence in the technology, they were far more likely to rely on traditional tools for lesson design.

Limitations of Study

There were a few limitations to this study. As part of the case study, I decided to interview teachers for my focus groups from a specific school district with teachers who taught only 7th and 8th grade. The limit to approaching just this grade level group was that I would be leaving out the full range of grades in a comprehensive K-12 public school district. Elementary and high school teachers may have had a different approach to implementing Universal Design for Learning as well as having different personal experiences that led them into teaching. The focus groups provided an important lens into understanding how teachers' own educational experiences impacted their lesson design process and willingness to redesign their instructional practices. By limiting my case study to the middle school grade bands, I might have missed hearing a different perspective of experiences as the elementary and high school teachers may have been influenced to become a teacher for other reasons or experiences.

The TUPS (Technology Usage Perception Survey) was intended to show teacher and student growth with technology use in the classroom. In addition, the professional development was designed to include opportunities for teachers to learn about new technology tools and websites that could increase student engagement, provide multiple means to access content, and give students choices with assessment. The survey was given at the start of the professional development experience, and the perception teachers had of their technology skills was higher than expected. Furthermore, we did not provide a list of the technology tools and resources that would be implemented throughout the professional development experiences. Therefore, the survey results may have been limited due to the fact that teachers realized that their skill level was not as high as they

originally thought based upon the introduction of new resources. As the teachers began to learn more about using the technology to enhance student learning, they may have become less confident in their ability based upon their increased experiences with new tools.

Lastly, the methodology of using the UDL Lesson Plan Bookmark (Appendix A) was the key tool used during the professional development. This design framework provided teachers with the roadmap for all their lesson design throughout the training. The tool was designed to support and guide teachers in the implementation of UDL within their classrooms. All the key components of UDL were embedded within the tool. However, as Edyburn (2021) notes there are concerns with, "(a) definitional clarity about a UDL intervention; (b) inability to isolate the active ingredients thought to make UDL effective." (p. 308) Lesson plans were a key artifact collected within this case study. Other artifacts, such as samples of student work and assessments may have provided additional data to support the impact of UDL implementation on teacher pedagogy and student engagement.

Directions for Future Research

Now, more than ever, we are seeing students who are disengaged with their learning and falling socially, emotionally, and academically behind. Reframing our instructional design model requires more than a simple retool. My research opens opportunities for future studies on how Universal Design for Learning professional development could be embedded within the school setting to provide: (1) teachers with reflection time with both a coach and administrator that requires and encourages changes in pedagogy and (2) a system-wide change to a district's teaching and learning framework.

One example of digging deeper into UDL professional development would be studying lesson design using a building- based coaching model. Much of the professional development provided throughout this case study was done on-line or off-site. By not having a systemic approach within the building for teacher reflection, the professional development became a series of events that teachers prepared for each time we met. Universal Design for Learning was intended to be a framework that is used to design instruction from the start with the learner being at the center of the work. Unfortunately, an unintended consequence of having a cohort of teachers receive professional development off-site, the day-to-day practices of the teachers were not dramatically changed, but rather they were tweaked or augmented to fit their traditional lessons. While the experience occurred over two years, with the plan for systemic change in practice, taking the work directly into the school building might have produced different levels in teacher change of pedagogy.

My study revealed the challenges that teachers had with identifying students' unique learning needs. The teachers understood the importance of student engagement; however, designing the lessons to create a learner-centered classroom required them to completely rethink their lesson design process. Even with providing teachers with an explicit UDL framework to follow, it almost seemed overwhelming for them to implement. Future research could be done around designing smaller lesson prototypes that teachers use within the classroom. With these smaller experiences, we could have time for peer reflection and administrative feedback. This could be studied at the building level with a higher level of fidelity than that which was experienced in the cohort model of professional development.

Additional research and data collection models need to be developed to measure the impact of the UDL framework. This type of research will help with the question that Edyburn (2021) asked, "Would you recognize universal design for learning if you saw it?" In his latest study, he discussed the importance of finding exemplars of UDL within the field of education:

> Three types of exemplars are highlighted: (a) platform tools, (b) web-based curricula, and (c) embedded supports. Such efforts provide a foundation for understanding the primary and secondary beneficiaries of UDL interventions and serve as an essential step forward in measuring claims about the efficacy and outcomes of UDL when implemented at scale. (p. 308)

Investing in research that supports studying the impact of these exemplars on student engagement and achievement would support the efficacy of the UDL framework and the benefits of supporting strategic and systemic implementation around UDL pedagogy.

