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Transformative Models in K-12 Education:
The Impact of a Blended Universal Design for Learning Intervention
An Experimental Mixed Methods Study

by

Kai Monet Mathews

A dissertation submitted in partial fulfillment
of the requirements for the degree of

Doctor of Philosophy

May 2016

Dissertation Committee

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University of San Diego

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UNIVERSITY OF SAN DIEGO
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TITLE OF
DISSERTATION: TRANSFORMATIVE MODELS IN K-12 EDUCATION:
THE IMPACT OF BLENDED UNIVERSAL DESIGN FOR
LEARNING INTERVENTION

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ABSTRACT

Accountability measures, by way of standardized curriculum and assessments, have played a large part in the attempt to ensure that students from all backgrounds receive equal access to quality education. However, the inherent disadvantage of a standardized system is the implied assumption that all students come in with the same knowledge, learn at the same pace, and learn the same way. In the wake of an increasingly diverse K-12 population, educational researchers, learning theorists, and practitioners agree that the concept of the average student is, in fact, a myth. Students come to school with different needs, norms, interests, cultural behavior, knowledge, motivations, and skill sets. In order for education to properly address the issue of equity, the issue of learner variance must first be attended to.

In 2010, the U.S. Department of Education released its educational plan encouraging teachers to address student variance through more inclusive learning environments. The report highlighted Blended Learning (BL) and Universal Design for Learning (UDL) as promising practices in enabling, motivating, and inspiring all students to achieve regardless of background, language, or disability. Research suggests that the combination of these two approaches could lead to transformative teaching practices that dramatically impact student learning. However, the efficacy of such a model has yet to be tested.

This study tested the efficacy of a Blended Universal Design for Learning (BUDL) model in improving student outcomes. An experimental design was used to explore the impact of a two-week BUDL intervention in an accelerated 7th grade math class. The effect on student achievement, engagement, and perception was measured.

Both quantitative and qualitative data were collected. Though results from the study were statistically insignificant, possible positive associations between a BUDL intervention and student achievement, engagement, and perception emerged. Considerations for clinical significance, suggestions for improvement on the BUDL model, and implications for future research are discussed.

DEDICATION

For my parents, Mark and Gail Mathews. Your relentless faith in my abilities, unyielding support in my development, and unconditional love have brought me thus far. I am grateful, blessed, and highly favored to have you two as parents. I love you.

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CHAPTER ONE: BACKGROUND AND PURPOSE OF THE STUDY

Introduction

In 2010, the U.S. Department of Education released a report, titled *Transforming American Education: Learning Powered by Technology*, a detailed plan to create more engaging, empowering, and personalized learning experiences (Atkins et al., 2010). Throughout the seventy-five-page plan, the authors consistently referred to the concept of teaching all students and addressing student variance by providing more inclusive learning environments. The model put forth in the report highlighted both Blended Learning and Universal Design for Learning as a means to enable, motivate, and inspire all students to achieve regardless of background, language, or disabilities (Atkins et al., 2010). Five years later, both of these approaches have garnered much attention and have been touted as potentially transformative practices in the field of K-12 education. To understand why, it is first necessary to understand what Blended Learning and Universal Design for Learning are and how aspects of their framework could affect the teaching and learning paradigm.

Blended Learning 101

In its simplest definition, Blended Learning (BL) is the merger of face-to-face and technology driven instruction. Crafted by researchers at the Clayton Christensen Institute for Disruptive Innovation, the elaborate and widely accepted definition is

A formal education in which a student learns at least in part through online learning, with some element of student control over time, place, path, and/or pace; at least in part in a supervised brick-and-mortar location away

from home; and the modalities along each student's learning path within a course or subject is connected to provide an integrated learning experience (Christensen, Horn & Staker, 2013).

This definition of Blended Learning has three significant implications for educators. First, technology becomes an integral part of the learning environment. Second, students get some say or choice in various aspects of the learning. Third, the different modalities inform each other to ensure the educational needs of each child are being properly met (Christensen, Horn & Staker, 2013).

Although there are varying models of BL, the potential outcomes (when implemented effectively) are positive across the spectrum. Blended Learning has been credited with increasing classroom flexibility, student engagement, and access to education (Bakia et al., 2012; Christensen & Horn, 2008; Lips, 2010; Watson and Gemin, 2008; Picciano & Dziuban, 2007). In addition, researchers and practitioners alike have attributed the practice to increasing such desired outcomes as personalized learning, thoughtful reflection, and differentiated instruction (Watson & Gemin, 2008).

Universal Design for Learning 101

Having evolved from the concepts of Universal Design in architecture, Universal Design for Learning (UDL) is based off the ideal that the "design of products and environments should be usable by all people to the greatest extent possible without the need for adaptation or specialized design" (as cited in McGuire, Scott, & Shaw, 2006). The approach was seen as a potentially viable way for general education teachers to implement more inclusionary practices that address the needs of students with disabilities. Although UDL started as a promising pedagogical strategy in the field of

Special Education, in the past few years the approach has gained traction in the ever-relevant debate of general education reform (Mcguire, Scott & Shaw, 2006).

The goal behind UDL is to significantly increase the flexibility and therefore, accessibility of a classrooms' curriculum by providing supports and alternatives that meet the needs of a wide range of students. The three core principles of UDL are to provide:

- Multiple means of engagement (the “why” of learning)
- Multiple means of representation (the “what” of learning)
- Multiple means of action and expression (the “how” of learning) (Meyer, Rose, & Gordon, 2014)

An example of UDL in practice is allowing students to choose how they will demonstrate their knowledge. For instance, if the goal of the lesson is to have students understand the thematic underpinnings of a novel, giving them the choice between doing a PowerPoint presentation, writing an essay, or creating their own one act play that aligns thematically to the story, is a way to address differences in students' skills, interests, and motivations. By intentionally creating a flexible curriculum, the promise of UDL is that it accounts for and adequately addresses the differences in how and why students learn. Through this approach student diversity is not only being supported, but also “proactively being valued” (Edyburn, 2010).

As the next few sections detail, the need to implement an approach that can address student variance and diversity through pedagogical practice is a timely one. With the changes in our student demographics, and our social and workplace connections exceeding the bounds of our country, the impact of such practices as Universal Design

for Learning and Blended Learning could very well be significant in improving educational opportunities for all students.

Addressing Student Diversity

Today, the issue of learner variance in education has been brought to the forefront due to the growing diversity of our student population. Carol Tomlinson, an expert in the field of differentiation in learning and teaching, gives a rich description of the average K-12 classroom in America today:

Seated side by side in classrooms that still harbor a myth of ‘homogeneity by virtue of chronological age’ are students with identified learning problems; highly advanced learners; students whose first language is not English; students who underachieve for a complex array of reasons; students from broadly diverse cultures, economic backgrounds, or both; students of both genders; motivated and unmotivated students; students who fit two or three of these categories; students who fall closer to the template of grade-level expectation and norms; and students of widely varying interests and preferred modes of learning. (Tomlinson et al., 2003, p. 119-120).

In the wake of an increasingly diverse student population, the need for teachers to provide a more flexible curriculum becomes apparent.

Learners come to school with different needs, motivations, and skill sets. The current education system is not set up to support or foster this diversity between students (Darling-Hammond, 2010; Tomlinson et al., 2003, Papert & Harel, 1991). Since *Brown vs. The Board of Education*, the historic Supreme Court decision that proclaimed the

racial segregation of children in public schools violated the Equal Protection Clause of the Fourteenth Amendment, the K-12 system has come a long way in providing equal schooling for all students across the country. The *Brown vs. Board* decision upheld the idea that “separate was not equal” and required changes in current policies and structures to mend the disparity between white and black students. In addition to desegregating school nationwide new standards were implemented to address issues of equality between schools and classrooms. This began the start of the accountability movement.

Accountability measures, by way of standardized curriculum and assessment, played a large part in the attempt to ensure that students from all backgrounds received equal access to quality education. However, the inherent disadvantage of a standardized accountability system is the implied assumption that all students come in with the same knowledge, learn at the same pace, and learn the same way. It has become abundantly clear in the years since *Brown vs. The Board of Education* that equality does not necessarily yield equity. Equality requires that everyone receives the same thing, equity requires that everyone receives what they need. In order for education to properly address the issue of equity or fairness, the issue of learner variance must first be attended to.

Tomlinson et al., (2003) description highlights the concept that student diversity extends beyond racial, ethnic, gender, and socioeconomic background to include student variant factors like interest, motivation, and skill level. Demographic factors, as well as student variant factors, can and do impact how and why a student learns. For this reason, it is important for learning environments to accommodate diversity as it is broadly defined by Tomlinson. For the purposes of this study, student variance and student diversity are used interchangeably.

The Needs of a Globalized Society

In addition to addressing the growing diversity (or variance) of the K-12 population, public education has also been charged with the laborious task of preparing students to enter a diverse, ever-expanding society and workforce. The Internet, expanded free trade agreements, liberal immigration policies, and multi-billion dollar transnational corporations have contributed to creating a globalized society. This shift has a profound implication for schools, whose purpose is to prepare college and career ready individuals. In his commentary to the AASA Journal of Scholarship and Practice, Christopher Tieken speaks in support of fostering student diversity, stating, “The diversity of the U.S. is its greatest strength. The U.S. economy is able to adapt to change because of the skill diversity of the work force” (2011, p. 11). Given the dynamic world we live in, it seems we would be remiss not to have an educational system that supports and nurtures the variety and wide range of skills innate in our K-12 student population.

The onus is on educators to prepare individuals who are qualified to take on the multi-dimensional jobs our society has to offer or will have to offer. Cathy Davidson, a distinguished scholar on the history of technology and a recently appointed member of the National Humanities Council, prophesized that 65% of today’s grade school kids will end up at a job that has not been invented yet (Heffernan, 2011). The implication of this statistic is that students must learn today how to continue learning for tomorrow. The current practice of simple knowledge acquisition will not sufficiently educate our students for the workforce or for the world that awaits them after high school. Students’ success will be based on their ability to continuously construct new knowledge, new ways of learning, and new ways of thinking.

Seminal Learning Theories

Addressing student variance in instruction is not a new concept. In fact, though the basis of UDL was not constructed until the late 1900s, the learning theories on which this approach is based have been around for almost seventy years. For instance, Jean Piaget promoted the theory of a developmentally appropriate education, which is “an education with environments, curriculum, materials, and instruction that are suitable for students in terms of their physical and cognitive abilities and their social and emotional needs” (as cited in Slavin, 2000, pg. 41). Piaget believed that a child’s past experience and existing knowledge contributes to how they learn and how they understand new concepts. He also felt that in order for instruction to be effective it must be adapted to the developmental status of the child.

Lev Vygotsky is another prominent theorist whose work supported the nurturing of student diversity in educational settings. Vygotsky believed that learning took place when children were working within their zone of proximal development (ZPD). The zone of proximal development “describes tasks that a child has not yet learned but is capable of learning at a given time” (Slavin, 2000, pg. 45). These tasks are just above a child’s current ability, but are accessible with assistance. Because children can be in different developmental stages, it is necessary for instructors to provide curriculum that supports multiple zones of proximal development. Vygotsky’s theory on social learning has also led to the paradigm of scaffolding. Scaffolding is the practice of providing student support in the beginning of their learning, then progressively diminishing the support as the student becomes more competent (Sawyer, 2014). Scaffolding can come in different forms depending on the educational needs of the child. Providing appropriate levels of

entry to a problem or concept is another way to differentiate instruction to address student variance.

Howard Gardner's theory of multiple intelligences also lends credence to the idea that students require different ways to engage with learning material or content. Gardner believed that there were as many as eight intelligences, including linguistic, spatial, and logical. The theory of multiple intelligences "implies that concepts should be taught a variety of ways that call on many types of intelligence" (as cited in Slavin, 2000, pg. 130), which is reminiscent of UDL's principle of providing multiple means of engagement. Related to Gardner's theory of multiple intelligences is the work of American educational psychologist, David Kolb, on learning styles. Kolb believes that people have different ways of learning and that teachers need to adapt their teaching methods to address the learning styles of their students. Kolb's theory closely aligns with UDL's principle of providing multiple means of representation.

Both Piaget and Vygotsky have been instrumental in framing constructivist models of learning, which emphasize that learners should be allowed to personalize the pace and type of information they receive. In constructivist classrooms students have some control over their learning much like they do in Blended Learning classrooms. Research shows that teachers who demonstrate more constructivist views and practices are more likely to use technology to support higher order thinking skills (Baylor & Ritchie, 2002; Levin & Wadmany, 2006; Hirumi, 2002). Given what we know about our student population, the changed expectation in our workplace, and the highly regarded beliefs of renowned learning and educational theorists, incorporating the practice of UDL and BL in education seem worthy of consideration.

Statement of the Problem

The current education system fails to properly address and support student variance. Blended Learning and Universal Design for Learning are two potential practices that could assist teachers in creating more inclusive classrooms that enable and motivate students regardless of background, language, and/or disability. This study tests the efficacy of an education model that combines Blended Learning and Universal Design for Learning, called Blended Universal Design for Learning. The study will examine if a Blended Universal Design for Learning model improves student achievement, engagement, and perception. Given the current state of public education, research investigating the utility of these two practices could greatly benefit the field and positively impact the teaching and learning paradigm. However, at present, research on the effectiveness of BL and UDL is limited in scope, design, and empirical evidence. To make significant contributions to the current knowledge base, future research would also need to address the current gaps in literature surrounding these practices. The following sections provide a gap analysis of the current research on Blended Learning and Universal Design for Learning and highlight areas that should be considered when researching the effectiveness of BL and UDL.

Gaps in Blended Learning Research

Researchers and practitioners have realized that Blended Learning integration can vary. From the literature three categories of blends, or blended learning environments, have emerged: enabling, enhancing, and transformative (Bonk & Graham, 2012; Graham, 2009). These categories are on somewhat of a continuum. Enabling blends are primarily put in place to provide access and convenience to students who, without the technology,

would not receive that particular instruction (Graham, 2009). Two examples of this are: Students who live in extreme rural areas who would only be able to go to school a few days a week, and high school students taking Advanced Placement courses that are not offered at their school site. Enhancing blends utilize the technology as a supplemental resource or tool. An example of this is a primarily face-to-face instructional environment where technology is used for in-class presentations, online research, and submitting homework.

Transformative blends, however, tend to support learning that is focused on individualization, differentiation, personalization, increased student engagement, real-time feedback, immediate intervention, and student-centric learning (Christensen, Horn & Johnson, 2008; Dziuban, Moskal, & Hartman, 2005; Garrison & Kanuka, 2004; Graham, 2009; Graham & Robinson, 2007; Staker et al., 2011; Watson and Gemin, 2008). Although many schools are adopting a Blended Learning approach, few are reaching this transformative level of integration (Sparks, 2015).

Addressing this issue back in 1995, the U.S. Office of Technology Assessment stated, “It is becoming increasingly clear, that technology, in and of itself, does not directly change teaching or learning. Rather the critical element is how technology is incorporated into instruction” (1995, p. 57). How a teacher utilizes technology has a major impact on its effectiveness in the classroom. Many scholars believe that effective Blended Learning cannot occur unless its implementation is intentional, meaningful, and purposeful (Garrison & Kanuka, 2004; Dziuban et al., 2005; Picciano, Seaman, Shea, & Swan, 2012). For Blended Learning to be transformative, teachers must have a strategic approach and purpose for integrating technology.

Though most studies focus on the physical attributes or structural elements of Blended Learning, there are still a substantial lack of exploratory, explanatory, and subsequently design research on pedagogical practices in Blended K-12 environments (Drysdale et al., 2012; Graham, 2012; Picciano, Dziuban, & Graham, 2013; Halverson et al., 2012). However, as previously mentioned, research has indicated that teachers with more constructivist views and practices tend to not only use technology to support higher order thinking skills, but also use technology more frequently, and to support more student-centered curricula (An & Reigeluth, 2011; Baylor & Ritchie, 2002; Ertmer et al. 2012; Hirumi, 2006; Levin & Wadmany, 2006; Overbay et al. 2010).

In addition to limited studies on teacher practice, very few studies have sought to “quantify the impact of BL on accessibility” (Graham, 2012). Underpinning these gaps is the need for more theoretical development that would ground Blended Learning as a valuable practice. According to Charles Graham “while some of the research in BL is solidly grounded in theory, most of the existing research has sought to describe or solve localized challenges without contributing to a coherent development of theory” (2012, pg.13). To further the practice of Blended Learning, future research should include investigations on teacher practice and its impact on student’s access to education. In essence, future studies should also contribute to the development of a theory of practice for Blended Learning.

Gaps in Universal Design for Learning Research

Though Universal Design for Learning was introduced over 25 years ago, it is only now being realized to its full potential. At the center of UDL lies the use of technology. “The reason UDL is possible today as oppose to the 1950s or even 1970s is

that digital technology provides a high degree of flexibility” (Edyburn, 2010, pg. 6). For the past two decades the extent to which UDL could be introduced into the classroom relied heavily on the extent to which modern technology was available and capable. Until recently, the implementation of UDL required the use of specialized equipment that was not readily available in the average classroom. Today, with the proliferation of devices being purchased by schools and the implementation of such practices as Blended Learning, the time is ripe for Universal Design for Learning to become a fundamental practice in special and general education alike.

Research in the efficacy of the Universal Design for Learning framework is still nascent. Though some have claimed otherwise, UDL has yet to be scientifically validated through research (Edyburn, 2010; Rao, Ok, & Bryant, 2014). Many UDL studies focus on the perception and experiences of students and teachers, but fail to examine whether a UDL intervention “caused improved student outcomes in terms of content and/or skill acquisition” (Rao et al., 2014, pg. 164). To show causality of increased favorable outcomes through UDL, more experimental designed studies are needed.

The gaps in BL and UDL literature need to be empirically addressed. The design of this study was heavily influenced by the results of this gap analysis. This study considers the need for more experimental designs, the need to focus on teacher practice, the need to build a concrete theory supporting the use of BL and UDL, and the need for more non-anecdotal evidence.

Conceptual Underpinnings for the Study

Robert Erlandson describes teachers as “educational designers,” stating that their job is to “[design] educational activities, materials and curricula” (2002, pg. 2). He also

states that teachers or educational designers have “one simple goal: to create the best possible design.” Picciano et al., (2014) agree that the instructional design of every classroom is composed of two layers, a physical layer and a pedagogical layer. The physical layer is “the presentation of or delivery of instruction, while the pedagogical layer is the strategy that enables learning to take place” (Picciano et al., 2014, pg. 28). The physical layer can encompass tools, equipment, devices, hardware, and software. It is usually a tangible artifact. The pedagogical layer can encompass teacher practice, strategy, and lesson designs. It is often an intangible artifact. These layers interplay in every lesson and in every classroom. Aspects of the physical layer can have an impact on the availability and effectiveness of the pedagogical layer (Picciano et al., 2014) and aspects of the pedagogical layer can have an impact on the necessity of the physical layer. For this reason, it is imperative that instructional designers (teachers) integrate delivery mechanisms that complement their pedagogical strategies and vice versa.

Keeping in mind that Blended Learning is the merger of technology and face-to-face instruction, and that UDL is a teaching strategy for providing students with alternative avenues for learning, BL would be the physical layer and UDL would be the pedagogical layer in a classroom that is integrating both practices. True to theory, the physical layer (BL) does affect the availability and effectiveness of the pedagogical layer (UDL) and the pedagogical layer (UDL) necessitates the physical layer (BL). As mentioned earlier, the effectiveness of Universal Design for Learning highly depends on the availability of modern technology and Blended Learning requires a purposeful and strategic approach (like UDL) to be transformative. As such, it is my belief that the merger of these two practices could produce an exceptional instructional design. Given

the potential benefits these practices boast in isolation, the theoretical framework underpinning this study is that the combination of these two practices could produce a flexible learning and teaching model that supports the diverse needs of students and improves upon traditional models of education. This study examines the efficacy of such a model, one that I will be referring to as Blended Universal Design for Learning (BUDL). Figure 1 depicts the formation of the Blended Universal Design for Learning (BUDL) model.

Figure 1. Conceptual creation of the Blended Universal Design for Learning (BUDL) model from the merger of Blended Learning and Universal Design for Learning.

Purpose of the Study

The purpose of this study was to test the efficacy of a Blended Universal Design for Learning model in improving student achievement, engagement, and perception. Changes within a teacher's perception of his practice are also explored. This research also attempts to contribute to the body of knowledge on the effectiveness of both Blended Learning and Universal Design for Learning on serving the needs of all learners.

Guiding Research Question

Through an experimental design and a mixed-method analysis the impact of implementing a BUDL intervention in a classroom is explored. The guiding research question is: How does a Blended Universal Design for Learning intervention impact an accelerated 7th grade math class?

Definition of Key Terms

This study is embedded in the K-12 sector and frequently references terms or acronyms commonly used in K-12 education and known by K-12 professionals and/or researchers. To assist in the dissemination of this study, a list of key terms and corresponding definitions are provided in this section.

21st Century Learning. A set of standards and/or skills that students are expected to have in order to be successful in the Age of Information or Digital Age.

Achievement. In this study, achievement refers strictly to academic achievement and is measured by the scores from teacher designed assessments.

Curriculum. Curriculum is generally considered the academic content taught in the classroom. However, for this study, the definition of curriculum includes the instructional goals, methods, materials, and assessments used in a classroom. This definition stems from the work produced by the Center for Applied Special Technology (CAST).

Engagement. Engagement in this study refers specifically to student engagement. “In education, student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education”

(edglossary.org, 2015). In this study, engagement is measured through observational data and a student response survey on their attitude towards math.

English Language Learner (ELL). ELL refers to English Language Learner. ELLs are students who speak limited English and/or have difficulty learning in English. These students sometimes require specialized or modified curriculum.

Individualized Education Plan (IEP). A IEP is an Individualized Education Plan or program that has been specifically designed to help meet the unique needs of a student with disabilities (U.S. Department of Education, 2016). These students sometimes require specialized or modified curriculum.

Pedagogy and Pedagogical. Pedagogy is the method or practice of teaching.

Perception. In this study perception refers to the way the teacher feels about the curriculum and the way students feel or think about their class.

Summary

This chapter provided an overview of how the K-12 system is currently failing to address student variance in the wake of an increasingly diverse student population and globalized society. With the apparent need for teachers to provide a more flexible curriculum, the U.S Department of Education has pushed two pedagogical strategies (Blended Learning and Universal Design for Learning) as potential solutions. Evidence suggests that individually these practices can positively effect student outcomes. Conceptually, the merger of these two strategies would produce a more effective model for learning and teaching, Blended Universal Design for Learning. However, the efficacy of this model needs to be further researched. The purpose of this study is to examine the viability of Blended Universal Design for Learning and assess its impact on student

achievement, engagement, and perception. Chapter Two takes a closer look at existing research and practice on Blended Learning and Universal Design for Learning.

CHAPTER TWO: REVIEW OF THE LITERATURE

The Next Big Thing

In 2002, the American Society for Training and Development argued, “Blended Learning was one of the top emerging trends in the knowledge delivery industry.” Since then, Blended Learning (BL) has indeed gained mainstream popularity and has become a buzzword of sorts in the field of education (Dzuiban et al., 2005; Graham, 2009; Oliver & Trigwell, 2005). It has been recognized for its transformative potential (Dziuban et al., 2005; Garrison & Kanuka, 2004; Graham & Robison, 2007; Staker et al., 2011) and has even been regarded as a “disruptive innovation “or a service that is simple in application that starts at the bottom of the market, but eventually displaces established entities” (Christensen, Horn & Johnson, 2008). In 2008, John Watson predicted that Blended Learning was likely to emerge as the predominant teaching model of the future and become far more common than either online or face-to-face learning alone.

While the concept has been around for over a decade and has made its mark in other industries such as higher education and corporate training, the practice of Blended Learning in K-12 settings is relatively new (Drysdale et al., 2013; Graham, 2012; Halverson et al., 2012). With increased budget cuts, a demand for 21st Century learning, and the transition to the technology imbued Common Core Standards, Blended Learning has seemingly been thrust onto the main stage of K-12 education reform.

Rivaling Blended Learning’s fanfare, the practice of Universal Design for Learning has also gained in popularity since its incorporation into the 2008 Higher Education Opportunity Act. Through this policy the U.S. Department of Education has committed to providing funds to pre-service teacher programs that include UDL in their

curricula (Vitelli, 2015). UDL has been encouraged as a promising practice to address not only the needs of students with disabilities, but also as a way to confront the differences of learners embedded in the general education system.

From its infancy, the Center for Applied Special Technology (CAST) has described UDL “as a blueprint for creating a curriculum (instructional goals, methods, materials, and assessments) that works for everyone - not a single, one-size-fits-all solution, but rather flexible approaches that can be customized and adjusted for individual needs” (udlcenter.org, 2015). This chapter takes an in-depth look at both of these phenomena: exploring their definitions, examining their conceptual frameworks, and reviewing current research.

Blended Learning

Conceptual Framework

In 2002, Margaret Driscoll identified four interpretations of Blended Learning that were dominating the literature at the time. Due to its interdisciplinary use, BL holds different meanings in different contexts (Driscoll, 2002; Drysdale et al., 2013; Graham, 2006; Graham, 2012; Oliver & Trigwell, 2005; Osguthorpe & Graham, 2003). Graham (2012) simplified Driscoll’s definitions into three general concepts: (1) blending online and face-to-face instruction, (2) blending instructional modalities (or delivery media), and (3) blending instructional methods.

Though all of these conceptual practices show promise, it is the first concept that is garnering the most attention. For the purpose of this study, Blended Learning is identified as the blending of online and face-to-face instruction.

The Definition

The flexibility of its conceptual application and the versatility of its properties have made the definition of Blended Learning as ambiguous as the practice. Though most researchers agree that in its simplest form BL is the combination of face-to-face instruction with computer-mediated instruction, there is no universally recognized definition for Blended Learning (Driscoll, 2002; Drysdale et al., 2013; Graham, 2006; Graham, 2012; Oliver & Trigwell, 2005; Osguthorpe & Graham, 2003). Over the years, researchers have proposed more comprehensive definitions in an attempt to either underscore the importance of implementation and structure, and/or feature its distinctive characteristics.

In his seminal piece, *Blended Learning: Uncovering It's Transformative Potential in Higher Education*, Randy Garrison describes Blended Learning as the “thoughtful integration of classroom face-to-face learning experiences with online learning experiences” (2004). Garrison includes in his definition what I call an impactful stipulation on implementation. He asserts that true BL can only occur with thoughtful integration, suggesting that the devices alone do not cause transformation. To him and many others, Blended Learning is not just the merger of technology and education; it is a methodology that supports deeper learning (Dziuban et al., 2005; Garrison & Kanuka, 2004; Picciano et al., 2012; Singh & Reed, 2001).

Similarly, in 2005 the Sloan Consortium defined BL as the integration of “online with traditional face-to-face class activities in a planned, pedagogically valuable manner in which a portion of (institutionally defined) face-to-face time is replaced by online

activity” (Picciano, p. 1). Again, this definition suggests that the integration of technology in the classroom must be coupled with purpose.

Other stipulations that have been attached to BL are requirements on structure. For instance, in the 2004 research brief for EDUCAUSE, Blended Learning was described as “courses that combine face-to-face classroom instruction with online learning and reduced classroom contact hours (reduced seat time)” (Dzuiban, Hartman, & Moskal, 2004). Along the same lines the 2007 report by Elaine Allen et al., titled *Blended In: The Extent and Promise of Blended Education in the United States*, claims that Blended Learning only occurs when “30% to 79% of course content is delivered online” (p.5).

More recently in 2012, the Clayton Christensen Institute for Disruptive Innovation¹ released a white paper stating multiple stipulations, describing Blended Learning as a “formal education program in which a student learns at least in part through online delivery of content and instruction with some element of student control over time, place, path, and/or pace and at least in part at a supervised brick-and-mortar location away from home (Staker, 2012). This definition gave stipulations on the medium (online), location (brick and mortar, away from home) and control (student). It did three things that the other definitions did not: It insisted that Blended Learning be a part of a validated and recognized education system; it required that students at some point are being supervised; and it placed the learner at the focal point, making it a student-driven practice. Though the Institutes’ definition was just the latest in a long line of varying

¹ Formerly known as Innosight Institute.

definitions, it gained widespread acceptance due to its comprehensive description and its basis in K-12 education. But even this definition had its critics.

In its annual *Keeping Pace* report, after admitting to not having seen a better definition of Blended Learning, the Evergreen Education Group recommended one key element be added to the Institutes' definition: data-driven decision-making. The report states:

Although we like the definition, we also believe a further description can be useful, and the key element we like to see described in a Blended Learning model is a way in which students' online work generates data that are used by the instructional system (teacher, technology, or both) to personalize and improve instruction for each student. (p.17)

In 2014, these suggestions were implemented into the Institute's revised and current definition for Blended Learning:

A formal education in which a student learns at least in part through online learning, with some element of student control over time, place, path and/or pace; at least in part in a supervised brick-and-mortar location away from home; and the modalities along each student's learning path within a course or subject are connected to provide an integrated learning experience (Christensen, Horn & Staker, 2013).

As the use of Blended Learning evolves, so do researchers attempt to adequately describe this unique pedagogical and methodological practice. A common definition for Blended Learning will most likely be debated for years. Some see this as a good thing, suggesting that the lack of a formal definition exhibits Blended Learning's "untapped

potential” (Driscoll, 2002), and that it allows for flexibility, giving practitioners the ability “to adapt and use the term as they see fit” (Sharpe et al., 2006). Alternatively, there are those who believe that having contrasting definitions make practicing and researching Blended Learning almost impossible due to the inconsistencies in how it is defined (Oliver & Trigwell, 2005).

Another issue is that Blended Learning is often labeled as something different. Studies that focus on Information and Communications Technology (ICT), Hybrid Learning, Technology-Rich environments and even just technology integration are sometimes referring to some type of Blended Learning method, but fail to identify it as such. Regardless of how it is defined, most researchers and practitioners do agree on two things: One, the structure of Blended Learning can vary, and two, when implemented properly, BL produces recognized benefits. The next two sections take a closer look at these two axioms.

Varying Models and Practices

Leading the way on Blended Learning research in May 2011, the Clayton Christensen Institute released a report, titled *The Rise of K-12 Blended Learning*. The report profiled over forty K-12 programs and examined their use of technology in the classroom. The investigation revealed six distinct models that were operating within the Blended Learning framework. A year after this report was released and with feedback from over one hundred researchers, educators, and practitioners from the field, the Institute issued another report collapsing the six models into four (see Figure 2).

Figure 2. The Blended Learning taxonomy suggested by the Clayton Christensen Institute formerly Innosight Institute. Image taken from Staker, H. and Horn, M. (2012). *Classifying K-12 Blended Learning*, p.2. Copyright 2012 by Innosight Institute.

Rotation Model. The Rotational Model of Blended Learning (RMBL) is the most commonly used model of BL in classrooms today. One theory behind this is that this model requires the least amount of change to the current structure of education (Christensen, Horn, & Staker, 2013). The Rotational Model consists of students rotating on a fixed schedule or at the teacher’s discretion between learning modalities, at least one of which is online learning” (Staker & Horn, 2012). Within this model there are four sub-categories: Station Rotation, Lab Rotation, Flipped Classroom, and Individual Rotation. With the exception of the Individual Rotation model, all other models under the RMBL continue to emphasize teacher-driven activity and whole-class instruction with little personalization. In the Individual Rotation model, students still rotate based on a customized fixed schedule among learning modalities, but they are not required to rotate to each available station or modality, giving students some control/choice in their learning (Staker & Horn, 2012).

Flex Model. In the Flex Model of Blended Learning (FMBL), students receive content and instruction primarily through the Internet. Students have their own customized and fluid schedule. In this model, teachers and other adults provide face-to-face support on a flexible and adaptive basis as needed (Staker & Horn, 2012). This model allows for even more student control/choice in that students can determine when they need extra support. FMBL also breaks out from the standard structure of K-12 education by providing the majority of instruction through online resources, allowing students to progress through levels based on their competency and making age-based cohorts and seat-time requirements inconsequential (Christensen, Horn, & Staker, 2013).

Enriched Virtual Model. The Enriched Virtual Model of Blended Learning (EVMBL) is where students split their time between a traditional campus and learning remotely through online content and instruction (Christensen, Horn, & Staker, 2013). This model does not require students to attend the brick-and-mortar campus every day of the week and is a whole-school experience, meaning the entire school splits their time between onsite and offsite learning.

Self-Blend Model. In the Self-Blend Model, now referred to as the A La Carte Model (Christensen, Horn, & Staker, 2013), students continue to have classes on a physical campus, but supplement their education with one or more classes that are delivered solely online. Students in this model can choose what classes they want to take offsite or onsite, and are usually offered instructional support and mentoring in both forums. This model differs from the Enriched Virtual Model because blending is done by the student at the course level instead of by administration at the school-wide level.

These models vary in their structure, use of technology, and placement of teachers

and students, yet all have been generally cited as providing benefits beyond the traditional classroom (Dziuban, Moskal, & Hartman, 2005; Garrison & Kanuka, 2004; Graham, 2006; Graham, 2012; Graham & Robison, 2007; Osguthorpe & Graham, 2003; Staker et al., 2011). These benefits are explored in the next section.