Conclusions

The purpose of this study was to understand the impact of the Universal Design for Learning framework on teaching practices. The case study sought to provide how implementing the UDL framework would change teacher pedagogy and enhance student self-efficacy and engagement. This was done through explicit professional development focusing on the three key principles of UDL:

- Multiple Means of Engagement (Affective)
- Multiple Means of Representation (Recognition)
- Multiple Means of Action and Expression (Strategic)

In addition, teachers received training on how technology could be leveraged in their lesson design to increase multiple means of engagement, representation, action and

expression respectively. Key themes that emerged through this study included: (1) the importance of recognizing the impact teachers' own personal school experiences (self-efficacy) have on their teaching practices (2) the UDL framework needs to be experienced in a systematic way, with embedded coaching and administrative support, that allows teachers to redesign their instruction rather than retrofit current practices, and (3) technology implementation needs to be part of the design within the UDL framework and not be the main driver of instruction framework.

A major finding of this study was the need for teachers to experience the UDL framework from the perspective of good design from the start that does not begin with their old model of lesson planning. The professional development's strong focus around lesson design did not allow for teachers to experience the UDL framework in a way that would allow them to implement these strategies with a more personal approach. Based upon the narratives that emerged in the focus groups, the personal experiences teachers had with their own learning strongly influenced how they currently taught. Those personal experiences clearly influenced how teachers ran their classrooms, designed lessons, and assessed students.

With such a high level of focus on lesson design during the professional development, the important aspect of creating a culture of learning within the classroom was not a focus of this case study. Teachers were very focused on their lesson or unit design, and the results showed that rather than a systemic implementation around the UDL framework occurring, more modular and segmental examples of specific UDL strategies emerged. While these strategies were helpful to student learning, they did not systemically change teacher practices or cause a significant change in student

engagement. The UDL framework was not internalized in the sense that it became a natural and regular part of teachers' instructional practices. Rather, elements of UDL were implemented within the traditional lesson plans. New lesson designs were not created, but rather old lessons were retrofitted with pieces of the UDL framework added into the original lesson design.

Lastly, using technology in lesson design was not seen as lever to support students in multiple means of accessing content or providing choice with assessments. Technology was used to increase engagement, novelty, or review. Teachers shared reluctance in their confidence in the infrastructure and stability of the technology. They all shared a concern with the need to have a stand-by activity in the ready in case the technology was not working. The lack of confidence in technology made designing UDL lessons with certain web-based tools a challenge, and it impacted the types of lessons that were designed in the classroom. Unlike the other challenges that emerged in implementing the UDL framework, this was an issue that was outside of the control of the classroom teacher.

Moving forward, this study provides recommendations and the need for systemic support within schools around a teaching and learning framework. This case study focused on Universal Design for Learning as the pedagogy and design framework for classroom instruction. Schools need to have a foundational pedagogy that drives how students will learn. UDL provides that framework; however, the school system must believe in the framework and offer the necessary support with coaching, administrative feedback, and infrastructure to see real changes and improvements in student learning. Supporting our teachers in becoming instructional designers of their teaching practices

gives them the confidence to teach our students differently with opportunities for choice, voice, and ownership of their learning.

APPENDICES

APPENDIX A

UDL LESSON PLAN BOOKMARK

UDL Lesson Plan Creator

The E3T Lesson Plan Creator for universally designed curriculum focuses on the following main elements.