Reported Instructional Outcomes

Blended learning has been widely described as the “best of both worlds”, combining the best elements of face-to-face instruction with the best elements of online learning (Dziuban, Moskal, & Hartman, 2005; Graham, 2006; Laumakis, Graham, & Dziuban, 2009). It has been credited with increasing classroom flexibility, student engagement, and access to education. In the same report where John Watson (2006) predicted the inevitable rise of Blended Learning, he credited the practice to producing such desired outcomes as personalized learning, thoughtful reflection, and individualization.

In higher education, three major outcomes have been identified: 1) improved learning effectiveness, 2) increased access and convenience, and 3) greater cost effectiveness (Graham, 2006). In K-12 education where learners of all different abilities and interests must be served in the same classroom, “improved learning effectiveness” distills down to concepts such as differentiated instruction, real-time feedback, and student-centered learning. The following sections examine a few of the reported outcomes of Blended Learning and technology integration, in general. Examples of how these outcomes have been realized in K-12 classrooms across the country are presented.

Individualized & Differentiated Instruction. Though these practices are combined here, individualization and differentiation are very different outcomes. The

U.S. Department of Education (2010) defines individualization as instruction that is *paced* to the different learning needs learners. Differentiation is instruction that is tailored to the *learning preferences* of different learners. Research and practice have shown that Blended Learning can give teachers the flexibility to provide these types of learning environments for their students (Bakia et al., 2012; Christensen & Horn, 2008; Haelermans, Ghysels, & Prince, 2015; Lips, 2010; Watson & Gemin, 2008). In these environments, technology is used to broaden students' access to content, provide multiple avenues for creative production and help scaffold the progression of work. In 2015, Haelermans et al. carried out an experimental study over 12 weeks involving 115 secondary students. The treatment group (58 students) received "digital differentiation," which helped determine what level of work students would focus on the following week. The results of the study showed a significant effect on the posttest scores of the treatment group. In the conclusion, the researchers implied that differentiation was possible and beneficial to the degree that it was due to the integration of digital tools.

As an example of technology being used as delineated above, students at the School of One in New York receives customized schedules that change daily depending on their needs. A digital bulletin board displays their schedule, which is created by their counselors who assess their performance data and individual progress through their online learning work (Christensen, Horn, & Staker, 2013). The students rotate through different modalities, such as virtual tutoring, small-group collaboration and instruction, and independent practice. This program structure is designed to allow students to work at their own pace and choose the learning modality that works best for them, the program was both individualized and differentiated.

Real-Time Feedback. The increased ability for teachers to provide real-time feedback is another reported outcome of Blended Learning. The premise behind real-time feedback is that a computer can aggregate data in a timely and efficient manner, allowing teachers to make data-driven instructional decisions in their classrooms. Formative online assessments allow for teachers and students to receive real-time feedback, information that can reveal how well the student understands the subject matter. Online assessments make it easier for a teacher to test more frequently and provide feedback to the student while the information is still relevant (Lips, 2010; Picciano & Dziuban, 2007). In his, 2008, book *Visible Learning: A Synthesis of Over 800 Meta-Analysis relating to Achievement*, John Hattie, a notable educational researcher, revealed that out of hundreds of pedagogical practices, individual feedback had the single most significant effect on student achievement. Formative feedback, mediated through technology, has reportedly increased student achievement and performance, elicited positive feelings from students, and decreased boredom (Tempelaar, Rienties, Giesbers, 2015; Martinez, Valdivia, & Ortiz, 2015; Muis et al., 2015, Thomas & Sondergeld, 2015).

Through the districtwide purchase of an adaptive learning software called STMath, students in the Cajon Valley School District in San Diego, California, receive ongoing formative feedback on their performance in math. As a requirement, students in this elementary district interact with game-like software daily and get real-time feedback on their mastery of skills and concepts through built-in program assessments. This feedback is used by students to self-correct their work and by the teacher to identify students for intervention purposes.

Student-Centered Environment. A student-centered (also known as a learner-centered or personalized) environment is where students have opportunities to make decisions, based on their own interest and preference, that directly impact their learning. When a student has control over their learning, their invested interest, engagement, and overall disposition towards school can positively increase. Some researchers believe that through Blended Learning, schools have the potential to create more student-centered environments by allowing students to take part in deciding their schedule, their pace through content or classes, and/or by offering students choice in their preferred learning modality (Atkins et al., 2010; Picciano & Dziuban, 2007;).

At High Tech High, a network of K-12 charter schools based in San Diego, California, technology aided student-centered learning is realized through the use of specialty labs which are equipped with a range of technology for student use (Moeller & Reitzes, 2011). Through their tenure at High Tech High, students are required to compile and present their work through digital portfolios that can take the form of movies, e-books, power-points, cartoons and more. For the most part, students work on their portfolios independently throughout the year. They have control over their pace, the content included, and the form their portfolios take. Moeller and Reitzes assert that the technology available in the specialty labs helps students to work independently and allows them more opportunity to develop their own ideas and engage in their creativity.

The classroom or learning environment outcomes mentioned here have a widespread influence, affecting not only the teacher and students, but also the curriculum, classroom management, and even school structures. The research shows that the impact of integrating technology can be advantageous, if done effectively. These outcomes give

credence to the idea that Blended Learning could dramatically enhance teacher practice and the learning environment. The following section specifically highlights research on the three main student outcomes being investigated in this study: student achievement, engagement, and perception. The influence Blended Learning has on these outcomes is examined.

As a note, much of the Blended Learning research lives at the higher education level with very few statistically significant K-12 studies to pull from. In the celebrated 2009 Means et al. meta-analysis on online learning effects, twenty-three of the forty-five studies used compared Blended Learning vs. face-to-face environments (the rest focused on purely online vs. face-to-face), and of those twenty-three only five involved K-12 students. Though this comprehensive analysis was conducted almost eight years ago, the lack of rigorous studies (ones that include random-assignment and a controlled experimental design) is still an issue plaguing Blended Learning research today. As a result, the following section includes Blended Learning research from both the K-12 and higher education level. This section only references research that has specifically identified Blended Learning.

Reported Student Outcomes

Student Achievement. Within the literature, the impact of Blended Learning on student achievement is disparate. For every study that reports a positive impact, there are two others that report negative or neutral outcomes. However, two highly regarded meta-analysis on the issue report positive effects of technology on student achievement.

In 2009 Means et al. published their seminal 2009 U.S. Department of Education sponsored meta-analysis on the effectiveness of online and Blended Learning. The

analysis, which included published studies from 1996 to 2008, reported that students in Blended Learning environments performed significantly better than students in face-to-face environments. The analysis also revealed that Blended Learning environments “tended to involve additional learning time, instructional resources, and course elements that encouraged interactions among learners” (Means et al., 2014).

In their second order meta-analysis, *What Forty Years of Research Says About the Impact of Technology on Learning*, Tamim et al. revealed that there is a “significant positive small to moderate effect size favoring the utilization of technology” (2011, pg. 14). Moreover, the study found that students in technology rich classrooms performed 12% higher than the average student in a classroom that does not use technology (Tamim et al., 2011). What made this study so significant to K-12 supporters of Blended Learning is that this study includes 25 meta-analysis covering over forty years of research. Unlike the Means et al. analysis, the majority of work used in this analysis involved K-12 applications of technology; 20 of the 25 studies were K-12 focused.

These two analyses reveal promising results for the impact of Blended Learning on student achievement. The next section discusses research on the affect BL can have on student engagement and perception.

Student Engagement and Perception. Some research suggests that technology can stimulate a students’ engagement level (Bakia et al., 2012; Brown & Adler, 2008; Picciano, 2007; Atkins et al., 2010; Watson & Gemin, 2008). Because technology can broaden access, expand support, assist in scaffolding, and provide opportunities for more complex interactions, students in Blended environments have more opportunities to actively engage in the classroom. The reported instructional outcomes of a Blended

Learning environment also contribute to heightening of a students' level of engagement. In the 2010 National Technology Plan, experts claimed that when curriculum was individualized, differentiated, and/or personalized, student engagement levels increased (Atkins et al., 2010).

Like engagement, students' perception of their learning can be influenced by a variety of environmental factors. Student perception (which can also be characterized as attitude) can be defined as the way students think about their classroom or understand the curriculum, the learning activities, the subject matter, and/or the instruction. The quality and clarity of instruction, and the availability of the learning content (is the content easy for the learner to access, given their preferred method of learning and current level of understanding) can all impact a students' perception of their learning environment and their ability to learn.

As with student engagement, the flexibility provided by technology can assist in eliciting positive perceptions from students, who may prefer or fare better with, alternative learning and teaching avenues. When examining satisfaction in over 1,400 students in a Blended-style accounting course, Lopez-Perez et al., (2011) discovered that students rated items related to their Blended Learning experience fairly high. Students noted that the Blended Learning aspects of the class proved useful in understanding and learning the subject matter. Furthermore, students reported that BL "contributed to increasing their motivation to study the subject" (Lopez-Perez et al., 2011, pg. 822).

The cited outcomes of Blended Learning have made it a recognized practice among researchers and educators in enhancing classroom environments. Given the data presented above, as the physical layer in the BUDL design model, Blended Learning

could further the impact of a teacher's practice through the efficient delivery and presentation of instruction. The next portion of this chapter focuses on Universal Design for Learning research and what features this pedagogical practice adds to the BUDL design model.

Universal Design for Learning

Conceptual Framework

Universal Design for Learning (UDL) was founded on the principles of Universal Design in architecture. Pioneered in the 1980's by Ron Mace, an environmental design researcher at North Carolina State University, the Universal Design movement aimed to "create places, structures, or products that are conceived and built to accommodate the widest spectrum of uses without the need for subsequent adaptation of specialized design" (Meyer et al., 2014). In the industry of architecture, an example of this theory in practice is curbcuts. The rudimentary purpose of curb cuts is to allow people with physical disabilities (wheelchair users, vision impaired, etc.,) easy access to cross street intersections, yet this design is also beneficial to what would typically be the "average" person: skateboarders, people with strollers or carts, a delivery person with a dolly, etc. (Quaglia, 2015). Ron Mace and colleagues did not believe that a person's ability should negatively impact their access to the world around them. Their research proactively focused on "reducing environmental barriers and providing increased access to the physical environment" (Rao et al., 2014).

Approximately two decades after this movement started, it began to infiltrate its way into the education sector. The Center for Applied Special Technology (CAST), which focuses on inclusionary educational practices for students with disabilities, began

shifting their approach and way of thinking about the Universal Design movement. CAST began centering their resources around addressing the “disabilities of schools, rather than students” (Meyer et al., 2014). Universal Design for Learning was introduced and coined by CAST in the late 1990’s after the reauthorization of the Individuals with Disabilities Education Act (IDEA). UDL was born out of the idea that all students can achieve if given the proper supports and that the failure was not innately in students, but in the inaccessible nature of the learning environments they occupy.

The Definition

From its infancy, CAST² has been at the forefront in developing the framework and essential guidelines for Universal Design for Learning. Unlike Blended Learning terminology, the terminology around UDL has been primarily fostered by only one source, CAST, which means the definition of UDL has stayed consistent throughout the years. CAST defines UDL as “a set of principles for curriculum development that give all individuals equal opportunities to learn” (udlcenter.org, 2015). As mentioned in the *Definition of Terms*, CAST defines curriculum as the instructional goals, methods, materials, and assessments. The goal of UDL is to assist teachers in creating a curriculum that works for everyone, “not a single, one-size-fits-all solution, but rather flexible approaches that can be customized and adjusted for individual needs” (udlcenter.org, 2015).

² Created by CAST, the National Center for Universal Design for Learning is now responsible for the continuous research and development of UDL.

Varying Models and Practice

There are three educational models built off the Universal Design concept³. The first is Universal Design for Learning, which lives at the K-12 level and has been championed by CAST and the National Center for Universal Design for Learning. The other two are Universal Design for Instruction (UDI) and Universal Instructional Design (UID), which live at the higher education level and have been spearheaded by various researchers in postsecondary education. Though the models vary on their population and institutional focus, their objectives remain similar: to expand teaching methodologies so that all students have equal access to classroom teaching and learning, regardless of their ability or learning needs (Pliner & Johnson, 2004). Though all the models are heavily influenced by the work done at the National Center for Universal Design for Learning, the principles guiding them differ. Figure 3 displays the various guiding principles of Universal Instructional Design, Universal Design for Learning, and Universal Design for Instruction.

The guiding principles for UID, UDL, and UDI are fluid, almost boundless, allowing the practices to take shape any way an instructor deems appropriate. Unlike Blended Learning, there are no definitive formats for how these models are organized or constructed. In this way, it is very often the case that no two Universal Design Education Models or UDEM are alike. Advocates for UDEMs argue that the principles are merely guidelines and are ambiguous to allow instructors the maximum amount of flexibility. After all, it is the uncompromising structure of the traditional classroom that UDEM's were conceived to combat. However, the lack of clarity on how these environments

³ Also know as Universal Design Education Models (UDEMs)

operate has caused issues for researchers. Rao et al., note that there are “innumerable ways that the principles can be applied to practice” (2014), which makes it difficult to determine what actually constitutes a classroom as a UID, UDL, or UDI classroom.

As nebulous as the practice may seem, educational models of Universal Design have begun to make their mark in classrooms around the country. The following section highlights a few of the reported student outcomes of implementing such practices, specifically Universal Design for Learning.

Universal Design Educational Models

Educational Model	Main Principles or Guidelines
UID: Universal Instructional Design (Goff & Higbee, 2008)	<ul style="list-style-type: none"> a. Creating welcoming classrooms b. Determining essential components of a course c. Communicating clear expectations d. Providing timely and constructive feedback e. Exploring use of natural supports for learning, including technology f. Designing teaching methods that consider diverse learning styles, abilities, ways of knowing, and previous experience and background knowledge g. Creating multiple ways for students to demonstrate their knowledge h. Promoting interaction among and between faculty and students
UDL: Universal Design for Learning (National Center on Universal Design for Learning, 2010)	<p>Principle I. Provide Multiple Means of Representation</p> <p>Principle II. Provide Multiple Means of Action and Expression</p> <p>Principle III. Provide Multiple Means of Engagement</p>
UDI: Universal Design of Instruction (Burgstahler, 2009)	<ul style="list-style-type: none"> 1. Class climate 2. Interaction 3. Physical environments and products 4. Delivery methods 5. Information resources and technology 6. Feedback 7. Assessment 8. Accommodation

Figure 3. Universal Design Education Models. Image taken from Rao & Tanners (2011). Curb Cuts in Cyberspace: Universal Instructional Design for Online Courses. Journal of Postsecondary Education and Disability. 24(3), p.212.

Reported Student Outcomes

As students marked for special education begin to integrate more frequently into general education classrooms, the push for teachers to experiment with inclusive pedagogies has increased. Meyer et al. explains that with new technologies promising to be “powerful agents of change” and the diversity of students continuing to increase, Universal Design for Learning has the ability to “turn the aspiration of free and appropriate education for all into a reality” (2014, pg.1). Since its’ introduction in the 90’s, the reported impact of integrating UDL has been favorable. UDL has been credited with increasing student academic self-efficacy, student academic achievement, and student engagement (Abell, Jung & Taylor, 2011; Kortering, McClannon, & Braziel, 2008; Meyer et al., 2014; Rappolt-Schlichtmann & Daley, 2013; Schelly, Davies & Spooner, 2011)

As a note, the research on UDL has been heavily criticized for not possessing enough empirically valid studies (Edyburn, 2010; Rao et al., 2014). Additional experimental studies are more commonly found at the higher education level; this review includes studies from both the K-12 and higher education sector. This section also features studies that include both students with and without disabilities. Lastly, because Universal Design for Learning is a pedagogical strategy, significant changes in instruction that aligns to the UDL principles are assumed (i.e., increased flexibility, increased options, etc.). As a result, studies on UDL do not frequently focus their investigation on the impact of the practice to instruction. Therefore, unlike the outcomes section on Blended Learning, the UDL outcomes section only focuses on student outcomes.

Student Achievement. Much of the literature on UDL is anecdotal in nature (Edyburn, 2010; Schelly, Davies, Spooner, 2011). However, of the few experimental studies that do exist, outcomes for student achievement have been either neutral or very positive. In their 2012 study on the effects of *Literacy by Design*, a UDL based literacy program, Coyne et al., trained five out of nine K-12 teachers scaffolding strategies and required them to implement differentiating software four to five times weekly. As a result of the 10-month long intervention, students in the treatment classes showed “significant gains” in reading comprehension (Coyne et al. 2012). Similar results came out of Rappolt-Schlichtmann et al., 2013 study that tested the impact of implementing a UDL designed a web-based science notebook in 28 different K-8 classrooms. Students in classrooms that utilized the UDL science notebook experienced “improved science content learning outcomes,” as compared with their counter-parts who utilized traditional paper-and-pencil science notebooks (Rappolt-Schlichtmann et al., 2013).

Though positive, these two studies do not represent the norm. In 2015, King-Sears et al. conducted an experimental study with four high school chemistry classrooms. The classes were composed of a mix of students with high-incidence disabilities (HID) and students without. After a two-week UDL intervention, featuring videos, self-management strategies and various engagement methods, no significant difference was found between the treatment and control group (King-Sears et al., 2015). Unfortunately, outcomes like the one in this study are more frequent than the outcomes found in the first two studies highlighted. Factors such as student demographics, the fidelity of model implementation, and teacher pedagogical practices could all have accounted for these mixed results.

Student Engagement. The ability to increase student engagement is a fundamental claim of Universal Design for Learning (Meyer et al. 2014), yet empirical studies on this outcome for UDL are limited. As a meta-construct, true engagement is often difficult to measure. That problem, combined with the already limited amount of scientific studies on UDL interventions, may explain the lack of research on the topic. One exception is the research of Dr. Jennifer Katz, founder of Manitoba Alliance for Universal Design for Learning and creator of the Three-Block Model of UDL. Katz has been studying the effects of UDL on student engagement in classrooms across Canada for over five years. In her 2013 study, involving over 630 students from grades 1st to 12th attending ten schools, Katz examined the impact of integrating a UDL intervention on students' academic and social engagement using several instruments to measure students' engaged behavior.

The intervention included aspects of differentiated instruction, inquiry based learning, and assessment for learning. Results from the study showed that post intervention, students in the treatment group were significantly more actively engaged, while students in the control group were more significantly passively and/or not engaged (Katz, 2013). In fact, high school students in the UDL classes spent “44/60 minutes actively engaged, while those in control classes spent 16/60 minutes actively engaged” (Katz, 2013, pg. 176).

Student Academic Self-Efficacy (Student Perception). Academic self-efficacy can be described as the “perceived confidence in one’s ability to execute actions for attaining academic goals” (Schunk & Mullen, 2012, pg. 222). Because a students’ self-efficacy is closely tied to their perceptions, research outcomes on these two concepts are

typically presented together. The impact of UDL on social factors such as engagement, attitude, and perception has been well researched and documented. Most of the studies on Universal Design for Learning are qualitative by design and focus on human effects rather than academic. Unlike the research on student achievement, the majority of studies on student perception have resulted in positive outcomes, focusing particularly on how UDL has bolstered students' confidence in their own capacity to learn.

Students in the UDL enriched classes for the Rappolt-Schlichtmann et al. study not only scored better on their posttest than students in non-UDL enriched classes, but also reported feeling more confident and competent in their work. In the focus groups, students explicitly acknowledged that the support features embedded in the virtual notebooks were useful in helping them understand how to accomplish the given tasks (Rappolt-Schlichtmann, 2013). Similar results were concluded from a UDL intervention conducted by Kumar & Wideman in 2014. The study focused on the impact of adding UDL elements (such as allowing students options in completing assignments and showing instruction and content in multiple formats) to a first-year undergraduate health science course. On the open-ended portion of the post-survey, students commented on aspects of the increased flexibility of the course (ability to choose due dates, assignments, and group or individual work), stating that it was beneficial and positively contributing to their learning (Kumar & Wideman, 2014). Students also mentioned they "felt more in control of their learning," feelings which have been reported to contributing to a students' academic self-efficacy and success (Meyer et al., 2014).

Summary

This section looked at some of the literature regarding both Blended Learning and Universal Design for Learning. Their conceptual frameworks, working definitions, and various models were explored. Highlighted here were also some of the reported outcomes from studies examining the implementation of BL and UDL interventions. It is important to note that much of the literature presented positive evidence for the implementation of these practices. This was done intentionally to showcase the potential of each method and to highlight the reasons why BL and UDL have been chosen as my theories of practice for this study. Although their potential may be great, the gaps in research and lack of empirical data leave many questions. It is the goal of this study to help fill some of those gaps and contribute scientific knowledge regarding the impact Blended Learning and Universal Design for Learning have on students. In Chapter Four a detailed description of the study and methodology are provided.

CHAPTER THREE: A PREFACE TO THE METHODOLOGY

Changes in the Proposed Study

Since the initial proposal of this study, significant changes have been made to the methodology that I feel obliged to mention here. Originally this study was designed to test the impact of integrating UDL principles into a BL classroom, making it solely a UDL intervention. During the study's conception, one teacher in particular had influenced this design and structure. This teacher had been identified through her previous involvement in another study I had conducted. Through this other work, I had observed this teacher for approximately a year and purposefully chose her to participate in the current study. This teacher was targeted due to her high level of technology integration and the innate plasticity observed in her practices. To get a better understanding of how UDL can impact teaching and learning in a BL environment it was necessary to select a teacher who practiced Blended Learning to fidelity. Due to the short timeframe it was also necessary to select a teacher who already had the capacity to deliver lessons that showed accommodations for student variance. In addition, the diversity within that teacher's school population was beneficial for a study investigating how BUDL addressed the needs of diverse learners.

Given the technical skill level, engagement level, and innate disposition of the original teacher, a more involved and intricate intervention was planned that would have allowed greater adherence to the principles of Blended Learning and Universal Design for Learning. However, six weeks prior to the new school year, the teacher was offered and accepted a position at the district office. The loss of this teacher had a ripple effect on

the entire study changing, not only the intervention design, but the student demographics, the type of data collected, and the general research question.

The teacher who ended up participating in the study varied from the original teacher in many ways. The student population this teacher served was homogenous in race, socioeconomic status, and skill level. This shift in demographics made it difficult to measure the impact of BUDL on diverse learners. However, the classrooms being more homogenous in nature reduced the variance within groups, making it easier to isolate the variance between groups and identify possible intervention effects. The teacher's initial engagement in and disposition toward the study was wary, which led to minor challenges in the beginning stages of the intervention.

Though there was a class set of laptop devices, such technology was rarely integrated into the lessons by the teacher. The new classrooms were not Blended Learning environments, causing a revision in the research question and a rethinking of the intervention design. Though BL was still incorporated through facets of the intervention, it was not implemented to the standards referenced in the definition provided by the Clayton Christensen Institute. Students did not have control over the time, place, path, and/or pace. Moreover, data from the online component was not used to change instructional practice. Instead, Blended Learning was integrated in its simplest form, as the merger of computer mediated instruction and face-to-face instruction.

Lastly, due to strong parental and systemic influences, the proposition of implementing alternative assessments, based on student choice, and alternative homework was unwelcome. These points of contention and the potential affect they had

on the study are further discussed and examined in Chapter Six. The following chapter covers the methodology implemented in the study with the new teacher, Mr. Martin⁴.

CHAPTER FOUR: METHODOLOGY

Research Methods

An experimental mixed methods design was used to answer the following guiding question and subsequent research questions: How does a Blended Universal Design for Learning intervention impact an accelerated 7th grade math class?

1. How does the intervention impact student achievement?
2. How does the intervention impact student engagement?
3. How does the intervention impact students' perception of the classroom?
4. How does the intervention impact student with Individualized Educational Plans (IEP)?
5. How does the intervention impact English Language Learners (ELL)?
6. How does the intervention impact teacher perception of the curriculum?

Experimental research is best when examining the effects of an intervention on a specific group. The benefit of using experimental methods in the field of education is that when “properly implemented, they allow for drawing causal conclusions such as the conclusion that a particular instructional method causes better learning outcomes” (Mayer, 2005, pg. 75). To be categorized as a true experiment, the research design must encompass three elements: manipulation, control, and random assignment. Manipulation entails “intervening in a situation to determine the impact of the manipulation” (Bryman,

⁴ Mr. Martin, and the forthcoming school and district name are pseudonyms and have been changed to protect the privacy of the participating teacher, students, and school.

2012, pg. 50). Control refers to the presence of a control group that does not receive the intervention, and which can be used to compare performance against the experimental group. Finally, in order to be labeled as an experiment, the participants must be randomly assigned to ensure that there are no systemic differences between the groups that could potentially affect the outcomes. The students in this study tested into the accelerated math classes. This test was offered to the entire 7th grade population at the school. The students were assigned to their teacher and their respective classroom through standard organizational and administrative processes without the involvement of the teacher or myself. Random placement of these students is assumed and the class chosen to receive the intervention was randomly assigned.

The study is a standard field experiment involving one teacher and two classrooms, where the effects of incorporating BUDL is measured and observed. BUDL was introduced in one of the classrooms (the experimental class), while the other class (the control classroom), received the standard curriculum. The class chosen to receive the intervention was randomly selected. Besides the intervention, all other control variables (the teacher, the classroom, and the school environment) remained consistent. Pre and post data were collected from both classrooms in the form of classroom observations, student focus groups, teacher interviews, student assessment scores, and student responses on an attitudinal survey.

Site and Participant Selection

This study took place in two 7th grade math classes in a small suburban Southern California K-12 district, Dillon Unified School District (DUSD)⁵. Dillon USD is situated in a relatively small city made up of fewer than 25,000 people. The median household income in the city is approximately \$91,000 (U.S. Census Bureau, 2013). The district itself serves approximately 3,100 students among seven schools. Table 1 displays further important demographics of the district and the school site involved in the study.

A combination of purposeful and convenience sampling were used for the study. Purposeful sampling involves selecting cases “in a strategic way, so that those sampled are relevant to the research questions being posed” (Bryman, 2012, pg. 418). Both of the participating classes were selected from Dillon Middle School. This school was purposefully chosen due to its high involvement in 21st Century efforts. The school has had a Bring Your Own Device (BYOD) program for almost 10 years and purchased 1:1 laptop carts for every classroom to ensure equitable access for all students.

The participating teacher, Mr. Martin was conveniently sampled, identified by his principal as an effective educator and a willing volunteer for the study. Mr. Martin is a white male, between the ages of 25-35 years old and has been a full-time teacher for 11 years.

⁵ The name of the school district and school are pseudonyms and have been changed to protect the privacy of the participating teacher, students, and school.

Table 1

Site Demographics

	Dillon USD	Dillon Middle School
2013 Growth API Score	897	923
District Size	3,169	750
Student Population	5.3% Asian or Filipino; 1.5% Black; 20.4% Hispanic or Latino; 4.1% Two or More Races; 67.7% White	4% Asian or Filipino; 1.8% Black; 18.9% Hispanic or Latino; 4.5% Two or More Races; 69.9% White
Free/Reduced Meals	221	54
English Language Learners	74	12
Title 1 Status	Not a Title 1 district	Not a Title 1 school

Note. Information taken from Eddata.org and is based on the 2014-2015 school year.

The two classes chosen for the intervention were purposefully selected out of the four taught by Mr. Martin. These two classes were accelerated math classes, and similar in student achievement scores and student demographics, as compared to the school population. They both were also overwhelmingly white. Before the start of the school year the students, who are the main subjects of this study, were assigned to their teacher and their respective classroom through standard organizational and administrative processes without the involvement of the teacher or myself. The class chosen to receive the intervention was randomly assigned. The demographics of both the control class and treatment class can be seen in Table 2.

Table 2

Control and Treatment Class Demographics

	Control	Treatment
Class Size	39	40
Student Population	2 - Asian or Filipino; 1 - Black; 1 - Decline to State; 7 - Hispanic or Latino; 2 - Two or More Races; 26 - White	5 - Asian or Filipino; 0 - Black; 2 - Decline to State; 2 - Hispanic or Latino; 0 - Two or More Races; 31 – White
Students with IEP's	3	1
English Language Learners	3	3

Note. Information provided by the Dillon Middle School.

Mr. Martin's pedagogical preferences contributed to the lack of student technology use. Mr. Martin's instructional practice was traditional in nature; the majority of his classrooms followed a rigid, teacher-driven structure. Through pre-intervention observations it was determined that the configuration of Mr. Martin's classroom typically went as follows:

- In the first 10-15 minutes of class students would work on warm-up problems displayed on the Smartboard. During this time he would go around and check to make sure students have their homework from the night before. He would not check it for completion or accuracy.
- The next 15-20 minutes would be spent on reviewing the warm-up and the homework from the night before. During this time he would answer students' questions, physically demonstrate how to do certain problems on the Smartboard,

and at times allowed students to come up and demonstrate how they solved the problem.

- Then 10-15 minutes are spent explaining a new concept that builds on or reinforces old concepts that were learned earlier in the week. For this process, Mr. Martin is at the front of the classroom working through example problems on the Smartboard. He uses a call and response type method to check for understanding.
- Students are given the last 10-15 minutes of class to start working on their homework. During this time the teacher walks around the classroom answering individual students' questions. If during this time, Mr. Martin notices the same issue arising or question being asked he stops the whole class to address the issue.

Despite the timing varying day to day, the order of these activities stayed consistent (unless it was a test day). According to Mr. Martin, the structure of these two classes was necessary in order to get through all the content required each week. During the weeks of the intervention, the control classroom continued to receive this format of instruction.

Power Sample

Since this study is limited to one teacher with two classrooms, the number of students available to participate was fixed. To determine the sample size necessary to achieve statistical significance, a power sample test was conducted. When conducting a power sample there are three parameters that need to be identified: Alpha, power, and the effect size. Alpha indicates the probability of finding significance where there is none; it is usually set at .05. Power is the probability of finding true significance and is usually set at .80. The effect size, or the expected effect, is usually determined from the literature or a pilot study and can vary from small (.20), medium (.50), and large (.80). Since there is a

lack of literature and studies on UDL and BL interventions, all effect sizes are tested to determine appropriate sample sizes. Table 3 displays the results of the power sample.

Table 3

Effect and Sample Sizes

Effect Size	Sample Size
Small Effect (.2)	788 participants
Medium Effect (.5)	128 participants
Large Effect (.8)	52 participants

Given that this study used a set sample size of approximately 79 students, a large effect size is needed in order for the study to have sufficient power and achieve statistical significance. Though obtaining a large effect size was unlikely in a study of this nature, potentially meaningful differences based on qualitative data may still be relevant.

The Intervention

In Mr. Martin's class, student technology use was not a part of the daily, or weekly curriculum. Though there was a class set of laptops available, the timing in class rarely allowed him to utilize them. Mr. Martin only saw his students for approximately 55 minutes a day. In addition, the two classes chosen to participate in the study were 7th grade accelerated math classes, as such, these two classes were required to cover 7th grade and 8th grade content in one year. On average, students in these classes were learning two to three math concepts a week, as compared to their regular math counterparts, who learned on average one concept a week. These requirements left major constraints on time and added to the basis of why Mr. Martin did not regularly use the

technology provided in his classroom. The task of allowing students to use the laptops to complete classwork or homework is a timely one. The time it takes to pass out the laptops, to boot them up, for students to access the desired content, to shut the down and to properly store them can take approximately 15 to 20 minutes of class time.

Though willing to participate in the study, Mr. Martin was adamant about keeping a similar structure to both classrooms. He still wanted to reserve time to go over the homework and teach a new concept, but he was willing to forgo the warm-up and allowed me to use the homework time to implement a learning activity related to the concept taught in class that day. After meeting with Mr. Martin a few times, it was decided that I would have approximately 30 minutes, three to four times a week over the course of one math unit (polynomials) to implement learning activities in relation to the study. This particular unit took 15 school days to cover; eight of those 15 days were allocated for experimental learning activities. Due to the short timeframe allowed for the intervention, I decided to forgo individual use of the laptops and subsequently the opportunity to use online student data to inform teacher instruction. The implications of this decision are discussed further in Chapter Six.

It was also decided that the intervention would not include alternative homework options due to both his pedagogical preferences and the general concern over parent opposition. At this particular school, parents are very active in their students' education. The idea of providing alternative homework for the treatment class arose as a potential point of contention because of siblings in different sections receiving different homework. However, keeping the homework the same added to the consistency of the

instruction, and again assisted in the analysis of the intervention by minimizing measurement error.

Experimental Curriculum

As a reminder, the curriculum in this study is referring to the learning goals, the means of assessment, the teaching methods, and the materials. Due to the aforementioned restrictions on classroom structure and assessments, only the teaching methods and materials are addressed in the intervention. After observing both classes for 6 days (12 hours) over a two-week period, I began curating alternative academic material from various open educational resources (OER) such as CK-12.org, teacherspayteachers.com, nextlesson.org, and letsgolearn.com. The lessons gathered from these sites were chosen because of their alignment to one or more UDL principles. Table 4 provides a list of the activities, along with a description, the student grouping used, and the UDL principle the activity addressed.