☐ **BIG IDEAS:** *The concepts or principles central to the lesson that anchor or connect the smaller ideas.*

☐ **ESSENTIAL QUESTIONS:** *Questions that help students probe for deeper meaning.*

☐ **LEARNING OBJECTIVES:** *2-4 learning targets that reflect the understandings or insights students are expected to develop by the end of this lesson.*

☐ **SUMMATIVE ASSESSMENT:** *Provide a choice of topics (when appropriate) and multiple options of means for completing the assessment to support different learning needs/preferences. Include an explicit description of the criteria for quality work.*

☐ **LESSON OPENING:** *Lesson openers establish a purpose, are engaging and activate prior knowledge.*

☐ **EXPLORATION:** *Activities that help students make discoveries related to big idea(s) and promote student inquiry.*

☐ **CHECK FOR UNDERSTANDING:** *Determine the student's level of understanding as it relates to the big idea, essential questions and learning objectives. Use methods that assess all learners and addresses the next steps based on the assessment results.*

☐ **EXPLANATION:** *Information delivered so that students develop a mastery of the objectives. Includes explicit learning strategies, multiple representations of info provided, frequent opportunities for response and practice and a variety of student centered learning activities.*

☐ **CHECK FOR UNDERSTANDING:** *Determine the student's level of understanding as it relates to the big idea, essential questions and learning objectives. Includes a plan for re-teaching material as needed.*

☐ **EXTENDED PRACTICE:** *Activities used to help deepen understanding and provide for greater fluency and accuracy of new skills.*

☐ **CLOSING:** *A review of big ideas for the purpose of tying ideas together, transitioning to next lesson or continuing practice.*

Adapted from: Planning Effective Instruction (Price, Nelson) 2008

E3T UDL Principles Checklist

As you plan your lesson, keep track of the UDL principles you have included. The goal is to include as many as possible. This checklist is attached in the lesson planning form on our website.

- ☐ Make expectations (objectives, rubrics, grading) explicit from the start
- ☐ Include multiple ways to engage students
- ☐ Include multiple means of representing the big ideas
- ☐ Include alternatives to the text e.g. website, article, video, audio summary, or lower reading level text
- ☐ Include checks for understanding to shape instruction
- ☐ Include methods that require students' active participation
- ☐ Include a choice of learning options that provide greater support or challenge
- ☐ Include options to help students learn from the text and classroom materials e.g., text-reader, comprehension supports
- ☐ Provide step by step instructions for using learning strategies
- ☐ Provide access to class notes in various formats e.g., outline, graphic, studycast
- ☐ Include multiple ways for students to show what they know (formative and summative assessment)

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APPENDIX B

TECHNOLOGY USAGE PERCEPTION SURVEY

Technology Usage and Perception Survey

Part I: Technology Access and Support

For the following statements, please select the one response that best describes the technology specialist support at your school.

Responses: 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree

1. I have adequate access to a technology specialist.
2. The technology specialist adequately assists me in solving technical problems with hardware or software.
3. The technology specialist is committed to helping teachers find solutions.
4. The technology specialist responds promptly to my requests for assistance.
5. The technology specialist models techniques to integrate technology into my teaching.
6. The technology specialist provides professional development.
7. The technology specialist adequately assists me in planning and implementing the use of technology in my teaching.

Part II: Preparation for Technology Use (In School)

Descriptions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.

Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

For the following items, please select the one response that best reflects the extent to which you've acquired technology skills from the following sources.

Responses: 1-not at all, 2-to a small extent, 3-to a moderate extent, 4-to a great extent, 5-entirely

1. As a part of my undergraduate coursework
2. In-service courses or workshops
3. Independent learning (e.g., online tutorials or books)
4. Distance learning courses
5. Interaction with colleagues
6. Interaction with others (e.g., friends, family, etc.)

Part III: Preparation for Technology (Professional Development)

To what extent do you think the following types of technology-related professional development would be beneficial to you?

Responses: 1-not at all, 2-to a small extent, 3-to a moderate extent, 4-to a great extent, 5-entirely

1. Introductory technology skills
2. Professional productivity (e.g., gradebooks, calendar, address book)
3. Instructional applications (e.g., presentation, digital content creation)
4. Training on applications used by students
5. Specialized training on pedagogy of technology integration

Part IV: PERCEPTIONS – Perceptions of Teaching Use

Descriptions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.

Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

Please read the following statements and select the one response that best reflects your level of agreement.

Responses: 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree

1. I would like every student in my class(es) to have access to a digital device.
2. Technology skills are essential to my students' success in school.
3. Technology skills are essential to my students' success in their future workplace.
4. More training would increase my use of technology in my teaching.
5. Technology makes my job easier.
6. Technology changes my role as a teacher.
7. I can help others solve technology problems.
8. Technology enhances my teaching.
9. Student use of technology enhances student performance.