The *LetsGoLearn* website was used for whole class instruction and activity. On days where Mr. Martin would introduce a new concept, a corresponding video from the *LetsGoLearn* repository was shown to reinforce the lesson. The videos were animated and included songs to help students remember certain processes. The videos also included two to three digital practice problems after each concept. Mr. Martin had all the students solve the problems individually in their notebooks, then called on one student to come up to his computer to solve the problem for the class. The *LetsGoLearn* videos, which students watched twice a week for two weeks, were ultimately the only integration of technology provided by the intervention.

As there is no explicit model for UDL, Mr. Martin and I worked as co-designers in creating this enhanced curriculum. All materials and instructions necessary to carry out the lessons were provided by me, but delivered in the classroom by him. Over 20 lessons and resources were collected and given to Mr. Martin for review. From those 20, eight lessons were chosen, considering Mr. Martins' preference and comfort level. Ultimately, no lesson was implemented without his approval.

Table 4

Experimental Learning Activities

Name	Description	Student Grouping	UDL Principle
Scientific Notation Puzzle	Math manipulative to visually solve scientific to standard notation conversions and vice versa	Small Groups	Alternative form of engagement & action and expression
Let's Go Learn	Instructional Videos	Whole Class	Alternative form of representation & engagement
Who Dunnit	Students solved 10 practice problems that increase in difficulty. After each answer they received a clue to a fictional "murder". The goal: to determine who, what and where.	Partners	Alternative form of engagement & action and expression
Roll The Dice	Students rolled dice covered in terms and then flip a penny, based on the penny they must multiply or divide the terms.	Small Groups	Alternative form of engagement & action and expression
Scavenger Hunt	Students solved problems that lead them to different math problems around the room, first team to finish received a pen.	Partners	Alternative form of engagement & action and expression
CSI Review	Students worked in teams to investigate the culprit of six fictional thefts. The criminal has left six messages, layered with algebra. Teams worked to build a case and present their findings	Partners	Alternative form of engagement & action and expression

Data Collection

Data was collected from October 2015 to December 2015, lasting a total of eight weeks. Throughout the first three weeks, only baseline data was collected. Student demographic data, along with data from teacher interviews, student focus groups, student assessment scores, student survey responses, and classroom observations, were collected both prior to and after the intervention.

Demographic Data. Student demographic data was collected at the onset of the school year. Information was provided from the school with the permission of the principal and district superintendent. The data indicated the participant students' race, Individual Educational Plan (IEP) status, and English Language Learner (ELL) status.

Teacher Interviews. A semi-structured interview protocol was used to give me “latitude to ask further questions in response” (Bryman, 2012) to what was seen during classroom observations. Teacher interviews took place before and at the end of the intervention. The interviews were used to assess, among other things, perceived changes, in student behavior and differences in classroom dynamics. The teachers' pedagogical beliefs on the efficacy of the intervention were also explored. The teacher interview protocol can be found in Appendix A.

Classroom Observations. Classroom observations were used to obtain a visual comparison of student behavior pre and post intervention. Observations took place two to three days a week across six consecutive weeks. A daily observation protocol was used to compare student behavioral engagement (see “Behavioral Engagement” in the Measuring Engagement section). The classroom observation protocol can be found in Appendix B.

Attitude Towards Mathematics Inventory (ATMI). The Attitude Towards

Mathematics Inventory (ATMI) was used to measure student affective and cognitive engagement (see “Emotional Engagement” and “Cognitive Engagement” in the Measuring Engagement section). The ATMI is a 40 item, 5-point Likert scale questionnaire designed to measure student’s attitudes towards mathematics. The scale consists of four subscales, which measure enjoyment (the degree to which students enjoy working on mathematics); motivation (student’s interest in mathematics); self-confidence (confidence and self-concept in their performance in mathematics); and value (student’s belief on the usefulness and worth of mathematics) (Tapia & Marsh, 2004). The scale has been tested with middle school, high school, and college age students, with alpha reliability coefficients that ranged from .95 to .97. The scale also produced high Cronbach alpha coefficients of .89 for enjoyment, .88 for motivation, .95 for self-confidence, and .89 for value (Tapia & Marsh, 2004). The test-retest reliability of the scale over a 4-month period is .89, making the ATMI a reliable instrument. The “correlations between the ATMI subscales, and their correlations with theoretically related constructs (mathematics anxiety, ease, and achievement), were all in line with the results of numerous other empirical studies and theoretical reasoning, and supported the construct validity of the instrument” (Lim & Chapman, 2013). The survey was administered pre and post intervention by the teacher. The ATMI can be found in Appendix C.

Student Focus Groups. Pre and Post intervention focus groups, for both the control and treatment class, were conducted to obtain student perceptions (see “Measuring Student Perception”) of the lessons and classroom activities. These student focus groups were also used as a way to better understand student responses on the

ATMI. The student focus group protocol can be found in Appendix D.

Student Test/Assessment Scores. Student quiz and test scores were collected to measure student achievement (See “Measuring Student Achievement”). During the intervention, the students completed one pop quiz (formative) and one chapter test (summative). Both assessments were generated and graded by the teacher.

Analytical Memos. Though not included in the data analysis, I reflected and wrote about emergent themes, concepts, inquiries, connections or any issues I had about the students, teacher or the study itself. These memos were used to help me understand what was occurring in the classroom and in the study more generally, and to interrogate my initial assertions.

The data collected from the teacher interviews, classroom observations, and the student focus group were used for triangulation purposes, giving further detail and explanation of the quantitative results. Data was collected through a variety of sources (data triangulation) and was analyzed using both quantitative and qualitative methods in an effort to strengthen the credibility and validity of the findings (Patton, 1999). Patton defines data triangulation as a “means [of] comparing and cross-checking the consistency of information derived at different times and by different means within qualitative methods” (Patton, 1999, pg. 1195). Two examples Patton gives are “comparing observational data with interview data” and “comparing the perspectives of people from different points of view” (1999, pg. 1195). In this study data was collected from four different primary sources. The data was triangulated by examining various stakeholder perspectives, which included the perspective of the researcher; teacher, and the students. Table 5 depicts what data was collected to answer each research question.

Table 5

Research Questions and Data Collected

Research Question	Data Collected
Q1	Student Assessments
Q2	ATMI Teacher Interviews Classroom Observations
Q3	Student Focus Groups
Q4 & Q5	Teacher Interviews Student Assessments Demographic ATMI Classroom Observations Student Focus Groups
Q6	Teacher Interview

Data Analysis

A mixture of t-tests, descriptive statistics, thematic analysis, and a mixed between-within subjects analysis of variance were used to determine and examine any differences between the treatment and control group on the variables of achievement, engagement, perception, IEP and ELL status. An independent sample t-test on the student assessment scores was conducted to determine whether the average difference between the two groups was significant or instead due to random chance. Independent sample t-test and a mixed between-within subjects analysis of variance were run on the ATMI pre and post responses to determine if any significant differences exist between the classes on

each subscale (value, enjoyment, motivation and self-confidence). Descriptive statistics were used to describe and summarize the differences between groups in student test scores and ATMI results. Thematic analysis was employed to characterize patterns and themes within the teacher interview, classroom observations, and student focus groups. Table 6 further illustrates which processes were used to answer each of the research questions.

Table 6

Research Questions and Data Analysis

Research Question	T-test & Between-Within Subjects Analysis of Variance	Thematic Analysis	Descriptive Statistics
Q1	Do differences in achievement exist?	X	What are the differences in achievement?
Q2	Do differences in engagement exist?	What observable differences in engagement exist?	What are the differences in engagement?
Q3	x	How do students perception compare and contrast between groups?	What are the differences in perception?
Q4 & Q5	Do differences in achievement & engagement exist?	How do students perception compare and contrast between IEP and ELL groups?	What are the differences in perception?
Q6	x	In what ways, if any has the intervention affected the teacher's perception?	x

SPSS and Dedoose were the analytical software used in the data analysis process.

In coding the qualitative data, a combination of protocol, process, and affective coding

(Saldana, 2013) was employed. Protocol codes were used from the three UDL principles: multiple means of engagement, representation, and action and expression. Process coding, also known as action coding, was used to describe what was happening in the classroom, what subjects were doing and what interactions took place. Affective codes, also known as emotion codes, were used to identify and name reactions, feelings, and attitude. In addition to those three coding processes, emergent codes stemming from the researchers' analytical memos were also used to help identify significant events that may occur.

Measures of Student Achievement. Student achievement was based on the teacher generated assessments that were given to students to test their knowledge acquisition of the material. All forms of assessments were graded solely by the teacher and based on the students' ability to demonstrate their understanding of the week's lesson or concept. Content acquisition and understanding of core concepts were the determinant factor in the grading process.

Measures of Student Engagement. As a meta-construct, student engagement was measured on three main dimensions: behavioral engagement, emotional or affective engagement, and cognitive engagement.

Behavioral engagement. Behavioral engagement included time on task, classroom participation, adherence to classroom rules and appropriate classroom behavior, and perceived effort, among other things. Primarily measured through teacher perception (captured by teacher interviews) and classroom observations, behavioral engagement was measured at the classroom level. For an extensive list of behavioral factors that are used to quantify engagement, please refer to the classroom observation

protocol (Appendix B) and the teacher interview protocol (Appendix A).

Emotional (affective) engagement. Emotional engagement included factors such as interest in, perceived value of, attitude towards, and emotional reactions to mathematics. Christenson and Reschly posit that self-reporting is the best method for collecting information on student emotional engagement, stating that “their reports are likely more accurate, or at a minimum, an important addition to the information obtained from other sources (peers, adults, etc.)” (2012, pg.13). For this reason, emotional or affective engagement was measured through the ATMI (Appendix C).

Cognitive Engagement. Cognitive engagement was measured by academic self-efficacy. Academic self-efficacy is the “perceived confidence in one’s ability to execute actions for attaining academic goals” (Schunk & Mullen, 2012, pg. 222). Research indicates that a high sense of academic self-efficacy can positively influence effort, persistence, motivation, and the use of effective learning strategies (Bandura, 1997, Schunk & Mullen, 2012, Schunk & Pajares, 2009). Due to the personal nature of this construct, it was also measured through items on the ATMI (Appendix C).

Measures of Student Perception. Student perception was analyzed through the student focus groups. The open-ended questions in the focus group assisted in providing insight on how student perceived the learning activities and their learning environment. Emergent data was coded. The student focus protocol can be found in Appendix D.

Positionality

For transparency, it is important that I not only acknowledge any preconceptions or predisposition I may have, but also illuminate how these may or may not have influenced the study. The lens through which I approached this study resulted from my

experiences as a researcher, former Title 1 grant coordinator and being the daughter of a former assistant superintendent. Though I have been immersed in K-12 education most of my life, I have never been a teacher. Moreover, I do not consider myself math inclined. As such, my positionality within this study is that of an insider-outsider (Banks, 1998). As a result of my professional and personal experiences, I do have an intimate knowledge of K-12 environments and classroom proceedings, allowing me to recognize typical and atypical situations, behavior, and activities. However, due to my mild aversion to math, I acknowledge that my ability to critically choose appropriate alternative content and objectively evaluate math instruction is limited. To mitigate the issue of choosing appropriate content, Mr. Martin (a content expert) worked as a co-designer on the intervention, reviewing and essentially approving of all material used in the lessons. Findings related to the critique of instruction were triangulated through at least three sources of data to ensure objectivity.

Design Limitations

The design of this study is feasible, logical, and tenable, but it is not without limitations. Ecological validity is sometimes difficult to ensure within classroom settings. Ecological validity is the extent to which “social scientific findings are applicable to people’s every day, natural social settings” (Bryman, 2012, pg. 48). For instance, the findings derived from the student survey could be internally and externally valid and have measurement validity, but the process of filling out a survey for students is unnatural and could limit the ecological validity of the experiment. A similar limitation is the Hawthorne effect, in which individuals alter their behavior in response to their awareness of being observed. If students in the experimental group adjust their survey

responses to reflect more positive results because they know they are being monitored, then the true significance and effect size of the intervention could be threatened. To minimize these limitations, the student survey was introduced and distributed by the teacher as part of students' weekly assignments for the class.

The lack of generalizability is also a limitation due to the small sample size of both the control and experimental group. The target population is all K-12 students, however for time and management purposes, only 80 students, in one grade, at one school, in one district participated in this study. In order to substantiate any significant impact the intervention might have on student achievement and student engagement, subsequent experiments with various grade levels, teachers and school are necessary. The content specificity of the classrooms involved in the study also hinder its generalizability. Findings may not be transferable to classrooms that focus on other content areas, such as English, history or even science.

A two-week long intervention was chosen to coincide with the dissemination of one math unit (i.e., polynomials) and during a stretch of uninterrupted school days (i.e., no holidays or vacation days). Though various components of the intervention were delivered to the students multiple times a day and multiple days a week, it is uncertain if the length of the intervention affected its impact on student outcomes.

Lastly, since the same teacher provided instruction to both the experimental and control groups, there was a chance of cross-contamination. The teacher could have consciously or unconsciously applied some of the UDL enhanced strategies in the control classroom, thus potentially impacting results. To combat this issue, I closely monitored the teacher's practice in both classes at least two days a week to ensure that the control

group was given the standard curriculum. I was also able to meet with the teacher a few days a week to address any issues or concerns about providing two classes with separate curriculum. Of course, underlying dynamics such as social and cultural factors (such as students' relationship or historical feelings toward the teacher), that are not exposed in the study may also have impacted student outcomes.

Summary

This chapter outlined the intervention, identified the participants, and described the overall methodology for this study. The next chapter, Chapter Five, details the results of the intervention.

CHAPTER FIVE: FINDINGS

Introduction

Through an experimental design, this study sought to determine the impact of a Blended Universal Design for Learning intervention on students in an accelerated 7th grade math class. Specifically, the interventions' effect on student achievement, engagement, and perception was examined. Differences in impact among English Language Learners and students with Individualized Education Plans (IEP) were also investigated. Finally, changes in the teachers' perception as a result of the intervention were documented. In this chapter, the findings will be organized by each research question.

Impact on Student Achievement

In this study, student achievement was measured by the grade students received on assessments. Over the course of the intervention two assessments were given to both classes: a pop quiz and a chapter test. Both tests measured the students' ability to add, subtract, multiply and divide polynomials and convert standard notation to scientific notation and vice versa, content that was covered extensively in class over a two-week period. The assessments were generated and graded by the teacher.

Quiz Results

The quiz, which consisted of 10 questions, was given approximately one week into the intervention. During this first week, students watched two LetsGoLearn videos, completed the Scientific Notation Puzzle, and two Who Dunit activities (for more information about these activities please refer to Table 4). The pop quiz was the fourth quiz taken in the class, but the students were not forewarned that they were going to be

taking this quiz. At first examination the impact of the intervention on the quiz scores of the experimental group seemed significant. Of the 40 students in the experimental group, 21 of them received 100% or higher (extra credit) on the quiz, as compared to the control group where only 13 of the 39 students received a 100% or higher. Figure 4 displays the spread of scores across both the control and experimental class.

Figure 4. Quiz 4 Score Distribution.

As Figure 4 indicates, 73% of the students in the treatment group received an A or better on the quiz. In the control group 64% of the students received an A or better on the quiz.

The class average for the experimental group was 94.3% as compared to the class average of 90.5% for the control group. To help assess if this 3.8% difference had been due to the intervention or a normality of class variation, all prior quiz scores were collected and examined. Prior scores revealed that the experimental class scored higher than the control class on all quizzes. That is, the experimental group typically performs higher than the control group. Therefore, the experimental groups' higher average alone can not necessarily be attributed to the intervention. However, there was a noticeable

increase in the average difference between the two classes that may have been influenced by the intervention. Typically, on quizzes, the experimental class averages 1.7% higher than the control class, but on the polynomial quiz the experimental class averaged 3.8% higher. That is a 2.1% increase of the experimental class scores post-intervention. Table 7 shows the experimental and control class average for each quiz taken that semester and the difference between class scores. Quiz 4 is the polynomial quiz that was given during the intervention.

Table 7
Quiz 4 Class Averages

	Quiz 1	Quiz 2	Quiz 3	Quiz 4
Experimental (n=40)	89.7%	90.9%	90.7%	94.3%%
Control (n=39)	87.0%	88.9%	90.3%	90.5%
Difference	2.7%	2.0%	0.4%	3.8%

For 58% of the students in the treatment group, the score they received on their polynomial quiz was one of the highest scores they had ever received on a quiz in that class; this was true for 36% of the students in the control group⁶. Though these results are positive, an independent-samples t-test was conducted to compare the Quiz 4 scores for the control and experimental class. The results from the test indicate that there is no statistically significant difference in scores for the experimental class ($M = 94.25$; $SD = 13.85$) and the control class ($M = 90.46$; $SD = 10.97$); $t(77) = 1.345$, $p = .18$, two-tailed).

⁶ This percentage includes students who had received the exact score on a previous test (i.e., they scored a 95% on quiz 4, but had also scored a 95% on quiz 2).

The magnitude of the differences in the means (mean difference = 3.8, 95% CI: -1.82 to 9.4) was small ($d = .3$). As mentioned in the limitations, the small sample size of 79 participants likely contributed to the non-significant result of the t-test. The implications of these results will be discussed in Chapter Six.

Test Results

The students were given a culminating chapter test at the end of the two-week intervention. The test, consisting of 25 questions, was the fourth test the students had taken in the class. The students knew this test was going to be given and participated in test preparation the day before. The experimental class received an altered lesson (CSI Review, see Table 4), influenced by the intervention. Though not as considerable as the results on the pop quiz, the scores on the chapter test were also revealed positive trends for the experimental group. Only 1 student in the experimental group received a 100% or higher (extra credit) on the test, whereas 3 students in the control group received a 100% or higher. Though the control group had more students score 100%, 60% of the students in the treatment group received a grade of an A or better on test, compared to 38% of students in the control group. Figure 5 displays the distribution of scores for both the control and experimental group for the Test 4.

Figure 5. Test 4 Score Distribution .

The experimental groups' class average on Test 4 was 88.2%, the control group received a class average of 85.7%. To assess if the 2.5% difference in averages were normal for the two classes, all prior test scores were collected and examined. Again, the experimental group, on average, scored higher on their tests than the control group. Once again, the experimental groups higher average on the test can not be directly attributed to the intervention. However, as with the quiz, the experimental groups' average did increase post-intervention. The experimental class average is usually 1.2% higher than the control class average, but on Test 4 the treatment groups' average increased to 2.5%. Table 8 shows class averages for each test taken that semester and the difference between class scores.

Table 8

Test 4 Class Averages

	Test 1	Test 2	Test 3	Test 4
Experimental (n=40)	87.7%	92.4%	90.8%	88.2%
Control (n=39)	86.6%	91.9%	88.8%	85.7%
Difference	1.1%	0.5%	2%	2.5%

The experimental class average went down 2.1% on the test. There are potentially two explanations for this outcome. One explanation for this outcome may be attributed to the intervention. Unlike the quiz, the test had problems on how to multiply polynomials, a concept (according to the teacher) students, in both the experimental and control class, had major trouble grasping. The main learning activity in the intervention for multiplying polynomials was the dice game. The dice game included a pair of dice with polynomials on each side and a penny. Students were put in groups and were required to roll the dice and flip the penny. If the penny landed head up they would divide the two polynomials facing up on the dice, if the penny landed tails up they would divide. The probability of students working on a multiplication problem was, theoretically reduced by half during this activity. If students had been given more dedicated time to practice multiplying polynomials, such problems may not have caused such an issue for students on the test. This would be a direct fault in the lesson. However, the other explanation is that the test, in general, was harder than usual. In addition to the experimental group, the control group also went down in their class average by 3.4%. That both classes scored below their usual

average could infer that the test (being the common denominator), and not the intervention influenced the decrease in scores.

An independent-samples t-test was conducted to compare the Test 4 scores for the control and experimental class. Again the results from the test indicate that there is no statistically significant difference in scores for the experimental class ($M = 88.18$; $SD = 10.11$) and the control class ($M = 85.67$; $SD = 10.95$); $t(77) = 1.058$, $p = .3$, two-tailed). The magnitude of the differences in the means (mean difference = 2.5, 95% CI: -2.21 to 7.23) was small ($d = .24$). As previously mentioned, the non-significant result may be due to insufficient power as a result of the small sample. The implications of these results will be discussed in Chapter Six.

Impact on Student Engagement

Student engagement refers to “the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education” (edglossary.org, 2015). As a meta-construct, student engagement was measured on three dimensions: behavioral, emotional and cognitive. Data from the observation notes, teacher interviews, and Attitude Towards Math Inventory (ATMI) were analyzed to interpret the overall impact of the intervention on student engagement. The following sections report the findings by data source.

ATMI Results

The ATMI is a 40-item questionnaire that measures students attitude towards mathematics. Emotional and cognitive engagements were the constructs specifically addressed through this measure. The questionnaire itself measures a student’s response

across four subscales: enjoyment (the degree to which students enjoy working on mathematics); motivation (student's interest in mathematics); self-confidence (confidence in their performance in mathematics); and value (student's belief on the usefulness and worth of mathematics) (Tapia & Marsh, 2004). Combined, these subscales for this particular study produced a high Cronbach Alpha of .97, indicating good internal consistency. The ATMI was administered pre and post intervention to both the experimental and the control group. A copy of the ATMI can be found in Appendix C.

The questionnaire was on a 5-point Likert scale with 1 being strongly disagree and 5 being strongly agree. Negatively worded questions were reversed valued, resulting in a ATMI score range of 40-200. There were 10 enjoyment items, 5 motivation items, 15 self-confidence items, and 10 value items. As such the scale for each subscale was within the following ranges: enjoyment (10-50); motivation (5-25); self-confidence (15-75); and value (10-50).

The administration of the ATMI, pre intervention, resulted in 33 submissions, however, two were thrown out due to being incomplete. Thirteen of the 31 submissions were from students in the control class, with the other 18 being from students in the experimental group. Table 9 displays the class pre mean scores for the individual subscales and the ATMI as a whole. An Independent-samples t-test was conducted to compare the total attitude towards math scores for the two classes. There were no significant differences in the scores for the control ($M = 167.08$, $SD = 15.5$) and experimental class ($M = 163.22$, $SD = 18.63$; $t(29) = .608$, $p = .65$, two tailed). The magnitude of the differences in the means (mean difference = 3.9, 95% CI: -9.12 to 16.83) was small (eta squared = .224).

Table 9

Pre ATMI Averages

Subscale	Class	Mean	N
Value Pre	Control	45.69	13
	Experimental	43.89	18
Enjoyment Pre	Control	39.62	13
	Experimental	37.44	18
Motivation Pre	Control	20.15	13
	Experimental	20.72	18
Self Confidence Pre	Control	61.62	13
	Experimental	61.17	18
Pre Attitude Towards Math	Control	167.08	13
	Experimental	163.22	18

Though no statistical significance was found, it is important to note that before the intervention, the control group self-reported higher scores than the experimental group. These scores indicate that these students' attitude towards math and general engagement in math was already, (pre-intervention) fairly positive. Examining the subscales separately led to similar outcomes. Both classes scored higher than average for each subscale. The control class did report higher scores on their perceived value of math, their enjoyment of math and their overall self-confidence doing math. Motivation was the only subscale that the experimental group scored higher in than the control group.

The administration of the ATMI post intervention resulted in 60 responses; three of which were not included in the analysis due to being incomplete. The increase in ATMI responses from pre to post can most likely be attributed to one of two things: an increase in parent permission slips allowing the child to take the survey and an improved relationship with the researcher and a recognized association of the ATMI with the researcher. Of the 57 complete surveys, 33 came from the control class and 24 came from the experimental class. Table 10 displays the post class mean scores for the individual subscales and the ATMI as a whole.

Table 10

Post ATMI Averages

Subscale	Class	Mean	N
Value Post	Control	42.36	33
	Experimental	42.58	24
Enjoyment Post	Control	37.67	33
	Experimental	35.58	24
Motivation Post	Control	18.91	33
	Experimental	19.96	24
Self Confidence Post	Control	60.18	33
	Experimental	60.17	24
Post Attitude Towards Math	Control	159.12	33
	Experimental	158.29	24

An Independent-samples t-test was conducted to compare the total attitude towards math scores for the two classes. Again there were no significant differences in the post scores for the control ($M = 159.12$, $SD = 22.45$) and experimental class ($M = 158.29$, $SD = 25.65$); $t(55) = .730$, $p = .90$, two tailed). The magnitude of the differences in the means (mean difference = .83, 95% CI: -12 to 13.65) was very small (eta squared = .034). Again the control group scored higher on their overall attitude towards math than the experimental group. Interestingly, both groups' post ATMI averages went down on every subscale. The control group remained higher than the experimental group on the self-confidence and enjoyment subscale, yet fell slightly below the experimental group on the value subscale. The experimental group again averaged higher than the control group on the motivation subscale.

It could be assumed that any ATMI score variation could be attributed to sampling error. To possibly get a truer estimate of the impact of the intervention, a mixed between-within subjects analysis of variance was conducted to assess the impact of the intervention on participants who completed both the pre and post ATMI. Only students who took both the pre and post ATMI were examined, therefore only 22 students were included in this analysis. As expected, there was no significant interaction between the class and time, Wilks' Lambda = .1, $F(1, 20) = .009$, $p = .93$, partial eta squared = .000. There was no substantial main effect for time, Wilks' Lambda = .1, $F(1, 20) = .034$, $p = .86$, partial eta squared = .002. The main effect of comparing the two classes was not significant, $F(1, 20) = 1.83$, $p = .19$, partial eta squared = .084.

Table 11

Pre & Post ATMI Averages

Subscales	Class	Pre Mean	Post Mean	N
Value	Control	46	44.5	10
	Experimental	43.1	44	12
Enjoyment	Control	37.6	38.5	10
	Experimental	35.4	34.8	12
Motivation	Control	18.3	17.8	10
	Experimental	18.2	18.1	12
Self Confidence	Control	40.8	39.8	10
	Experimental	40	39.6	12
Attitude Towards Math	Control	170.5	170	10
	Experimental	161.67	161.5	12

As shown in Table 11, the total ATMI score for both the control and experimental group did not change much from pre to post. Similar to the whole class analysis, the ATMI score for students who took both pre and post decreased. Results from this analysis suggest that there is no difference between the control group and group that received the intervention. It also indicates that there was no significant difference in the pre or post scores of these students. The implications of these statistics will be discussed in Chapter Six.

Classroom Observation Results

Classroom observations were conducted specifically to examine student behavior during the various learning activities. During the intervention, particular attention was paid to verbal and nonverbal indicators of students' engagement. The intervention

exposed the experimental class to alternative learning activities, however, the learning objectives (e.g., learning how to divide polynomials) for both classes remained the same. Comparisons were made between the control and experimental group on the way students behaved during their respective learning activities. For a general idea of what verbal and nonverbal indicators were documented, please refer to the observation protocol in Appendix B.

Both classes were generally well behaved, which could have been assumed given their achievement level, and their high scores for perceived value, enjoyment, and motivation on the ATMI. Students, in both classes, followed along with teacher instruction, adhered to basic classroom rules and regulations, and were on-task a majority of the time. However, a thorough coding of the observation notes revealed that the experimental class demonstrated higher levels of behavioral engagement and spent more time actively learning than the control class. Active learning requires students “participate in the learning process and do something besides passively listening” (Bonwell & Eison, 1991, pg.5).

In the control classroom, where the learning activities were mostly teacher directed, active learning was limited. Students spent the majority of their learning activity time listening to teacher instruction, completing independent work, responding to queries posed to the class, and asking for clarification on classwork or homework. Because these activities did not require all students to be actively involved, many students did not participate (e.g., they did not ask questions, they did not offer answers, and demonstrated off-task behavior during instruction). Students in the control class were more frequently seen engaging in off-task communication, off-task manipulation (e.g., drawing, poking

their neighbor, etc.,) and aimlessly gazing. Figure 6 is a picture of the control class participating in their learning activity for adding and subtracting polynomials. During this activity students are supposed to be working individually in their notebooks, but as the picture shows some students are turned around in their seats, talking to their peers or even have their head on their desks.

Figure 6. A picture of the control class engaged in a learning activity on adding and subtracting polynomials.

The snapshot presented in this picture is an accurate and consistent example of students' behavior in the control class during the learning activities. Though students were on-task for the most part, their lack of active involvement, combined with their off-task behavior, demonstrated an overall lower level of student engagement.

The experimental class, on the other hand, demonstrated considerably less off-task behavior. The activities presented in this class required all students to be more

actively involved. In addition to listening to teacher instruction, responding to queries posed to the class, and asking for clarification on classwork or homework, students in the experimental class also had to demonstrate their learning, assist others in their learning, communicate with their peers, manipulate learning materials, and cognitively connect math concepts to bigger ideas. These activities required the active involvement of all students. During these activities, though off-task communication was heard from time to time, off-task manipulation, and aimless gazing were not apparent. Figure 7 and Figure 8 are pictures of students in the experimental class participating in a learning activity on adding and subtracting polynomials.

As the pictures show, students are actively participating in the activity. They are communicating with peers, searching for clues, problem solving, and manipulating lesson materials. The lack of negative behavior, along with the multitude of positive behavior displayed in the experimental class during intervention driven activities, connote higher levels of interest and overall engagement. Though these conclusions were derived from my own observations, when interviewed, the teacher gave similar accounts of the students' behavior. Results from the teachers' interview in regard to student engagement are highlighted in the next section.

Figure 7. A picture of the experimental class engaging in a learning activity on adding and subtracting polynomials.

Figure 8. A picture of the experimental class engaging in a learning activity on adding and subtracting polynomials (different angle).

Teacher Interview Results

Mr. Martin was interviewed twice, once at the beginning of the study and once at the end. Each interview lasted roughly 45 minutes. His opinions on the temperament of the two classes during the intervention, particularly questions about the students' behavior, were solicited. When asked if there were any perceived differences between the classes while students participated in the learning activities, the teacher acknowledged that the experimental class reacted more positively to their lessons. He stated, "They had a lot more fun doing what they were doing."

Mr. Martin theorized that allowing the students to move around and partner with their peers broke up the monotony of his typical classroom structure. He also believed that embedding the math problems into game-like activities increased students interest in and willingness to solve the problems.

When asked about the effects of the learning activities on students, Mr. Martin explained, "Overall the activities where they were up, engaged, walking around the classroom, having some sort of competition, I think definitely helped [with engagement] a lot." As part of the intervention, all three UDL principles (action and expression, representation, and engagement) were addressed within the learning activities (see Table 4). When asked about the various principles and their impact on students, Mr. Martin emphatically stated, "I think the engagement had the most impact. I think it helped with student motivation." Mr. Martin's statement aligns with the theory that engagement "extends to the level of motivation" (edglossary.org, 2015); students possess to progress in their education.

Students in the experimental classroom displayed behavior indicating an increase in attention and interest in what they were learning. Although the ATMI scores did not reveal a positive or negative impact, the observational data and teacher account suggest that giving students the opportunity to collaborate with peers, manipulate learning material, and focus on an objective other solving the problem may have positively influenced students' behavioral engagement. The nuances and implications of this finding will be further explored in Chapter Six.

Impact on Student Perception

In this study, perception refers to the way a students feel or thinks about the class. To gauge any changes in students' perceptions due to the intervention, pre and post student focus groups were held for both classes. The findings from this data are discussed in this section. As an aside, since the control class did not experience the intervention, the data gathered from their focus groups will not be used for these findings.

Pre Student Focus Group Results

The first focus group was held during lunch, a week before the intervention was to start. Thirteen students from the experimental class attended. Given the general high ATMI scores of the experimental class, it was no surprise that the students in the focus group felt very positively about the math class. All but one student commented that math was either their first or second favorite class (not including electives) in school. Students gave various reasons for liking the subject, from "I'm just good at it" and "It is just stress free" to "It will come in handy in the future." The latter comment is indicative of most of the students' fervent belief that math was necessary for their future success. From their comments, it became evident that students did not necessarily enjoy math as much as

they valued it. They recognized it as an important subject to learn and enjoyed the ease in which they understood it. However, when asked if any of them were interested in or would like to pursue a career that involved math, only one student raised their hand.

Since the intervention explicitly addressed the methods and materials used within a curriculum, the students were asked about Mr. Martin's teaching practice and the tools used in class. Students agreed that Mr. Martin was one of their favorite teachers. They remarked that he was funny, and that he was good at explaining problems. However, all 13 students did express that they would like to change the structure of his class. As previously mentioned, Mr. Martin's classroom was fairly regimented and very teacher-driven. Though many students liked "doing the same thing every day" because they "knew what to expect" and it reduced their "anxiety," all of them wanted him to "change it up." Students were vocal about wanting to do more activities and projects. They complained that the "routine" of the classroom was boring and the lack of active involvement made it hard to be engaged. One girl put it this way, "We are just sort of sitting in our seats the whole time and yeah, we are learning, but we are not really engaged."