10. My use of technology enhances student performance.
11. Technology should be used in all courses.
12. I would like my students to be able to use technology more in their classes.

Part V: Confidence and Comfort Using Technology

Descriptions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.

Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

Please read the following statements and select the one response that best reflects your level of agreement.

Responses: 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree

1. I have had adequate training in technical use.
2. I currently have adequate opportunities for technology training in my school.
3. I am prepared to effectively integrate technology into my teaching.
4. I am prepared to assess multimedia projects.
5. I am prepared to guide other teachers in planning and implementing lessons that incorporate technology.
6. I am comfortable using technology in my teaching.
7. I am comfortable assigning multimedia projects to my students.
8. I use technology effectively in my teaching.
9. I am developing expertise in the uses of technology in teaching.
10. I am prepared to recognize the unethical uses of technology.
11. I am comfortable teaching my students about copyright and fair use guidelines.

Part VI: Technology Integration

Descriptions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.

Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

Listed below are teaching modes in which technology may be used. Please select the response that best indicates how often you use technology in each teaching mode.

Responses: 1-not at all, 2-once per month or less, 3-once per week, 4-several times per week, 5-every day, 6-multiple times per day

1. Small group instruction
2. Individual instruction
3. Cooperative groups
4. Independent learning
5. As an extension activity
6. As a reward
7. To tutor/for remediation
8. As a research tool for my students

Responses: 1-not at all, 2-once per month or less, 3-once per week, 4-several times per week, 5-every day, 6-multiple times per day

9. As a tool for students to use in planning and managing projects (individual and group)
10. As a productivity tool for my instruction (e.g., to create charts, report or other products
11. As a student presentation tool (including multimedia)
12. Student discussion/communication
13. Instructional delivery
14. As a communication tool (e.g., email, electronic discussion)
15. To create online content for my students (web pages, blogs, etc.)
16. To assess student learning

Part VII: Teacher Use of Technology

Part VIII: Student Use of Technology

Descriptions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.

Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

1. ***For each type of software and hardware, please select the response that indicates how often YOU (THE TEACHER) USE the technology to complete school-related activities.***

2. ***Then select the response that indicates how often YOUR STUDENTS USE the software to complete school-related activities.***

[Scale: 1-not at all, 2-once per month or less, 3-once per week, 4-several times per week, 5-every day, 6-multiple times per day]

Teacher Use **Student Use**

1 2 3 4 5 6 **1 2 3 4 5 6**

Technology

1. Word processors (Word, Pages, etc.)
2. Spreadsheets (Excel, Numbers, etc.)
3. Databases (MileMaker Pro, Access, etc.)
4. Desktop publishing programs (e.g., InDesign, Publisher)
5. Presentation software (e.g., Powerpoint, Keynote, Prezi)
6. Concept mapping/Graphic organizers (e.g., Inspiration, Kidspiration)
7. Web publishing programs (e.g., DreamWeaver, Nvu, KampoZer)
8. Draw and print programs (e.g., KidPix, Illustrator, Paint.net)

[Scale: 1-not at all, 2-once per month or less, 3-once per week, 4-several times per week, 5-every day, 6-multiple times per day]

9. Photo editing (e.g., Photoshop, iPhoto)
10. Sound editing (e.g., Garageband, Audacity)
11. Video editing (e.g., iMovie, MovieMaker, Final Cut, Premier)

12. Authoring tools (e.g., Flash, HyperStudio, iBooks Author)
13. Animation (e.g., iStopMotion, Frames)
14. Drill and practice software (e.g., practice for spelling or math)
15. Instructional games (e.g., Oregon Trail, Lemonade Stand)
16. Simulations (e.g., frog dissections, science experiments)

[Scale: 1-not at all, 2-once per month or less, 3-once per week, 4-several times per week, 5-every day, 6-multiple times per day]

17. Simulations (e.g., frog dissections, science experiments)
18. Learning Management Systems (e.g., Edline, Blackboard, Moodle)
19. Email
20. Web browser (e.g., Chrome, Firefox, Internal Explorer, Safari)
21. Web 2.0 tools (e.g., blogs, wilds, GoogleDocs)
22. Social netwo
23. rking (e.g., Facebook, Twitter, Edmodon)
24. Video conferencing (e.g., Skype, Facetime)
25. Desktop computer

[Scale: 1-not at all, 2-once per month or less, 3-once per week, 4-several times per week, 5-every day, 6-multiple times per day]

26. Laptop computer
27. Tablet computer (e.g., iPad)
28. eReader (e.g., Kindle, Nook)
29. Digital camera
30. Digital video camera
31. Projector
32. DVD player
33. Interactive Whiteboard (e.g., SMART Board, Promethean)

Part IX: Technology Skills

Part X: Usefulness

Descriptions

Technology: Digital devices, software, and connectivity that allow the use of digital content in the classroom.

Digital Devices: Any hardware device that students or teachers can use to search for, create, manipulate, or consume digital content.

1. ***For each type of software and hardware, please select the response that indicates your level of skill with the technology in your teaching.***

2. ***Then select the response that indicates how often you think the technology is for your teaching area (usefulness).***

[Scale: 1-none, 2-very low, 3-low, 4-moderate, 5-high, 6-very high]

My Skill **Usefulness**

1 2 3 4 5 6 **1 2 3 4 5 6**

Technology

1. Word processors (Word, Pages, etc.)
2. Spreadsheets (Excel, Numbers, etc.
3. Databases (FileMaker Pro, Access, etc.)
4. Desktop publishing programs (e.g., InDesign, Publisher)
5. Presentation software (e.g., Powerpoint, Keynote, Prezi)
6. Concept mapping/Graphic organizers (e.g., Inspiration, Kidspiration)
7. Web publishing programs (e.g., DreamWeaver, Nvu, KampoZer)
8. Draw and paint programs (e.g., KidPix, Illustrator, Paint.net)

[Scale: 1-none, 2-very low, 3-low, 4-moderate, 5-high, 6-very high]

My Skill **Usefulness**

1 2 3 4 5 6 **1 2 3 4 5 6**

9. Photo editing (e.g., Photoshop, iPhoto)
10. Sound editing (e.g., Garageband, Audacity)
11. Video editing (e.g., iMovie, MovieMaker, Final Cut, Premier
12. Authoring tools (e.g., Flash, HyperStudio, iBooks Author)

13. Animation (e.g., iStopMotion, Frames)
14. Drill and practice software (e.g., practice for spelling or math)
15. Instructional games (e.g., Oregon Trail, Lemonade Stand)
16. Simulations (e.g., frog dissections, science experiments)

[Scale: 1-none, 2-very low, 3-low, 4-moderate, 5-high, 6-very high]

My Skill **Usefulness**

1 2 3 4 5 6 **1 2 3 4 5 6**

17. Tutorials (e.g., programs that teach specific subject matter)
18. Learning Management Systems (e.g., Edline, Blackboard, Moodle)
19. Email
20. Web browser (e.g., Chrome, Firefox, Internet Explorer, Safari)
21. Web 2.0 tools (e.g., blogs, wilds, GoogleDocs)
22. Social networking (e.g., Facebook, Twitter, Edmodo)
23. Video conferencing (e.g., Skype, Facetime)
24. Desktop computer

[Scale: 1-none, 2-very low, 3-low, 4-moderate, 5-high, 6-very high]

My Skill **Usefulness**

1 2 3 4 5 6 **1 2 3 4 5 6**

25. Laptop computer
26. Tablet computer (e.g., iPad)
27. eReader (e.g., Kindle, Nook)
28. Digital camera
29. Digital video camera
30. Projector
31. DVD player
32. Interactive Whiteboard (e.g., SMART Board, Promethean)

APPENDIX C

IRB APPROVAL LETTER

OAKLAND UNIVERSITY

Institutional Review Board for the Protection of Human Subjects

DATE:	April 19, 2016
TO:	Carrie Wozniak
FROM:	Oakland University IRB
PROJECT TITLE:	Universal Design for Learning - Professional Development Case Study
REFERENCE #:	867080-4
SUBMISSION TYPE:	New Project
ACTION:	APPROVED
APPROVAL DATE:	April 19, 2016
EXPIRATION DATE:	April 18, 2017
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # 7
IRB MEETING DATE:	April 28, 2016

Thank you for your submission of New Project materials for this project. The Oakland University IRB has APPROVED your submission. This approval is based on an appropriate risk/benefit ratio and a project design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

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