When asked, students unanimously stated that the learning activities would be the one thing they would change about the class if they could. They desired more opportunities to work with their peers and more opportunities to participate in activities instead of book work. For these students, their perspective of the class was that it was too predictable, too rigid, and "boring." However, these perspectives changed after the intervention was introduced.

Post Student Focus Group Results

The second focus group was held during lunch, three days after the intervention ended. Eighteen students showed up; nine of which had been at the first focus group. After experiencing the intervention activities over the past two weeks, students provided very positive feelings towards the methods and materials used in the class. Students described the new activities as being helpful, fun and interesting. One student commented that the new lessons were “really helpful, because there was more of a goal to reach than just doing the problem.” Another student said, “I think the activities were a lot more engaging and we were interacting more, like, with each other and with the problems and the unit.”

For many students, being able to move and actively participate was the best part of the lesson. When asked what exactly they liked about the lesson, 14 out of the 18 students mentioned movement of some kind or the opportunity to get out of their seat. Students were also fond of the chance to manipulate materials other than their pencil to solve problems. One student insisted that the activities were way better than “sitting at [their] desks and writing till [their] hands hurt.” Throughout the interview, students continued to link their physical engagement to their mental engagement. In fact, the majority of students believed the activities not only helped them learn the material, but also made them feel more confident and more prepared to take their chapter test. One student’s sentiments were adamantly agreed upon by others in the class, “If [Mr. Martin] just goes over it with just a boring old lesson and we just sit there, we’re not going to remember anything about it.”

Many in the focus group also enjoyed the collaborative nature of the activities. Much of the work prior to the intervention was individually completed, so the act of working with a partner or with a group was a novelty. A student shared, “Being able to get up and talk with our partners was nice. We would like learn more about them and how they would engage in solving the math question...just different ways to do it.” Students describe the experience as “interesting,” “exciting,” and “helpful.” One student even stated that, “It actually made [him] look forward to going to math class every day.” Though students’ perceptions of the altered curriculum were generally positive, there was one thing that students were ambivalent about, the videos. Students shared that they equally liked and hated the videos. Many thought the videos were immature and “made the lesson feel less intelligent.” However, they found them entertaining and realized that the songs in the video “got stuck in their head” and helped them remember how to do a problem. When asked if the videos should be taken out completely, if another intervention were scheduled in their classroom, the majority of students were conflicted. One thing that was made clear was that the videos were one of the least favorite aspects of the intervention, though their benefit to students it was left undetermined.

Given the feedback provided by the students in the focus groups, the intervention had a positive impact on their disposition towards the curriculum, specifically the methods and materials. As one student put it, “I really like [Mr. Martin’s] lesson, but like now it is less of him up on the board, doing the problems, and I really like that more. It’s like I’m getting to be more hands on with the new version.” All but one student wanted the teacher to continue with new curriculum. The student who did not want it to continue stated that though he liked the activities, he would rather have that time to do homework

because he was involved in a lot of after school activities. Overall, students' general opinion of the intervention was very positive, which raises questions as to why the ATMI scores went down instead of up. Thoughts on this incongruity will be shared in Chapter Six.

Impact on ELL and IEP

The questions regarding English Language Learners and students with Independent Education Plans were more suited for the school that I was originally going to work in, as it was much more diverse than Dillon Middle School. Out of all 79 students who participated in the study, six were ELLs and 4 had IEPs. Table 11 displays the distribution of these students. Due to their limited number, the results for ELL and IEP students will be reported together by class.

Table 12

Number of IEP and ELL Students by Class

Class	IEP	ELL
Control (n=6)	3	3
Experimental (n=4)	1	3
Total	4	6

Achievement Results

ELL and IEP students in the experimental class did perform better on test 4, however, the intervention may not have had any impact on those outcomes. After reviewing past quiz and test scores, the point differential between the two classes on Quiz 4 and Test 4 proved to be more typical of their normal scoring pattern than an effect of the intervention. Table 12 shows the spread of quiz and test averages by class. As the

table displays, there was zero difference between the two classes on Quiz 4 and a 7.6-point difference on Test 4, but as previously mentioned, the 7.6-point differential was not atypical.

Table 13

Class Averages for IEP & ELL

	Quiz 1	Test 1	Quiz 2	Test 2	Quiz 3	Test 3	Quiz 4	Test 4
Experimental	88.8	85.3	90.0	95.5	88.5	93.3	87.5	90.3
Control	82.3	75.5	85.8	87.7	88.0	92.3	87.5	82.7
Difference	-6.4	-9.8	-4.2	-7.8	-0.5	-0.9	0.0	-7.6

To see if the intervention had any impact on individual students' grades, disaggregated quiz and test scores for the experimental group were examined. Three out of the four students in the experimental group, scored within their normal grade range. However, there was one ELL student who scored almost 20-points below their normal scoring pattern on Quiz 4, but managed to bounce back within their regular range on Test 4. Unfortunately, it is impossible to tell if this temporary dip in scores had been due to the intervention or just an anomaly. Regardless, the overall scores for the experimental class did not indicate that the intervention had any effect on the achievement levels of IEP and ELL students.

Engagement & Perception Results

The data on student engagement and perception for the ELL and IEP students was sparse. Only nine of the 10 students completed a ATMI and out of those nine, only one completed a pre and post ATMI. That one student was in the control classroom, so measuring the effects of the intervention was not applicable. Student scores were representative of the larger class. All but one student reported a higher than average attitude towards math score. Other measures to indicate engagement were evaluated at the classroom level and not on an individual basis, making it impossible to give an account of these students' behavioral engagement.

As for the student perception outcome, two ELL and IEP students attended a focus group, however only one was in the experimental group. The status of this student was not known until after the completion of the study. Distinguishing this student's opinion and voice from the group at large is unfeasible. Unfortunately, though efforts were made, there is not enough data to indicate any effect of the intervention on IEP or ELL students. The implications of this result will be further discussed in Chapter Six.

Impact on Teacher Perception

The question on teacher perception explores the impact of the intervention on how the teacher views his curriculum, teaching practice and/or teaching philosophy. To answer this question a pre and post interview with the teacher was conducted.

Prior to the intervention, Mr. Martin was satisfied with the curriculum he provided in his class. He explained that he has been revising it for years, even making it a center focus for a curriculum development class he took at a university. His current curriculum is entirely based off the math textbook used in the class, which was published

in 1992. Though the textbook is almost two decades old, Mr. Martin suggests that it still aligns with current common core standards. One particular aspect of his curriculum that Mr. Martin was very proud of, were the notes he provided every student in his class. For every chapter, a typed packet of notes is given to students to help guide them through the chapter in their textbook. The notes included step-by-step instructions on how to solve problems and included sample problems.

Highlighting the teacher's contentment with the guided notes is important, as these packets helped to sustain the more teacher-driven, individual work supported in the classroom. Furthermore, Mr. Martin believed that the notes were enough to adequately engage the students, stating, "These kids are at such a high level for the most part. When you do teach it to them and you give them some practice problems, they got it. They don't have to sit there and explore or investigate things to put it to long-term memory. It's [his curriculum] working." Because the intervention supported more nontraditional, student-centered activities, it was assumed that Mr. Martin's affinity for, opinion of, and/or thoughts on his current curriculum would be challenged. To an extent this was true.

In his post interview, Mr. Martin disclosed that he "really liked the intervention," so much so, that he had decided that next year he would do the activities with both classes. He shared that "The group work and the activities that [they] did, by far, were much more superior than them just doing individual work straight out of the book." In addition to using these practices with both classes next year, Mr. Martin even declared that the intervention had "sparked ideas" for kids in his regular 7th grade math class and for students in those classes that were struggling. He believed that the activities, would

have a “much bigger impact” on with students who struggle. Again the students in the study were, in general, already highly motivated, self-confident and enjoyed doing math. Students who struggle in the subject may not enjoy doing math or be as confident in their abilities in the same manner and may benefit more from activities that offer new ways of learning and presents information in different ways.

However, though he acknowledged the positive effects of the intervention on his students’ achievement and behavior, he still favored his more traditional, teacher-driven practices. For instance, when asked if the intervention impacted the way he will design lessons in the future he stated, “As far as the notes and stuff, no, but I do want to, instead of doing the textbook self test A, self test b and the reviews, I do want to do a lot more of the scavenger hunts and the CSI type activities.” He also believed that not giving as much instruction, in some capacity, negatively affected the students stating that, “If I did an instructional lesson for even like 5 or 10 minutes longer I think [the experimental class] would have scored slightly higher than they did.” Post intervention, Mr. Martin also continued to believe that the students in his accelerated math class did not need such activities, stating “In the 7A class, I’m teaching a year and half in a year, so it’s compacted. Most of the time it is just teach a lesson, do some practice, and move on. And you’ve seen how smart most of these kids are, most of them pick it up and get it and that’s it. They don’t really need the intervention.” Mr. Martin’s point of “necessity” raises interesting questions. Is it necessary for students to be motivated in order to educate them? Does engagement matter if they are learning? How does one’s definition of learning and engagement play into these beliefs? These questions and the implications

of Mr. Martins' indifference towards the intervention for high achieving students will be further explored in Chapter Six.

Summary

The findings in this chapter were a little mixed. Though not statistically significant positive outcomes were produced for student achievement and student perception, but slightly positive or neutral outcomes (in terms of intervention impact) were revealed in regard to teacher perception and students' attitude towards math. Why the intervention had varying impact on the different measures will be discussed in Chapter Six, along with the general implications of this study, given the findings. Directions for future research will also be considered.

CHAPTER SIX: DISCUSSION AND IMPLICATIONS

The purpose of this study was to test the efficacy of a Blended Universal Design for Learning model in improving student achievement, engagement, and perception. The impact on teacher perception, English Language Learners, and students with Individual Education Plans was also explored. An experimental mixed methods design was implemented to answer the guiding research question: How does a Blended Universal Design for Learning intervention impact a 7th grade math class? The answer to this question, as noted in Chapter Five, is up for debate and will be discussed here.

This chapter will start by summarizing the findings provided in Chapter Five. An interpretation of the findings will be discussed, along with lingering questions brought forth by the study itself. Finally, the chapter will conclude with the limitations, implications for future research, the significance of the study and concluding remarks.

Summary of Findings

Student Achievement

As mentioned in Chapter Five, the experimental class did receive a better class average than the control class on Quiz 4 and Test 4. Though the experimental group typically scored higher than the control group, the percentage by which they outscored the control group increased by 2.1% on Quiz 4 and by 1.3% on Test 4. On the pop quiz, the experimental class average increased by 3.9% but decreased by 2.1% on the test. On the quiz, 73% of students in the experimental group received an A or better, while only 64% of students in the control group did the same. On the test, 60% of students in the experimental group received an A or better, while only 38% of students in the control

class received an A or better. Despite the disparity in these percentages, an individual samples t-test proved that the differences in scores were not statistically significant.

Student Engagement

Student engagement was measured by responses on the Attitude Towards Math Inventory, classroom observations and teacher testimony. Though evidence suggests that the intervention had some positive influence on student engagement, the raw data from the ATMI did not align with this argument. Pre and Post scores reveal that the class means for all four subscales (motivation, enjoyment, value and self-confidence) went down post intervention. However, this was true for both the experimental and control group. The decrease in scores, across the board, could be attributed to the increase in the number of students who completed the Post ATMI versus the Pre ATMI. The increase in student responses may have led to an increase in response variation, impacting the mean scores for both classes. When examining the data for students who took both the pre and post ATMI, the results were the same; students' overall attitude towards math decreased over the course of the intervention. Though there was a decrease in scores, the point differential is so small (.5 for the control group; .17 for the experimental group) that the assumed impact of the intervention on student's attitude towards math was ruled infinitesimal.

The classroom observations and the teacher testimony provided more positive results. Students in the experimental classroom had less off-task communication and manipulation. These students demonstrated more on task verbal and nonverbal behavior than their control classroom counterparts. Though the amounts of off-task behavior (gazing, irrelevant communication and manipulation, head on desk, etc.,) were limited for

both classes, students in the experimental class spent more time actively learning (asking relevant questions, providing relevant commentary, and analyzing and evaluating class content).

Student Perception

Again student perception, in this study, refers to the way students feel or think about the class. A students' positive perception of their learning environment can not only influence their behavior in class, but it can also encourage more positive attitudes toward learning (Dorman, 2001; Wild, 2015). The association between positive perception and positive attitude was made evident through many of the students' comments in the focus group. Students stated that the activities made them "look forward to math class every day" and that "The activities made [them] want to practice more." Students in the experimental group overwhelmingly preferred the altered curriculum describing it as more "fun", "exciting" and "engaging" than their traditional curriculum.

ELL & IEP Students

Of the 79 students involved in the study, only 10 students were identified as being English Language Learners or students with Individual Education Plans. The achievement differences between the control class and experimental class on Quiz 4 and Test 4 were negligible, resulting in either zero difference (Quiz 4) or falling within the normal scoring pattern (Test 4). No students in the experimental classroom completed the pre and post ATMI (Attitude Towards Math Inventory), and identifying the comments of the one qualifying student who participated in the focus group was not feasible. Unfortunately, there was not enough data to discern if the intervention had any impact on English Language Learners or students with Individual Education Plans.

Teacher Perception

In his post interview, Mr. Martin commented that he would do the learning activities associated with the intervention next year for both classes. He recognized having the students more involved in the learning process increased their engagement and their general enthusiasm in his class. He acknowledged that the students' behavior positively changed when doing the intervention activities, and he believed that the increase in test scores (though not statistically significant) was most likely due to the altered curriculum.

Additionally, during the final interview, Mr. Martin admitted that not having the experimental class do the alternative homework might have had a negative impact on their outcomes. He stated, "[...] It probably had a lot to do with the fact that they had the same homework; had we differentiated the homework I think the grades would have been a much bigger difference." The alternative homework would have extended the amount of the intervention received by the experimental class. It would have provided more opportunities to integrate technology, multiple forms of engagement and offered different ways for students to demonstrate their knowledge, which could have (with the learning activities) increased the effect of the intervention.

Mr. Martin's willingness to repeat the activities and speak positively about his experience is an indication that the invention positively impacted his perception of the curriculum. However, even with his desire to repeat the intervention, Mr. Martin's belief about the necessity for an intervention for accelerated students remained unchanged. He also continued to find his 15 to 20 minute lecture format essential in teaching his students.

Interpretation of Student Findings

After reviewing the results, it is clear that the outcome of the study is rather mixed. Though positive trends did emerge, two were found statistically insignificant and the other two could not be empirically validated. There are a number of possible interpretations for these findings; this section will illuminate a few.

Quantitative Findings

The quantitative findings in this study focused on achievement and engagement, with the data sources coming from the assessment and ATMI scores. Both quantitative findings were found to be statistically insignificant, possible explanations for these outcomes are discussed below.

The first possible explanation is that the intervention was simply ineffective. The positive shifts in student achievement and engagement may be due to nothing more than sampling error. In this case, Blended Learning and Universal Design for Learning principles had no tangible positive impact on student outcomes. This would explain why the ATMI results decreased after the intervention and why the experimental group scored below their normal class average on Test 4.

If the intervention, indeed, offered some real benefit, then the second explanation for the inconclusive results could be that there was not enough statistical power to rule out sampling error. This may explain why positive outcomes emerged, yet no statistical significance was found. This is especially true in the case of the ATMI, which had an even smaller response rate. It was known from the beginning, when the power analysis was conducted, that due to the small sample size, a large effect would be needed in order to reach statistical significance. If the sample or the effect of the intervention were larger

such significance may have been reached. Since significance was not reached a third possibility arises.

A third explanation for the lack of significance, if the intervention was beneficial and the sample size adequate, could be the diminished impact of the intervention due to its implementation. The intervention, itself, was a limitation in that it was not implemented to the degree originally proposed, which may have diminished its fidelity and impact. Parent concern prohibited the use of alternative homework. Again, the alternative homework would have provided more opportunities to integrate BL and UDL principles, which would have essentially increased the extent of the intervention. Technology was also not integrated to the desired degree. The potential impact of Blended Learning (student control over content, differentiated instruction, etc.,) was definitely hampered by the fact that students were not able to individually utilize technology during class time. Teacher efforts and the duration of the intervention, which are discussed in the forthcoming limitations section, may have also hindered the potential impact of the intervention. Without these alterations, a more authentic BUDL intervention would have been implemented and would perhaps have resulted in more positive, and more significant outcomes.

A fourth and final explanation for the inconclusive results could be that the intervention is effective in eliciting positive outcomes, but that it is not beneficial to the particular participants in the study. Again, these students were in an accelerated math class. They, as a whole, were high achieving and highly motivated. They saw an inherent value in learning math, had high confidence in their ability to successfully do math and actually enjoyed solving math problems. With already such high scores and seemingly

strong, positive attitudes, these students had limited space to improve and seem to have reached a ceiling effect or the point at which dependent variables (achievement and ATMI scores) are no longer impacted by the independent variable (the intervention). Questions arise as to how this intervention would have impacted lower achieving students. Would the impact of the intervention have been more significant? Would students with pre-existing, low scores, low motivation, and neutral/negative attitudes have benefited more from this intervention?

These explanations are not mutually exclusive and can interplay with one another in a variety of combinations, resulting in a myriad of possibilities. I believe that the lack of power, the small sample size, and the particular demographics of the students in the study resulted in findings that were insignificant. Though results from the study were statistically insignificant, possible positive associations between a BUDL intervention and student achievement and engagement still emerged. Considerations for the possible clinical significance of these outcomes will be discussed in the Implications for Future Research section.

Qualitative Findings

The qualitative findings in this study focused on engagement and perception, with the data sources coming from classroom observations, student focus groups, and the teacher interviews. Unlike the quantitative findings, the qualitative findings were fairly positive, resulting in strong associations between the intervention and improved engagement and perception. These findings are discussed below.

As a meta-construct engagement was measured on three dimensions: behavioral, emotional or affective, and cognitive. Behavioral engagement was measured through

classroom observations and teacher testimony, both of which yielded positive outcomes. Though students were not directly asked about engagement in the focus groups, the topic still arose, thus, data from the focus groups was also used to support the findings.

Students in the experimental class demonstrated less off-task behavior (gazing, irrelevant communication and manipulation, head on desk, etc.,) and spent more time actively learning. Active learning, again, refers to students participating in the learning process and doing something besides passively listening (Bonwell & Eison, 1991). Active learning requires students to be engaged in their learning and not merely recipients of information. This relates to what one student divulged when discussing her classroom before the intervention, “We are just sort of sitting in our seats the whole time and yeah, we are learning, but we are not really engaged.” In this study, students in the experimental group were required to ask more relevant questions, provided relevant commentary, and to analyze, synthesize, and evaluate class content more frequently than the control group. As a result, these students spent more time actively learning and more time engaged.

This finding also brings clarity as to why students in the experimental class continuously linked their physical participation to their overall engagement. One student commented, “[class during the intervention] was a lot more engaging and we were interacting more, like, with each other and with the problems and the unit.” Another stated, “We got to get up and walk around, instead of sitting at our desk the whole time, that made it interesting.” Students’ behavioral engagement was a symptom of their physical participation in the learning activities. When their physical participation increased due to the intervention so did their engagement.

As evidenced by the student focus groups, the intervention had a strong positive effect on students' perception of the class. Students in the experimental group overwhelmingly preferred the altered curriculum. Students stated that the activities made them "look forward to math class every day" and that "the activities made [them] want to practice more." A majority of the literature on Blended Learning and Universal Design for Learning is anecdotal in nature and focus on outcomes like student perception. The positive findings revealed in this study corroborate findings in previous studies and further support the theory that BL and UDL based educational models may attend to students' interest and satisfaction better than traditional models of schooling.

When taking into account the positive classroom observations, and the positive teacher and student testimony, an overall positive association exists between the intervention and student perception. Although qualitative results for student engagement were positive, the overall outcomes for this measure are inconclusive given that the ATMI results were statistically insignificant. The implications of these findings will be explored in the Implications for Future Research section.

Interpretation of Teacher Findings

The teacher findings in this study focused on Mr. Martin's perception of the curriculum, with the main data source being the teacher interviews. Mr. Martin in the end spoke very highly of the intervention and the curriculum and even mentioned the desire to use the curriculum in the future. However, Mr. Martin questioned the utility of such an intervention in a class where students were already high achieving. Mr. Martin's sentiments unearth some poignant questions. For instance, is it necessary for students to be motivated in order to educate them? Does engagement matter if they are learning?

Though I never questioned Mr. Martin on his definition of educating and learning, upon further reflection, I believe we may hold different understandings of the terms.

On one hand, educating students could simply mean the practice of teaching students basic knowledge, skills, theories and norms. Within this definition, the only requirement from students would be that they simply *understand*. Engagement as defined as “the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught, which extends to the level of motivation they have to learn and progress in their education” (edglossary.org, 2015) is not a prerequisite for understanding. Though understanding is a prerequisite for learning, it is only the beginning. In fact, on Benjamin Bloom’s famous taxonomy, which distinguishes learning objectives into levels of complexity and mastery, understanding and comprehension come only second on his six-tier model. More complex learning occurs beyond the realm of understanding. The purpose of education is to have students not only understand, but to also to analyze, create, and imagine. Educating students means facilitating the process by which they learn how to learn. The former definition is static and finite, but the latter is continuous and infinite, creating lifelong learners or students who seek willingly, their own path towards learning. Creating lifelong learners requires that students be psychologically invested in their learning; it requires them to be reflective, evaluative, self-disciplined, and engaged.

Thus, in answering the questions posed above, if educating students is about creating lifelong learners, then motivation is undoubtedly necessary. In order for learning to be a continuous practice, students must have an invested interest in or be engaged in their learning. Though these students were engaged in math, as evidenced by their high

ATMI scores, their investment was shallow, confined to the boundaries of the class. As mentioned in Chapter Five, only one student in the experimental focus group expressed that they wanted a math focus career. Students in this focus group also admitted that prior to the intervention, they were not engaged in class, content yes, but not class. This discussion evokes the question: If students were more engaged in class, would the interest in math-focused careers increase? Though not answered in this study, this question does elicit implications for future research.

Limitations of Study

This section highlights limitations that were not directly attributed to the design, but were rather unearthed throughout the implementation of the study. One limitation was the sample chosen to participate in the study. Students in the accelerated math class are a unique group and not necessarily representative of the student population. These students were also so high achieving and possessed such a high attitude towards math that the outcomes were probably hindered by a ceiling effect.

This limitation corresponds to the next issue, which was the lack of IEP and ELL students in the classrooms. One of the aims of this study was to test how a Blended Universal Design for Learning (BUDL) curriculum would accommodate diversity within the classroom, with IEP and ELL being the only two measures of diversity. The data gathered in this study, from the small representation of these students, did not allow for a proper analysis or subsequent interpretation of the interventions' impact. As a result, the question of whether BUDL could adequately address student variance or the learning needs of all students remains unanswered.

Another limitation is regarding the response rate of the Attitude Towards Math Inventory. The initial response rate of the ATMI was almost one-third the response rate of the post ATMI, making it difficult to draw comparisons on class averages before and after the intervention.

Teacher investment and effort were an unexpected limitation that surfaced at the beginning of the study. Though I had curated and prepped the curriculum, Mr. Martin was responsible for delivering it to the students. It was apparent that in the beginning Mr. Martin would not read the instructor guides for the lesson before delivering it in class. As a result, there were a few times he did not explain the lesson very well, which resulted in students being confused; or called on me for assistance to explain to the lesson, which involved me in the study in a way I did not initially intend. The delivery of this curriculum could have negatively impacted the way students approached the lessons. Even the smallest amount of initial confusion could have potentially affected students' view and response to the activity. As the days progressed, Mr. Martin began reading the guides prior to class, allowing him to present the material with authority and confidence, which (I believe) may have impacted the fidelity of the lessons being delivered.

Implications for Future Research

Findings from this study offer the first experimental exploration into the Blended Universal Design for Learning model. This section provides suggestions for future research.

As noted in the previous section, one aim of this study was to determine if BUDL could address student variance. Research on the two models that comprise BUDL suggest that diverse populations would benefit from various components of the model (such as

alternative modes of representation). Unfortunately, there was not enough variance between students to track impact. Future research should endeavor to test the efficacy of BUDL in notably diverse populations. Alternative variant factors (in addition to IEP and ELL) should also be explored.

Future research should focus on BUDL's effect on real time engagement levels. The ATMI, though suitable for gauging students' long-term engagement and invested interest, is not adequate in measuring real time fluctuations in engagement during intervention activities. Alternative measurements for engagement should also be considered.

Further iterations of BUDL should include more student technology use. As previously mentioned, this study limited technology use due to teacher preference and time. However, a more equitable representation of Blended Learning within the model may contribute to a larger impact on student outcomes. Also, increasing the presence of technology within the curriculum may lead to a more authentic BUDL model.

Future researchers should also consider increasing the length of the intervention. The intervention in this study, which spanned approximately two weeks, may not have been long enough to make a significant impact on the teacher or students. Moreover, testing the BUDL model on various populations should be explored. In particular populations with lower achievement and engagement levels should be considered to prevent a ceiling effect.

Lastly, the findings in this study raise questions as to whether there exists clinical significance within the outcomes. Clinical significance refers to the "practical or applied value or importance of the effect of an intervention—that is, whether the intervention

makes a real (i.e., genuine, palpable, practical, noticeable) difference in everyday life to the clients or to others with whom the clients interact” (Kazdin, 1999, pg. 1). While the experimental group may have scored below their typical class average on Test 4, they still managed to increase the percentage by which they outscored the control group. In addition, over half of the students in the experimental group received a 100% or higher (extra credit) on Quiz 4, while typically only 3-12 students receive such scores. In education, doubling the normal number of students in a class to receive a perfect score on a test is a practical, noticeable and genuine effect. However, due to sampling error, I cannot say whether these results are correlated to the intervention or were derived by pure happenstance. In the chance that the intervention did play a role, further research could support and further develop BUDL to be an effective model for K-12 education.

Significance & Closing Remarks

The purpose of this study was to test the efficacy of a Blended Universal Design for Learning model in improving student achievement, engagement, and perception. This research also attempted to contribute to the body of knowledge on the effectiveness of both Blended Learning and Universal Design for Learning on serving the needs of all learners.

Despite the limitations of the study, as well as the limited application of Blended Learning, this study introduced and tested the efficacy of a new teaching and learning model, Blended Universal Design for Learning. Results from this study indicate positive associations between a BUDL intervention and student perception. Though other results were statistically insignificant, possible positive associations between a BUDL intervention and student achievement and engagement also emerged. The heavy

implementation of UDL based principles adds to the body of research on the potential effectiveness of Universal Design for Learning on improving student outcomes. To date, this is one of the few empirical studies done on the effectiveness of UDL in K-12 classrooms.

Although the limitations in the design hindered the findings' generalizability to other students, classrooms, and content areas, the information presented herein can serve as an example for practitioners to implement such a model in their classroom. In addition to being used as an example, this study can also serve as a platform for further research on Blended Universal Design for Learning.

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APPENDIX A

Teacher Interview Guide

Teacher Interview Guide

Pre - Intervention

1. How long have you been:
 - a. Teaching?
 - b. In this district?
 - c. At this school?
2. What is your philosophy on teaching?
3. What is your philosophy on student learning?
4. How do you usually go about designing a lesson?
5. Can you describe one of your favorite lessons you have done this year?
6. How do you currently address student diversity in your classroom?
 - a. Can you give examples?
7. How well do you think you address issues with student diversity?
8. What is the current make-up of your classrooms in terms of student diversity (demographic, skill level, interest, motivation, learning disabilities, etc.)?
9. Are there significant differences that you currently notice between your two classes (i.e. behavioral, cognitive, engagement)?
 - a. If so, what are they? Please explain.
10. After working with UDL this summer what impact do you think it will have:
 - a. On your students?
 - b. On you as a teacher?
11. What concerns do you have about this study and/or the intervention?
12. Is there anything else you would like to add to help me better understand you as a teacher or your students?

Post-Intervention

1. How did the intervention go?
1. What types of issues arose in implementation? Any concerns of UDL strategies being used in the control classroom?
2. Are there significant differences that you currently notice between your two classes (i.e. behavioral, cognitive, engagement)?
 - a. If so, what are they? Please explain.
3. How do you think the intervention has impacted (give examples):
 - a. Student achievement?
 - b. Student engagement?
 - c. Classroom culture?
 - d. Students with IEPs?
4. What UDL strategies or principles seem to have the most impact? Please explain.
5. Thinking about UDL, how do you now go about designing lessons? Is it different than before?
6. Can you describe one of your favorite lessons you have done since the intervention?
 - a. Can you describe how the lesson differed between the experimental class and the control class?

7. What is your overall opinion of the UDL intervention so far?
8. Has your philosophy on teaching or student learning changed as a result of this study?
9. Is UDL a practice you will continue after this study? Why or why not?
10. What was the biggest challenge in implementing UDL?
11. Is there anything else you would like to add to help me better understand the impact of the intervention on you as a teacher or on your students?

APPENDIX B

Classroom Observation Protocol

Classroom Observation Protocol

Learning Activity

Nature of activity; what materials are being used?

What students are doing?

What teacher is doing?

Interactions? (i.e. teacher-student, student-student, student-software)

Student Verbal Behavior (i.e. Non-academic side talk? Asking questions? Active participation? Adding relevant commentary? Assisting others? Moaning? Verbal Excitement?)

Student Non-Verbal Behavior (i.e. Head on desk? Inactive? Off-task manipulation? Looking around the room? Self-regulated?)

APPENDIX C

Attitude Towards Math Inventory

Attitude Towards Math Inventory

1. Mathematics is a very worthwhile and necessary subject.
2. I want to develop my mathematical skills.
3. I get a great deal of satisfaction out of solving a mathematics problem.
4. Mathematics helps develop the mind and teaches a person to think.
5. Mathematics is important in everyday life.
6. Mathematics is one of the most important subjects for people to study.
7. High school math courses would be very helpful no matter what I decide to study.
8. I can think of many ways that I use math outside of school.
9. Mathematics is one of my most dreaded subjects.
10. My mind goes blank and I am unable to think clearly when working with mathematics.
11. Studying mathematics makes me feel nervous.
12. Mathematics makes me feel uncomfortable.
13. I am always under a terrible strain in a math class.
14. When I hear the word mathematics, I have a feeling of dislike.
15. It makes me nervous to even think about having to do a mathematics problem.
16. Mathematics does not scare me at all.
17. I have a lot of self-confidence when it comes to mathematics.
18. I am able to solve mathematics problems without too much difficulty.
19. I expect to do fairly well in any math class I take.
20. I am always confused in my mathematics class.
21. I feel a sense of insecurity when attempting mathematics.
22. I learn mathematics easily.
23. I am confident that I could learn advanced mathematics.
24. I have usually enjoyed studying mathematics in school.
25. Mathematics is dull and boring.
26. I like to solve new problems in mathematics.
27. I would prefer to do an assignment in math than to write an essay.
28. I would like to avoid using mathematics in college.
29. I really like mathematics.
30. I am happier in a math class than in any other class.
31. Mathematics is a very interesting subject.
32. I am willing to take more than the required amount of mathematics.
33. I plan to take as much mathematics as I can during my education.
34. The challenge of math appeals to me.
35. I think studying advanced mathematics is useful.
36. I believe studying math helps me with problem solving in other areas.
37. I am comfortable expressing my own ideas on how to look for solutions to a difficult problem in math.
38. I am comfortable answering questions in math class.
39. A strong math background could help me in my professional life.
40. I believe I am good at solving math problems.

APPENDIX D

Student Focus Group Protocol

Student Focus Group Protocol

Pre-Intervention

1. How do you all feel about Math?
2. How do you like to learn Math?
3. Are you currently taught the way you would like to learn Math? If not, what would you like to change?
4. What was your favorite activity from this past unit? Why?
5. What was your least favorite activity from this past unit? Why?
6. What is the most challenging thing about learning Math?
7. What are some things that help you to learn Math?

Post-Intervention

1. How do you all feel about Math? Has anything changed since the last time we talked?
2. Are you currently taught the way you would like to learn Math? If not, what would you like to change?
3. What was your favorite activity from this past unit? Why?
4. What was your least favorite activity from this past unit? Why?
5. What was the most challenging thing about learning this Math unit?
6. Where there some things in this unit that helped you to learn?

Institutional Review Board Project Action Summary

Action Date: October 1, 2015 *Note: Approval expires one year after this date.*

Type: ☐ New Full Review ☐ New Expedited Review ☐ Continuation Review ☒ Exempt Review
 ☐ Modification

Action: ☒ Approved ☐ Approved Pending Modification ☐ Not Approved

Project Number: 2015-0=10-022
Researcher(s): Kai Mathews Doc SOLES
 Lea Hubbard, PhD Fac SOLES
Project Title: The Impact of Universal Design for Learning in a Blended Learning Classroom

Note: We send IRB correspondence regarding student research to the faculty advisor, who bears the ultimate responsibility for the conduct of the research. We request that the faculty advisor share this correspondence with the student researcher.

Modifications Required or Reasons for Non-Approval

None

The next deadline for submitting project proposals to the Provost's Office for full review is N/A. You may submit a project proposal for expedited review at any time.

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